Korea's Green Growth Experience:
Process, Outcomes and Lessons Learned

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Foreword

Many countries look up to the Republic of Korea's (ROK) phenomenal rise when it morphed from a besieged underdog to an economic powerhouse. Left in ruins after years of colonization and war, the government pursued export-oriented industrialization strategies that enabled economic growth at an unprecedented scale and speed. The admiration for the ROK's rags-to-riches economic success stems largely from the fact that it is a nation devoid of natural resources, thus lacking the recourse to adopt resource-based approaches that have proven successful in many well-endowed countries.

However, the limitations of the ROK's manufacturing-driven and export-led growth have become more apparent in recent years. Despite having weathered the global oil shock in the 1970s and the emerging market debt crises in the 1980s, the nation's economy was hit severely by fluctuations in global trade and commodity prices during the 1990s-2000s. Today, the country stands at the crossroads – it has to address the growing perils of natural resource scarcity, climate change, and global economic slowdown.

The rapidly changing global landscape has pushed the ROK to position itself as a leading global force in promoting green growth as a new development paradigm. While various countries have also started to explore the merits of green growth in their policies and programs, the ROK raised the bar higher by embracing green growth as a national vision embedded in its governance system. Its confidence to explore this uncharted path deserves an in-depth analysis and since no exhaustive documentation has been undertaken so far to evaluate the progress of the ROK's green growth policy, this report – Korea's Green Growth Experience – intends to fill this knowledge gap.

The report highlights the processes, outcomes, and key takeaways in advancing green growth planning and implementation in the Korean context. Drawing on the expertise of a broad range of sector specialists and practitioners, the value-added knowledge from this report is expected to serve as the basis for more vigorous, long-term, and country-driven engagement on green growth. Specifically, it could inform policymakers, experts, advisers, scholars, and the broader development community of the emerging evidence for green growth and guide them in transforming the trade-offs into synergies in the form of bankable projects and win-win investments with tangible impacts on the ground. Given the solid global momentum to accelerate green growth, this is the opportune moment to look at the remarkable case of the ROK to cull out some useful lessons and relevant practices for other countries.

Yvo de Boer

Director-General
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Abbreviations and Acronyms

BAU	Business As Usual
CCS	Carbon Capture and Storage
CDM	Clean Development Mechanism
CPI	Creative Productivity Index
CSR	Corporate Social Responsibility
EEDI	Energy Efficiency Design Index
EMS	Emissions Trading Scheme
ESI	Environmental Sustainability Index
EU	European Union
EUA	European Union Allowance
EU-ETS	EU Emissions Trading System
EuPs	Energy Using Products
GBI	Green Building Index
GCF	Green Climate Fund
GDP	Gross Domestic Product
GGC	Green Growth Committee
GGGI	Global Green Growth Institute
GHG	Greenhouse Gases
GIR	Greenhouse Gas Inventory and Research Center
GLCI	Green Life Capacity Index
GR	Good Recycled
GTC	Green Technology Committee
GTC-K	Green Technology Center of Korea
IMO	International Maritime Organization
IPCC	Intergovernmental Panel on Climate Change
KCER	Korea Certified Emission Reduction
KDI	Korea Development Institute
KECO	Korea Environment Corporation
KEEI	Korea Energy Economics Institute
KEI	Korea Environment Institute
KEITI	Korea Environmental Industry and Technology Institute
KEMCO	Korea Energy Management Cooperation
KEPCO	Korea Electric Power Corporation
K-ETS	Korea Emissions Trading Scheme
KIER	Korea Institute of Energy Research
KIET	Korea Institute for Industrial Economics and Trade
KIST	Korea Institute of Science and Technology
KISTEP	Korea Institute of Science and Technology Evaluation and Planning
KOSTAT	Statistics Korea
KVER	Korea Voluntary Emission Reduction Program
LA21	Local Agenda 21
LCEGS	Low-Carbon and Environmental Goods and Services
LEDs	Light-Emitting Diodes
LGGC	Local Green Growth Committees
MAFRA	Ministry of Agriculture, Food and Rural Affairs
GPP	Green Public Procurement
MEST	Ministry of Education, Science and Technology

MKE	Ministry of Knowledge Economy
MoE	Ministry of Environment
MoFA	Ministry of Foreign Affairs
MOSF	Ministry of Strategy and Finance
MOTIE	Ministry of Trade, Industry, and Energy
MRV	Measurement, Report and Verification / Measurable, Reportable and Verifiable
MSIP	Ministry of Science, ICT and Future Planning
NAMA	Nationally Appropriate Mitigation Actions
NIR	National Inventory Report
NIRS	National Inventory Reporting System
NSTC	National Science and Technology Council
ODA	Official Development Assistance
OECD	Organisation for Economic Co-operation and Development
PCGG	Presidential Committee on Green Growth
RFID	Radio-Frequency Identification
ROK	Republic of Korea
SME	Small and Medium-sized Enterprises
STEPI	Science and Technology Policy Institute
TBT	Technical Barriers to Trade
TMS	Target Management Scheme
TOE	Ton of Oil Equivalent
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNFCCC	United Nations Framework Convention on Climate Change
VA	Voluntary Agreement
WTO	World Trade Organization

Executive Summary

Green growth offers opportunities to address the unprecedented development challenges of our age. It strives to provide innovative solutions that integrate economic growth, environmental sustainability, and social inclusiveness. As the global momentum for green growth accelerates, the Republic of Korea (ROK) has boldly pursued this path to address fossil fuel dependency, economic slowdown, and climate change. By minimizing the tradeoffs and maximizing the synergies of greening the economy, the ROK adopted green growth as a national development strategy under the Lee Myung-bak administration.

Being the only country so far that has embraced green growth at a scale and speed never been demonstrated elsewhere, the ROK's green growth experience thus deserves an in-depth analysis. Moreover, the fact that the ROK's development path is relevant to both developed and developing countries, given its rags-to-riches economic success, makes it case worth examining.

ROK's Low-Carbon Green Growth Model

The ROK's green growth model is distinctively characterized by its high degree of bureaucratic centralization and strong top-down leadership that elevated green growth as a national priority. Although energy conservation and environmental sustainability have long been a part of the ROK's development efforts, these issues were at the forefront of Lee Myung-bak administration's national agenda. Its leadership placed green growth as a long-term vision, development paradigm, and a key policy goal carried out not as a slow evolutionary effort but as a swift and politically charged decision that was perceived to even match the economic miracle of the post-Korean War period.

The path called "low carbon green growth" underscores the need to continue growing economically but under a scenario where greenhouse gas emissions are reduced at specific levels to mitigate climate change and also generate new growth engines such as green technology, green industries, and green jobs. Thus, this model advances the premise that emissions reduction need not hamper economic growth and can even unleash new growth nodes. As a matter of fact, the opportunities are immense especially for economies like the ROK with sophisticated levels of technology and industrial innovation.

In the ROK's pursuit of low-carbon green growth, four unique milestones are noteworthy:

(1) building the solid governance framework for green growth by establishing the Presidential Committee on Green Growth (PCGG) in 2009;

(2) strengthening the legal enabling environment for green growth by enacting the Framework Act on Low Carbon Green Growth in 2010;

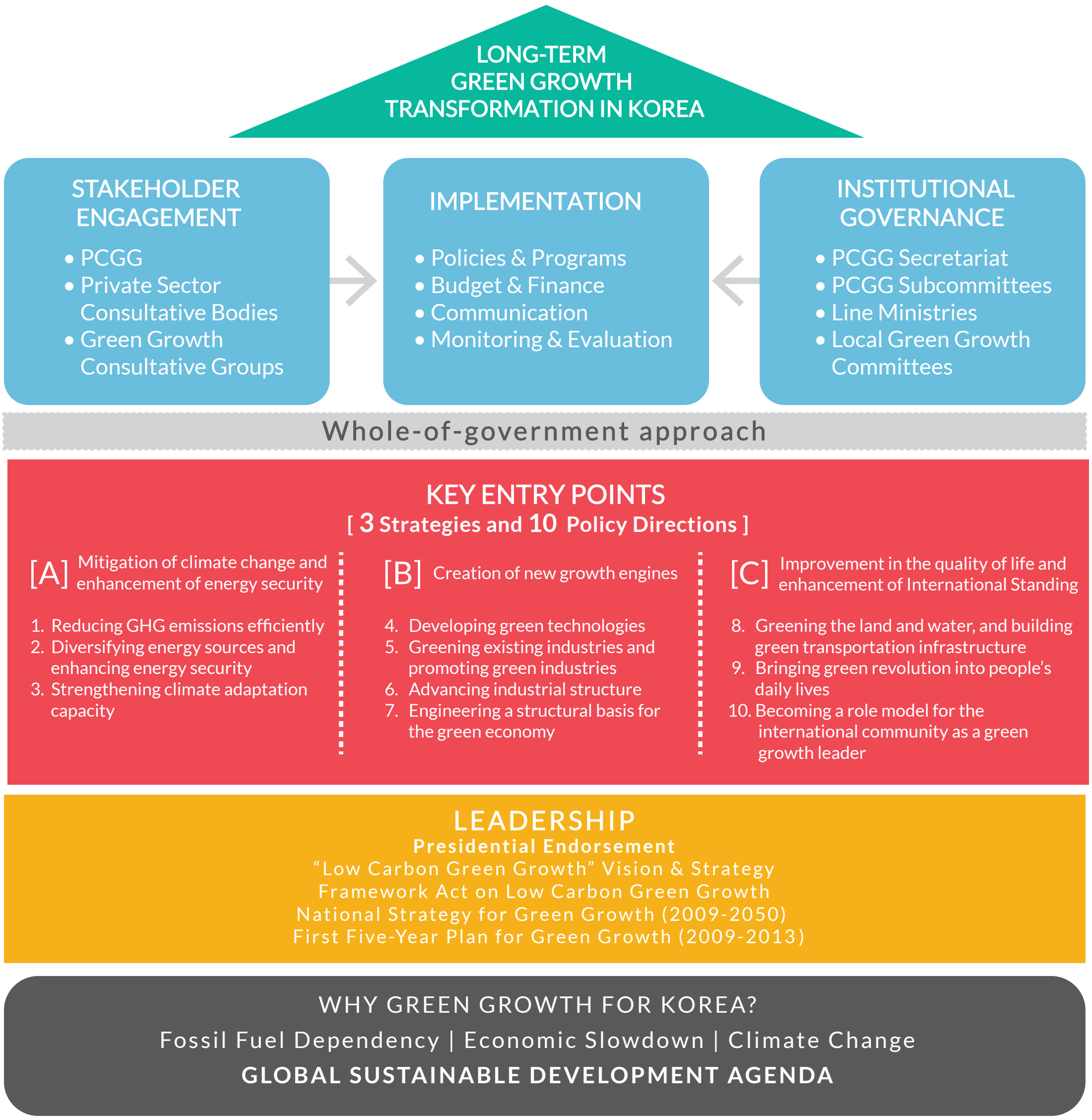
(3) mobilizing various ministries to formulate comprehensive green growth plans at various levels – sectoral, national, and local – including the National Strategy for Green Growth (2009-2050) and the Five-Year Plan (2009-2013); and

(4) honoring Korea's commitment in the global climate change agenda by setting an ambitious GHG reduction target of 30% by 2020, the highest recommended target for a non-Annex 1 country of the Kyoto Protocol.

The confluence of these milestones created a strong enabling environment for green growth in the ROK as it lays out the institutional, legal, and programmatic platform for green growth. The Framework Act on Low Carbon Green Growth has succeeded in institutionalizing green growth as a domestic policy and provided a good template for other countries in formulating a comprehensive and proactive policy that integrates economic, environmental, and social objectives in one framework.

The creation of the PCGG is a major organizational innovation given its independent capacity to mobilize inter-ministerial and multi-stakeholder efforts on green growth planning. Moreover, the ROK's action-oriented and whole-of-government approach to green growth strategy is another good policy practice that could be replicated in other countries. Figure 1 encapsulates the core elements

Figure 1: Strong foundation of the ROK's green growth policy



of the ROK's green growth policy, demonstrating how the convergence of these key factors helped create a strong foundation for green growth.

Progress by Themes

Low Carbon Society

In line with the ambitious target of reducing emissions by 30% from BAU levels by 2020 (the highest target recommended by IPCC), the government has implemented a comprehensive mitigation strategy. It has succeeded in establishing a specialized center for GHG inventory (Greenhouse Gas Inventory and Research Center) and has also involved the public and private sector in a number of emissions reduction programs. These initiatives provided the strong ground for the launch of the Korea Emissions Trading Scheme (K-ETS) in January 2015 despite the strong opposition from the industries over the policy's implications on the ROK's international competitiveness. The K-ETS will reinforce the ROK's climate change mitigation policy by targeting the biggest emitters and thus could yield the most extensive impacts.

Energy Efficiency and Renewable Energy

Through the introduction of the First National Basic Energy Plan as the new overarching national energy masterplan, the ROK's green growth strategy for the energy sector targets both the supply and demand-side of the market. Its interventions of reducing energy demand, improving energy efficiency, and deploying renewable energy do not only seek to address the impacts of oil crisis but also to enhance the ROK's environmental standing and strategically reform the economic structure based on new growth engines. The launch of the Renewable Portfolio Standard (RPS) in 2013 has placed stringent mandate on national power producers to meet targets for a proportion of their energy to come from renewables. Despite these efforts, greening the economy remains an enormous task for the ROK as there are no substantial improvements in energy intensity among its major industries especially the manufacturing sector.

Green Technology and Innovation

By adopting the formula of selection and concentration that has been an effective strategy for the ROK since its early stages of rapid economic growth, it has succeeded in narrowing the technological gap vis-à-vis its global counterparts and this could not have been possible without a significant boost in R&D investments for green innovation, specifically the promotion of convergence among existing and emerging technologies. Among the 27 key green technologies selected as priority areas for investment and commercialization, secondary cells and LED exhibited the best outcomes. Other technology items such as energy storage systems, renewable energy systems, and electric vehicles have made positive progress to become globally competitive while the progress in other technologies will require more time and resources to be globally competitive. The achievements in this area are critical as it will lay out the foundation for the generation of new growth engines.

Green Lifestyle

Greening people's lifestyle requires society-wide behavioral change and the ROK has pursued incremental steps toward this endeavor by implementing a combination of binding and incentivizing policies targeting specific groups and sectors as well as by integrating both top-down and bottom-up approaches to communication. Public awareness and participation across all sectors have improved through the successful launch of the nationwide movement for low-carbon green growth (the Green Start Movement) and the establishment of Local Green Growth Committees with the given roles of preparing and implementing green growth plans at the grassroots level. A wide range of government-led initiatives such as green procurement, carbon labeling, green education, and pay-as-you-throw waste management programs have entered a stage of maturity, serving a bottom-up momentum to pursue green life practices. To observe more proactive efforts from the public to shift to a greener lifestyle, longer term and tailor-made communication strategy is key to address this gap.

Green Homeland and Transportation

To transform the energy-intensive industrial structure of the cities, the Five-Year Plan has focused on three major entry points: urban planning, buildings, and transportation. Multiple pilot projects for greening of city operations and urban regeneration carried out by ministries and local governments have helped limit growth in urban energy consumption. Furthermore, the efficiency of the ROK's public transportation system has improved significantly through the years by increasing its number of passengers and now serves as a good benchmark for other countries such as its quasi-public bus scheme and integrated subway system. Moreover, the adoption of strengthened building codes and increased participation in energy-efficiency building certifications have helped prevent further growth in GHG emissions from the building sector. The ROK's experience in this area underscores the importance of addressing complex urban problems not as stand-alone issues but as a part of the larger integrated system covering a range of physical, economic, social, and behavioral factors.

Green Industries

Aiming to create new growth engines to weather the energy and environmental crisis, the ROK intends to green the existing industries and also create new ones. Its overall plan to pursue the "green transformation" of the industrial sector focuses on green innovation of core industrial sectors, industrial restructuring for low-carbon development, and greening of the value chain. Given the ROK's success in pressuring businesses to incorporate environmental considerations in

Table 1: Some of the ROK's green growth policies and programs covered in this study

	Enabling	Mandating	Incentivizing
Economy-wide	• Establishment of GHG Inventory and Research Center (CH-2) • Government R&D Grants for Development of Green Technologies and Greening of Strategic Industries (CH-4) • Government Grants for Fostering of Green Talents (CH-4)	• Target Management Scheme (TMS; CH-2) • Public Sector TMS (CH-2) • Korea Emissions Trading Scheme (K-ETS; CH-2)	• Korea Voluntary Emission Reduction (KVER; CH-2) • Green Store Certification Program (CH-5) • Voluntary Agreement for Green Procurement (CH-5) • Carbon Labeling System (CH-5) • Carbon Points System (CH-5)
Sector-wide	• Government Loans for Energy Use Rationalization Projects (CH-3) • Government Supported Energy Service Company or ESCO Projects (CH-3) • Government Grants for Voluntary Energy Diagnosis of SMEs (CH-3) • Green Leaders Program (CH-5) • Green Campus Initiative (CH-5) • "Cool-Mapsy" Campaign (CH-5) • Green Policy Loans, Guarantees, Funds and Insurance Programs (CH-6) • Establishment of Green Industrial Clusters (CH-6)	• Renewable Portfolio Standard (RPS; CH-3) • Renewable Fuel Standard (RFS; CH-3) • Mandatory Public Procurement of Energy Efficient Goods (CH-3) • Mandatory Green Public Procurement (CH-5) • Volume-based Waste Fee System (CH-5) • Weight-based Food Waste Fee System (CH-5) • Improvement of Vehicle-Emission and Fuel-Economy Standards (CH-7) • Building Design Criteria for Energy Saving (CH-7)	• Feed-in Tariff Policy for Renewable Energy (FIT; CH-3) • Tax Credits for Investments in Energy-Saving Facilities (CH-3) • Green Certification Schemes for Green Technologies, Products, Projects, and Businesses (CH-6) • Integrated Fare System for Public Transportation in Cities (CH-7) • Old Car Replacement Subsidy Programs (CH-7) • Green Standard for Energy and Environmental Design of Buildings (G-SEED, CH-7) • Building Energy-Efficiency Grade Certification Scheme (CH-7)

business operations, considerable progress has been achieved in greening its major industries such as steel, chemical, automobile, and electronics, which consume much energy and emit large amounts of GHG. To advance structural reform, the government has selected 17 industries with the highest potential to create new markets and bring positive spillover effects. Greening the value chain, on the other hand, entails fostering of green SMEs, promotion of resource circulation in the industrial processes, and the establishment of green industrial complexes incubating high-tech industries and innovative public-private partnerships.

Way Forward

In testing the merits of green growth as a development paradigm, the ROK's greatest contribution lies in its boldness and optimism to pursue green growth at a national scale with concrete targets and action plans. Its efforts are not futile given its achievements to date but its green growth model is not without limitations. Its degree of "greenness" remains debatable due to its alleged preference for market-driven growth that prioritizes the economy over the environment and social equity. The progress to date has been criticized for its vague substance and weak results due to the lack of appropriate metrics and indicators. Due to its highly top-down approach, bottom-up communication has not been sufficient, thus failing to induce active stakeholder participation.

Green growth as a policy approach remains embedded in the ROK's development strategy with the release of the Second Five-Year Plan for Green Growth (2014-2018). While the First Five-Year Plan has succeeded in establishing the institutional foundation for green growth, the Second Five-Year Plan is expected to focus on achieving substantial outcomes specifically on establishing a low-carbon socioeconomic infrastructure, achieving a creative economy through the convergence of green technology and ICT, and building a climate-resilient environment. As the ROK strives to pursue green growth beyond its borders, it has to achieve results at home and in this regard, demonstrating the tangible benefits of green growth on the ground remains a critical test.

Korea's Green Growth Experience: Process, Outcomes and Lessons Learned

Chapter 1: Introduction

CHAPTER 1

INTRODUCTION

Summary

The ROK pursued green growth in a holistic manner by forming a central governing body dedicated to green growth, mobilizing various line ministries, and involving stakeholders from different sectors of society to carry out the initiatives under a three-pronged strategy with ten policy directions. Driven by strong top-down leadership that envisages the enormous potential of green growth to create a new wave of economic dynamism without compromising environmental sustainability, the ROK provided sufficient mandate to the Presidential Committee on Green Growth (PCGG) to undertake nationwide green growth planning and implementation. The PCGG then formulated comprehensive green growth plans – both medium- and long-term – that integrated economic, environmental, and social objectives into one framework. Furthermore, the ROK's declaration of GHG reduction of 30 % by 2020 is the highest recommended target for a non-Annex-1 country of the Kyoto Protocol. Its enactment of the landmark legislation called the Framework Act on Low Carbon Green Growth is the only comprehensive blueprint so far for green growth policymaking at the national level. These milestones converged to forge the institutional, legal, and programmatic platform for green growth, thereby building up its solid foundation in the ROK.

1. Introduction

1.1 Overview

As an emerging policy with the ambitious goal of addressing the long-standing stalemate between economic growth and environmental sustainability, green growth has come a long way from a mere buzzword to a new development paradigm. As it revives the sustainable development agenda with a more aggressive approach to address climate change, resource-use inefficiencies, and the global economic slowdown, the growing momentum for green growth has been noteworthy as proven by a myriad of related efforts worldwide.

In the global effort toward green growth, no country has blazed this new trail with such unparalleled passion as the Republic of Korea (ROK or Korea hereafter). The country perceives green growth as an opportunity to achieve greater levels of prosperity by changing the ways in which it pursued development in the past because the business-as-usual ways have proven to be unsustainable. The ROK's green growth experience – uniquely characterized by its swift and sustained action of transforming the tradeoffs into synergies between "growing" and "greening" – deserves paramount attention from both developing and developed nations for the following reasons:

- The ROK's green growth policy is one of the most celebrated cases as it is the only country by far that adopted green growth as a new development strategy on an unprecedented scale, speed, and level of comprehensiveness. In short, there is an earnest motivation to pursue green growth in a systematic and grand manner.

- The ROK's green growth experience offers valuable lessons for countries that seek to enshrine green growth as a national policy. As the nation was once a developing country that successfully achieved a developed status in the shortest time, its development lessons could be relevant for both developing and developed countries.

- The ROK's transition to a new administration under the leadership of President Park Geun-Hye in 2013 is a good opportunity to examine the past outcomes of green growth initiatives and its continuity amid the power transition.

Since green growth is being sought as a solution that is yet to be proven, the next big step is to show how it really works. How does the ROK pursue its green growth policies and what are the outcomes, challenges, and key takeaways to date? While it is still premature to provide a comprehensive evaluation of the ROK's green growth experience, this report intends to provide an objective documentation of what has been achieved hitherto as a way to enrich the existing literature and strengthen the empirical evidences on the feasibility and transformational nature of green growth. Since there is no one-size-fits-all green growth solution, the initiatives discussed herein are not necessarily intended to be adopted by other countries but the lessons and good practices will hopefully be useful for governments in drafting their own green growth policies and programs.

Rise of Green Growth as a New Paradigm of Development

The rise of green growth as a development policy has been swift since the time when the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) brought green growth to the discussion table at the Fifth Ministerial Conference on Environment and Development in Asia and the Pacific in 2005, putting forward an official declaration that adopts green growth as a strategy toward sustainable development. What explains the shift from being a sheer attractive slogan (Schmalensee, 2012) to a policy approach that even defies traditional growth models?

Despite the traditionally perceived antithetical correlation of "green" and "growth," two major factors were identified to have triggered the strong endorsement of green growth in the international community:

(1) the global economic slowdown; and

(2) the shortcoming of sustainable development to live up to society's expectations. (Park, 2013):

- Global financial crisis. The prolonged global economic stagnation proved that the existing development strategies are no longer responsive to the evolving socioeconomic landscape. The World Bank (2012) even stressed that "our current growth patterns are not just unsustainable; they are also deeply inefficient," thereby recommending countries to veer away from the grow-dirty-and-clean-up-later strategy. The Stern Review (2010) warned that "high-carbon growth would kill itself" due to high carbon prices and hostile physical environments. As such, the challenging times pushed many governments to look for new sources of opportunities and green growth is heralded as a win-win solution with its assurance that environmental sustainability does not need to be compromised in favor of economic growth.

- Shortcomings of sustainable development. The grand promise of sustainable development to effectively juggle its three equally important pillars – economic, environmental, and social – remains elusive. The global economic situation might have improved significantly in the past two decades but it took place at a huge environmental cost and worsened the great divide between the haves and the have-nots. Sustainable development needs to be further tested with time, but to this date, it failed to satisfactorily deliver what it had promised. As a policy option, green growth is expected to offer a better deal by reconciling the conflicting goals and harmonizing the imperatives of economic growth and environmental sustainability.

- Thus, green growth is considered as the international community's best hope for the 25-year stalemate over the integration of the economic and environmental pillars of sustainable development (Samans, 2013).

The merits of green growth become even more salient when juxtaposed with "brown growth" (see Table 1). The stark difference is that brown growth – one that promotes the "grow first, clean up later" strategy – is too GDP-centric while green growth – which urges countries to "grow and clean up at the same time" – is more quality-oriented, as it attempts to tackle the deeply entrenched friction between the economic, environmental, and social dimensions. The economic success of today's industrialized countries could be fairly attributed to brown growth but today's developing economies cannot simply continue to follow suit to catch up with the rich countries. As aptly put by The Economist (2012): "Rich countries prospered without worrying much about the environment. Poor and middle-income countries do not have that luxury."

Being a relatively new subject in academic and policy discourse, it is no wonder why green growth is vaguely defined, especially in reference to sustainable development. Despite the growing literature, a universally accepted definition is still lacking (Jacobs, 2013) and much ambiguity surrounds this concept, specifically about its actual niche in the overall sustainability agenda. It is conceived as a sister concept of the low-carbon economy, a policy agenda, a means toward sustainability, a subset of sustainable development, and to a greater extent, a new development paradigm that is transformational in nature and a viable alternative to old growth models.

Several international organizations such as the Global Green Growth Institute, World Bank, Organisation for Economic Co-operation and Development, Asian Development Bank, and the United Nations have provided a working definition of green growth and the common denominator is not just the emphasis on the link between the economy and environment but also on social inclusiveness. If green growth also touches upon these three interlocking components (economic, environmental, and social), then how can it be differentiated from sustainable development?

The OECD (2011) emphasized the coherent relationship between the two, highlighting the fact that green growth is a subset of – instead of an alternative to – sustainable development. Green growth fits well into the conceptual framework of sustainable development but its narrower scope or focus on the environment-economy nexus (Statistics Netherlands, 2013) – thereby providing more details on environmental and resource productivity – makes green growth easier to operationalize, hence paving the way for measurable progress. Likewise, green growth represents a "reinforced emphasis" on sustainable development because of its cross-sectoral approach to development strengthened by enhanced upstream planning and diagnostics (AfDB, 2013).

Amid the absence of a universally accepted operational definition, it is worth noting nevertheless that the differences in the meaning of green growth mainly stem from the areas of emphasis (Scott et al., 2013). However, the various definitions are based on similar foundational goals that revolve around resource efficiency, environmental protection, economic growth, climate resilience, and social inclusiveness. Thus, although different stakeholders might not agree on a standard definition of green growth, there has been a broad consensus in the academic and policy sphere as to what green growth entails (Bowen, 2012), and this is expected to

Table 1: Comparison between brown growth and green growth

Brown Growth	Green Growth
Quantitative (GDP-focused/economy-centric)	Qualitative (holistic - economy, environment, society)
Resource-intensive (more input = more output)	Resource-efficient (less input = more output)
Production factor-intensive (labor, capital, natural asset)	Innovation-based technology, (value-added knowledge)
Energy dependency (fossil fuel-driven)	Energy self-sufficiency (renewables)
Climate-vulnerable (high risk, low adaptive capacity)	Climate-resilient (high risk, high adaptive capacity)
Unsustainable growth	Sustainable development

improve further given the ongoing experimentation worldwide that seeks to amass sufficient evidence to demonstrate that green growth actually works.

1.2 Low-Carbon Green Growth: The Korean Way

The ROK's rags-to-riches economic success is considered as one of the greatest development miracles of our era. After the Korean War, the country was almost as poor as Sudan with per capita income of a measly US$86, but it pulled off an exponential rise, growing by 750 times in absolute terms and by 300 times in per capita income (Lee, 2008). By joining the official club of foreign aid donors (Development Assistance Committee of OECD) in 2010, the ROK is the first and only country so far to transform itself from an aid recipient to an aid donor, and this was achieved within only half a century.

The growth was indeed swift but as a consequence, the nation has been locked into a quintessential growth trajectory that is highly dependent on imported fossil fuels given its lack of natural energy resources. Thus, its greenhouse gas emissions almost doubled from 1990 to 2005 (largely from its huge manufacturing sector), which is the highest among OECD countries (Jones and Yoo, 2011). The pace of economic activities has reached a level where it begins to threaten future growth prospects and social welfare. After decades of steady growth, the ROK is confronted with three major challenges or the so-called "triple crunch" – economic slowdown, climate change, and energy-import dependency. Particularly, it has to break away from lackluster growth by exploring new growth engines. It also has to address its heavy dependence on imported fossil fuel that costs approximately US$100 billion annually (even rising to US$140 billion during the oil price shock in 2008), an amount greater than its income from some its major export items. Moreover, the nation has not been spared from the harmful impacts of climate change given its temperature and sea-level rises that are both higher than the world average (GGGI, 2011).

In view of these challenges, President Lee Myung-Bak presented the concept of "low-carbon green growth" as the nation's new development paradigm in a speech he delivered in August 2008 marking the 60th founding anniversary of the ROK. Recognizing that the nation has only come halfway in graduating into the league of high-income countries, he boldly proposed that an active pursuit of the new paradigm would provide new engines of economic growth and jobs needed in continuing the nation's developmental success. "Low-carbon" highlights how the ROK envisioned transforming the nation's carbon-intensive economy into a low-carbon economy to be at the heart of realizing green growth. Indeed, "low-carbon" has been a dominant figure of the ROK's green growth goals, strategies, and action plans.

The ROK's Green Growth Milestones

Amid the looming uncertainties, green growth has gained significant resonance in the ROK as the country recognizes the need to shift toward a more sustainable growth path. Its green growth policy has been driven by a high degree of bureaucratic centralization and strong top-down leadership that links long-term development objectives with the greening of its economic activities. Korea's green growth trajectory is unlike the experience of most developed countries, which followed an evolutionary process. Korea's exceptional case of elevating green growth as a national vision stemmed from proactive leadership that set ambitious targets for a given period (Lee and Ahn, 2015).

It also embodies the spirit of "race to the swift" that has defined the nation's approach to rapid industrialization since the 1960s (Kim and Thurbon, 2015). In the ROK's journey toward low-carbon green growth, four milestones stand out. Although similar initiatives have taken place in the past (for example, the establishment of the Presidential Commission on Sustainable Development in 2000 under the Kim Dae-Jung administration), the unique convergence of the celebrated milestones described below are strong enough for meaningful policies to be actually implemented.

1. **Establishment of an executing organization for green growth:** Prior to the introduction of green growth as a national vision, there was no powerful apparatus for green growth from an institutional perspective.

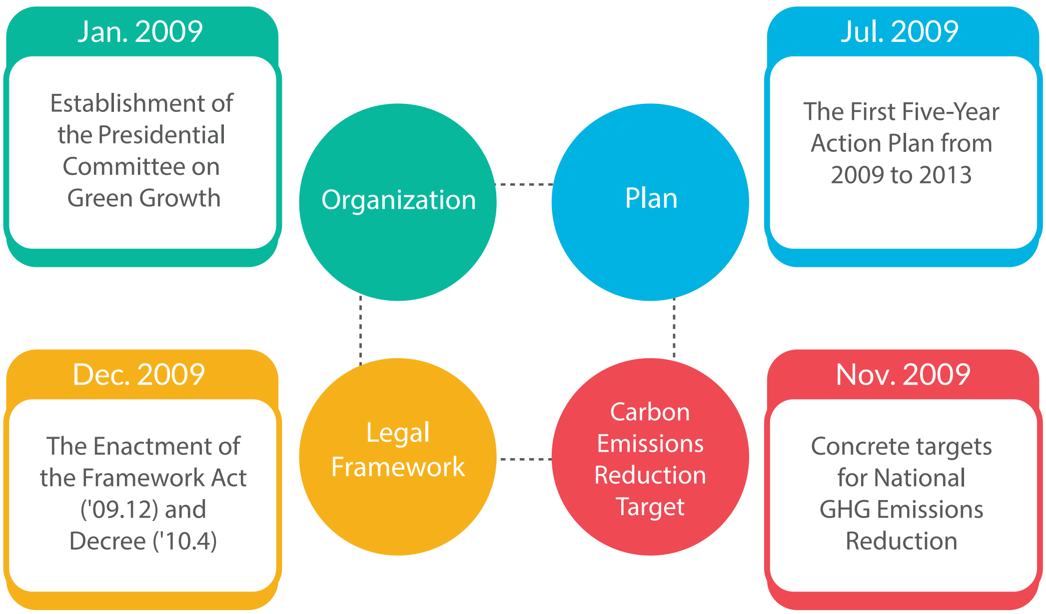
Thus, the Presidential Committee on Green Growth (PCGG1) was formed in 2009 as an inter-ministerial body that develops, implements, and coordinates the green growth efforts of various ministries and agencies.

2. **Formulation of national comprehensive plans on green growth:** The two major plans – the National Strategy for Green Growth (2009-2050) and the Five-Year Plan (2009-2013) – ensure that green growth activities are pursued in a systematic and organized manner with budget support. The long-term plan aims to achieve three main objectives elaborated by ten policy directions based on a consensus among the stakeholders from the public, private, and civil society sectors. The medium-term plan, on the other hand, includes hundreds of projects with a total budget of approximately US$100 billion. The volume of this plan constitutes 2% of its GDP, which is twice higher than the UN recommendation for green investments (UNEP, 2009) and also comparable with the annual military budget for services of most governments.

3. **Declaration of national GHG emission-reduction targets:** In November 2009, the government declared its ambitious reduction target – to reduce emissions by 30% below a business-as-usual level by 2020. This is the highest recommended target for a non-Annex 1 country under the Kyoto Protocol. The realization of this target is critical as it provides a solid direction for the ROK to truly build a low-carbon society. This commitment is being honored by the passage of legislation on a national GHG emissions trading scheme, a target management scheme, the creation of the national GHG inventory report system, and other relevant reforms.

4. **Enactment of the Framework Act on Low Carbon Green Growth.** This landmark legislation was passed to support the declaration of low-carbon green growth in 2008 as a new development strategy. Providing the legal framework for pursuing low-carbon green growth as a national agenda, the key aspect of the law is the institutionalization of green growth at the national level, which provides a good governance structure and coordination mechanism for the involved

Figure 1: Milestones of the ROK's green growth policy



1 | The PCGG used to be under the Office of the President during the Lee administration and during the succeeding administration, President Park continued embracing green growth through the establishment of the Prime Ministerial Green Growth Committee (GGC) in October 2013 to continue the mandate of the PCGG under the Office of the Prime Minister and in compliance with the Framework Act on Low Carbon Green Growth (which requires the creation of a new committee after the term of the PCGG ended in February 2013). GGC also maintains its status of sitting upon the apex of a vast network of government agencies involved in green growth planning and implementation. According to Seung-Hoon Lee (former head of the GGC), the main difference between the PCGG and the GGC is that the former PCGG focused on "platform building" while the GGC pays attention on implementing and extending the current work programs (Kim and Thurbon, 2015).

government agencies. It also supersedes other related laws such as the Energy Framework Act, Climate Change Act, Sustainable Development Act, Framework Act on Urban Development, and others.

1.3 Institutional Framework for Low-Carbon Green Growth

The Presidential Committee on Green Growth (PCGG)

As a policymaking body, the PCGG provides the overall direction of green growth activities at the national level by monitoring the implementation of the National Strategy for Green Growth and the Five-Year Plan. The PCGG was the outcome of the merger of three bodies: the Presidential Committee for Sustainable Development, the Presidential Energy Committee, and the Special Task Force for Climate Change (Kim and Thurbon, 2015). Based on the Framework Act on Low Carbon Green Growth, the PCGG is mandated to perform the following roles:

(1) deliberate on the government's major policies and plans related to green growth and matters concerning the performance of such policies and plans;

(2) coordinate with appropriate central administrative agencies and local governments;

(3) discuss various subjects relevant to pursuing green growth; and

(4) participate in the global green growth dialogue and international negotiations.

Under the co-chairman system, the Prime Minister represents *ex officio* members, who are ministers from relevant government bodies and heads of national research institutes.

On the other hand, the chairman from the private sector could come from one of the "commissioned members," who are experts from research institutes, universities, and nongovernmental organizations. From 2013 onwards, there are four subcommittees under the PCGG:

(1) Green Growth Strategy
(2) Climate Change Countermeasure
(3) Energy
(4) Green Technology and Industry

The subcommittees of the PCGG have been reorganized over time, starting with three subcommittees in the first phase (2009) and reorganized into four subcommittees in the second phase (2010) and third phase (2011). The Secretariat was also established to undertake administrative duties and support the work of the PCGG.

The Secretariat is composed of three teams:

(1) Policy Planning and Coordination
(2) Climate Change Policy
(3) Green Technology and Industry

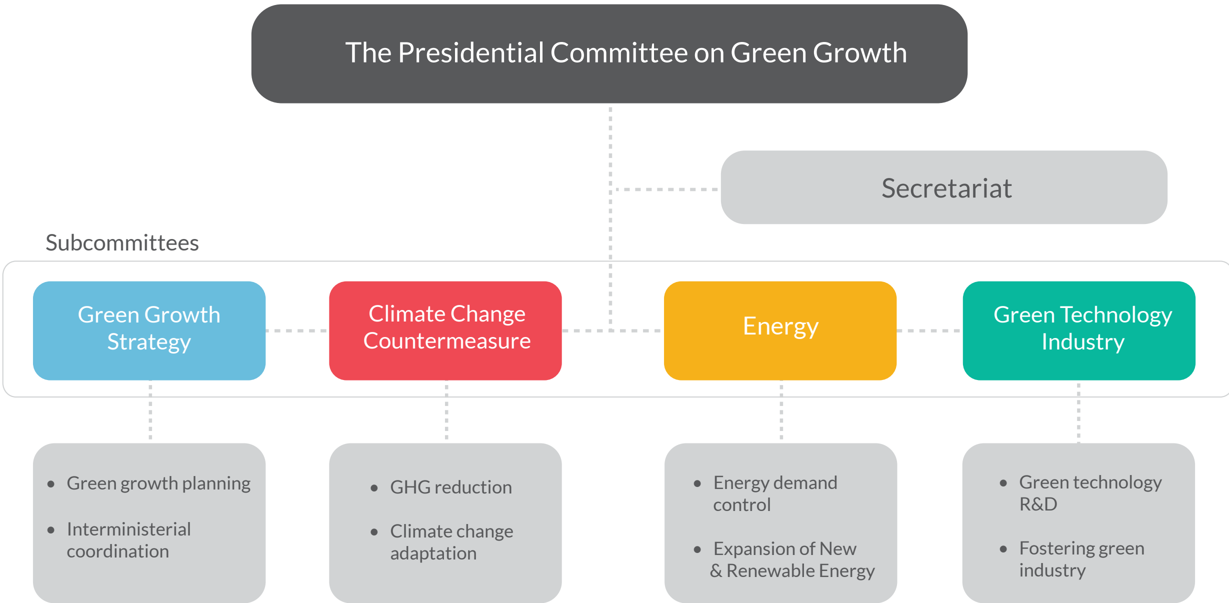
Each team is composed of experts from various relevant public institutions, research institutes, and businesses.

Since its foundation in January 2009 up to October 2012, the PCGG has conducted a total of 21 regular meetings and 11 policy implementation review meetings. During the regular meetings, all relevant ministries responsible for the ten policy directions reported on each agenda's strategy and action plan to the PCGG.

The implementation review meetings, on the other hand, focused on the results of policy enforcement along with countermeasures for the identified gaps in order to constantly monitor performance. In the process of promoting green growth, it is worth noting that PCGG's role is not limited to policy implementation and supervision but also includes preliminary gathering of feedback through the conduct of implementation review meetings. This is in contrast to the nation's unilateral, top-down approach to policymaking in the past. This approach has also enabled the PCGG to strengthen public-private partnership through multi-stakeholder engagement.

While PCGG is considered as one of the most significant institutional innovations on green growth, given its independent capacity to mobilize inter-ministerial and multi-stakeholder efforts on green growth planning, its major limitation is the lack of authority over the national budget since the budgeting process falls under the jurisdiction of the Ministry of Strategy and Finance.

Figure 2: Organizational structure of the PCGG



Source: PCGG, 2014

As such, while the PCGG can exercise sufficient authority on drafting medium- and long-term green growth plans, its capability to be completely in control of implementation is limited, especially in terms of advancing radical proposals. This was evident when PCGG's proposal to phase out subsidies on electricity was opposed by several ministries that might be severely affected (Kim and Thurbon, 2015).

Institutional Collaboration and Stakeholder Consultation

To ensure nationwide enforcement of green growth, local governments are encouraged to organize the Local Green Growth Committees (LGGCs), which have a similar organizational structure to the PCGG. The establishment of LGGCs in various cities and provinces facilitates the review of green growth policies and plans at the local level, thereby promoting a strong sense of local ownership and autonomy (Kim, 2013). It also complemented the top-down approach to green growth planning and implementation.

Given the critical role of the private sector in ensuring the success of green growth initiatives, the government included not only public officials but also private sector representatives as organizing members of the PCGG. Moreover, five public-private consultative groups called Green Growth Consultative Groups were launched: Industry, Finance, Science and Technology, Green Lifestyle, and Green IT. These groups are composed of members from local governments, research institutes, industry, finance, civil society organizations, and general citizens (Kim, 2013). The PCGG receives useful feedback from this group to make green growth policies more feasible and practical to implement. To maximize the role of the consultative groups as an effective communication channel, each group holds quarterly meetings on the main agenda that will be discussed in the regular meetings of PCGG. If needed, the groups can co-host conferences with PCGG where members can interact with each other to share experiences and ideas. Conference materials and publications are also delivered through e-mail as frequently as possible to facilitate information sharing and stakeholder networking.

Aside from PCGG, relevant ministries also play crucial roles in advancing the ROK's low-carbon green growth policy. For instance, the Ministry of Environment leads the implementation of the target management scheme (TMS) and the emissions trading scheme (ETS). The Ministry of Knowledge and Economy, on the other hand, leads in the areas related to energy efficiency, new and renewable energy, smart grid, and green technology such as public institutions under these ministries, specifically the Korea Environmental Industry and Technology Institute (KEITI), Korea Environment Corporation, Korea Energy Management Corporation (KEMCO), Green Business Association, and the Korea Technology Finance Corporation also serve as a bridge between the central and local governments, and work with PCGG and the Green Growth Consultative Groups to ensure the successful enforcement of green growth policies.

In terms of governance structure in implementing the green growth programs and projects, the implementing bodies are classified into two: central administrative body and local administrative body. The former is composed of PCGG, relevant ministries, and public institutions, which assume the role of a control tower by supervising the implementation of policies and managing the Green Growth Consultative Groups. On the other hand, the local administrative body – referring to the LGGCs and Green Growth Consultative Groups – is in charge of promoting green growth at the local community level and gathering feedback from businesses and local residents.

1.4 Implementation Plans for Green Growth

National Vision, Strategies, and Policy Directions

The ROK's comprehensive approach to green growth policy is reflected in its long-term and medium-term plans, which are anchored in low-carbon green growth as a national vision with three strategies and ten policy directions.

The three major strategies are:

(1) mitigation of climate change and enhancement of energy security
(2) creation of new growth engines; and
(3) improvement in the quality of life and enhancement of the ROK's international standing.

These strategies are further elaborated by ten policy directions and each policy direction is composed of several programs and projects on green growth.

The green growth plans of the ROK can be largely categorized into comprehensive plans and sectoral plans. Comprehensive plans are those that cross-cut

Figure 3: The ROK's green growth strategy and policy directions

Source: Office for Government Policy Coordination, 2010 tasks of central and local governments, as well as ministries. The National Strategy for Green Growth and the Five-Year Plan are the overarching plans, which provide directions for other central- and regional-level comprehensive plans formulated for green growth.

The ministries are mandated to include mainstream green growth in their relevant plans (i.e., sectoral plans), which are categorized into key plans, related plans, and associated plans, respectively.

- Key plans refer to those that are considered to have uppermost relevance to the national green growth strategy, such as the National Energy Basic Plan, Comprehensive Basic Plan to Respond to Climate Change, and Basic Plan for Sustainable Development. These plans usually have long planning horizons (20 years) and are to be deliberated by the PCGG before approval by the Cabinet.

- Relevant plans, on the other hand, are plans that are formulated under the nation's legislative framework and have indirect relevance to the nation's green growth agenda; they include the Comprehensive National Territorial Plan and the National Science and Technology Basic Plan.

- Associated plans are administrative plans formulated under ministerial initiatives, such as the New and Renewable Energy Development Plan under the Ministry of Knowledge Economy (currently the Ministry of Trade, Industry, and Energy, MOTIE).

Medium- and Long-Term Green Growth Plans

Some of the salient features of the National Strategy for Green Growth are the setting of basic policy directions for green growth, putting in place specific measures to meet the objectives, and designating the appropriate institutions. It also envisages green growth as a close collaboration between the public and the private sectors as well as the civil society. The timeline set under the ROK's green growth plan, especially the long-term plan that spans more than four decades, is also critical to ensure the continuity of green growth. The long-term period of the nation's green growth strategy confers a great sense of responsibility and accountability on any political leader in power to honor the commitments within the timeline. The ROK has set a long-term vision of being one of the world's seven "green" economic powers by 2020 and this was well-articulated in the international community in the hope that green growth would also be the main agenda of the

Figure 4: Framework of implementation plans for green growth

Source: Kim and Choi, 2013

succeeding governments (PCGG 2009c; see also PCGG, 2009d).

The Five-Year Plan, on the other hand, supported the implementation of the National Strategy for Green Growth through its investments, projects, and policy reforms in the areas of climate change, energy, transportation, and green technologies. While the plan emphasized the creation of new industries that are environmentally friendly, it also focused on the overall greening of existing industries. Thus, it highlighted the reduction of GHG emissions especially in the manufacturing sector while boosting productivity at the same time. It is worth noting that both plans were created through the active collaboration of the PCGG, the Prime Minister's office, relevant ministries and institutions, universities, and technical experts.

In order to avoid overlapping with other plans and strategies, the plan was reevaluated and adjusted to become the national plan that is both comprehensive and concise (PCGG, 2009b). As such, the announcement of the Five-Year Plan was backed up by follow-up policies of relevant ministries and local governments. The continuity of the plan in the succeeding years was also guaranteed by the Park Geun-Hye administration as it prepared the Second Five-Year Plan for the 2014-2018 period.

Budget Allocation for the Five-Year Plan for Green Growth

Prior to the announcement of the Five-Year Plan for Green Growth, the government launched the Green New Deal, which aimed to create green jobs and investments to overcome the global economic crisis. Aiming to generate 960,000 green jobs by investing 50 trillion KRW (roughly US$ 43 billion) over four years, the government, in collaboration with businesses, invested boldly in green technologies such as new and renewable energy, electric cars, rechargeable batteries, and light-emitting diodes (LEDs).

The Green New Deal was eventually integrated into the Five-Year Plan. During the initial establishment of the plan, the government estimated that a total of 107.4 trillion KRW (approximately US$ 100 billion) would be spent to support green growth from 2009 to 2013. In 2009, the first year of the project, approximately 17.5 trillion KRW was spent, and it was noted that an average annual increase of 10.2% in investment was required to meet the necessary budget. Such amount was equivalent to 2% of the ROK's annual GDP and was reflected in the National Fiscal Management Plan (2009-2013). This seemingly astounding amount, however, did include budget allocated to highly related areas such as economic, energy, industry, and environmental policies. Indeed, delineating budgets that are entirely specific to green growth is impractical, given how related actions span over a variety of economic, environmental, and social issues. The impact of the National Fiscal Management Plan (2009-2013) deserves recognition as it marked the period where green growth policies were prioritized in annual fiscal plans and where ample support was provided to push forward the nation's low-carbon green growth agenda.

Legal Framework for Green Growth

To establish a solid legal foundation for the ROK's green growth initiatives, the government submitted a draft bill – Framework Act on Low Carbon Green Growth – to the National Assembly in February 2009. Both the ruling and opposition parties unanimously passed the bill after forming the Special Committee on Climate Change and conducting in-depth discussions in public hearings. In January 2010, President Lee Myung-bak signed and promulgated this landmark legislation with the attendance of interested parties from relevant ministries, industries, and the general public. This Act, which includes seven chapters and 64 articles, is a fundamental law stipulating major policy directions on building a low-carbon green growth strategy as well as the necessary institutional framework and policy enforcement methods (Office for Government Policy Coordination, 2010).

The enactment of the law had three major objectives:

(1) to implement measures to effectively address climate change and energy issues and promote sustainable development;
(2) to build the implementation system for green growth, such as the establishment of the PCGG; and
(3) to devise a variety of institutional systems to promote low-carbon green growth in the region (Office for Government Policy Coordination, 2010).

The general provisions of the Act cover the basic purpose and definitions of terms, basic principles of low-carbon green growth, and responsibilities of different stakeholders. It also stipulates the implementation plans for green growth at the national and local government levels, and guidelines on the composition, operation, and functions of relevant authorities such as PCGG. It also includes provisions on the green economy and green industry, development and commercialization of green technology, and the creation of green jobs (Office for Government Policy Coordination, 2010). It should be noted that the Act is supported by an enforcement decree promulgated in April 2010, which provides detailed guidelines necessary for implementation of the Act. The enforcement decree serves as the last piece for the establishment of the nation's legal basis for pursuing green growth actions.

The Framework Act on Low Carbon Green Growth takes precedence over many of the (existing) related laws, such as the Sustainable Development Act, and the Energy Use Rationalization Act, which illustrates how the government was fully committed to make sure that the new paradigm of growth is legally enforceable. Of course, there are other relevant legislations that have been enacted to support the government's program-level actions for green growth. For example, the Act on the Allocation and Trading of GHG Emission Permits (2012), and its Enforcement Decree (2014) were enacted prior to the launch of the Emissions Trading Scheme in 2015. Some others include the Sustainable Transportation Logistics Development Act (2009), the Smart Grid Construction and Utilization Promotion Act (2011), the Green Building Development Support Act (2012), and the Act on Promotion of Purchase of Green Products (2013).

1.5 Scope and Method of Analysis

This report is intended to initiate an objective approach to sharing the ROK's green growth experience, given the country's outstanding ambition to actualize green growth on an unprecedented scale and at a speed never seen elsewhere.

In this light, this report seeks to achieve the following four-fold objectives:

(1) to describe the background (the "why") and steps taken for the setting of targets, strategies, and action plans under the National Five-Year Plan for Green Growth;

(2) to provide details (the "who and how") on some of the follow-up actions taken at the program or project levels;

(3) to conduct an objective assessment (both quantitative and qualitative) of the outcomes to date; and

(4) to provide key recommendations and major takeaways for other countries.

The structure of each chapter follows a uniform outline, covering key topics such as baseline analysis of relevant problems, challenges, and opportunities. It then explores the setting of targets, strategies, as well as implementation of policy actions, which are selected based on the level of relevance,

Table 2: Investment Plan for Green Growth (2009-2013)

Unit: KRW trillion (white row) and US$ billion (gray row)

Components	Total	2009	2010	2011	2012	2013
Mitigation of climate change and enhancement of energy security	**57.5**	8.5	15.5	16	9.8	7.7
	(51.9)	(7.7)	(14.0)	(14.4)	(8.8)	(6.9)
Creation of New Growth Engines	**29.0**	4.8	5.2	5.8	6.4	6.8
	(26.2)	(4.3)	(4.7)	(5.2)	(5.8)	(6.1)
Improvement in the Quality of Life and Enhancement of the ROK's International Standing	**27.2**	5.2	4.8	5.2	5.7	6.3
	(24.5)	(4.7)	(4.3)	(4.7)	(5.1)	(5.7)

* Note: Exchange Rate (US$ 1 = 1,108.5 KRW) of November 3, 2011

Source: GGGI, 2011

resource allocation, and degree of impact. Based on this documentation, quantitative and qualitative assessments of the outcomes to date are presented; the quantitative evaluation is based on the analysis of available secondary statistics from various sources, the results of which complement the merits of the qualitative evaluation. Finally, each chapter concludes with a set of recommendations and key takeaways that could be useful for other governments in identifying the entry points and benchmark cases for their own green growth policies. While the timeframe of the assessment follows the implementation period (2009-2013) of the Five-Year Plan, it is worth noting that some of the discussed initiatives have been implemented beforehand since the ROK has been successfully carrying out programs and projects in the past that are directly in line with the concept of green growth.

The target audience of this report includes government officials at different levels who have the authority to carry out green growth planning and implementation in their respective countries. This group refers to not just the politicians but also the whole range of people in the civil service such as the technical bureaucrats, planners, legislators, local leaders, and decision makers. The analysis also caters to researchers and technical experts who are interested in delving deeper into the latest developments of the ROK's green growth initiatives. Other important stakeholders in the policymaking process such as the private sector, nongovernmental organizations, and the civil society groups whose organizational values are aligned with the principal tenets of green growth could also benefit in many ways from the findings of this study. This report is very timely given the increasing demand especially from developing countries to learn about the ROK's green growth experience. It also comes at a very opportune time with the release of the new National Five-Year Plan for Green Growth (2014-2018) in 2014, which marked the ROK government's renewed enthusiasm for continuing to promote low-carbon green growth in the coming years.

The report is structured in chapters that correspond to the areas prioritized in the Five-Year Plan except for four areas of the ten agenda items, namely:

(a) increasing the climate change adaptation capacity;
(b) enhancing the industrial structure;
(c) laying the foundation for a green economy; and
(d) becoming a role model for the international community as a green growth leader.

While the report tries to be as comprehensive as possible, the exclusion of these areas is done deliberately due to specific reasons. The agenda item pertaining to climate change adaptation largely involves the Four Major Rivers Restoration Project, which has been mired in controversy over its alleged detrimental impact on the natural ecosystem, as well as other pertinent issues.

Another hotly debated issue is the ROK's nuclear energy program, which forms part of the nation's green growth policy despite the big question of whether or not nuclear energy can be considered a "green" alternative to fossil fuels. This report intends to exercise objectivity in its analysis as much as possible, and since evaluating the progress and outcomes of the programs that are linked to controversies would inevitably entail value judgments, thereby jeopardizing neutrality, the areas related to the four-river restoration project as well as nuclear energy have been omitted.

Moreover, as the target audience of this report is the developing countries, it is best to limit the scope of the study to the most relevant areas. In the context of Korea's 10 policy directions, three areas (enhancing the industrial structure, laying the foundation for a green economy, and becoming a role model for the international community as a green growth leader) are deemed less relevant for developing countries given the differences in the industrial base and development assistance landscape between Korea and the developing countries.

It should also be noted that the report is a compilation of essays written by different authors both within and outside GGGI, with expertise in different green growth-related areas such as energy, transport, waste management, green technology, emissions reduction, green industries, green lifestyle, and other related fields. Regular discussions were conducted with and among the writers to gain a common understanding of the proposed content. The individual chapters also went through a rigorous peer review conducted by GGGI's internal staff; the feedback solicited from the reviewers was used as inputs to the revisions. The report acknowledges its limitations in not covering the whole gamut of relevant green growth initiatives, due to time and resource constraints. It also recognizes the analytical uncertainties that readers should be critical about. Given the long-term timeframe for green growth initiatives to actually bear fruit, the discussion focuses on mid-term success and early lessons that could be instrumental in achieving the long-term green growth objectives.

To disseminate the content of this report, outreach activities will be conducted on an ad hoc basis through GGGI's capacity development programs. In the process of imparting the cases and lessons from this report, ample prudence will be exercised to make it clear that the purpose of undertaking this initiative is not to impose the ROK's green growth policies on other countries, but rather to provide them with tested ideas and experiences learned on the ground as good starting points for designing their own green growth activities. Therefore, the critical question at the end of the day for countries with the vision to embrace a sustained shift toward green growth will always be: how relevant is this policy to my country, and what could be the windows of opportunity for innovation based on the local context?

References

AfDB (African Development Bank Group). 2013. "Chapter 9. Facilitating Green Growth in Africa: Reflection on Entry Points for Action and the Way Forward." African Development Report 2012: Towards Green Growth in Africa, 2013 African Development Bank Group, Tunis.

Bowen, Alex. 2012. ""Green" Growth: What does it mean?" *Environmental Scientist* 21.4: 7-11.

Energy Use Rationalization Act. 2014. Republic of Korea Statutes Act No. 12298.

Enforcement Decree for the Framework Act on Low-Carbon Green Growth. 2010. Republic of Korea Statutes Presidential Decree No. 25456.

Framework Act on Low-Carbon Green Growth. 2010. Republic of Korea Statutes Act No. 11965.

GGGI (Global Green Growth Institute). 2011. *Green Growth in Motion: Sharing Korea's Experience.*

Jacobs, Michael. 2013. "Green Growth." In *Handbook of Global Climate and Environmental Policy*, edited by Robert Falkner, 197-214. Oxford: Wiley Blackwell.

Joint Work of Relevant Ministries. 2012. *The Second Five-Year Plan for Green Growth (2014-2018).* Accessed April 17, 2015. http://www.greengrowth.go.kr/?page_id=2452.

Jones, Randall S., and Byung-seo Yoo. 2011. "Korea's Green Growth Strategy: Mitigating Climate Change and Developing New Growth Engines." *OECD Economics Department Working Papers*, No. 798, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/5kmbhk4gh1ns-en.

Kim, Sang-hyup. 2013. *Green Growth and Future Growth Engine: White Book on Korean Green Growth Policy, 2008-2013.* Seoul: Government of the Republic of Korea. Accessed May 25, 2015. http://president.leemyungbak.pa.go.kr/paperView.Index=1&srchKeyword=#03ATzTzgRoDGJMPSV000

Kim, Sang-hyup, and Hyeon-jung Choi. 2013. *Green Growth for a Greater Korea: White Book on Korean Green Growth Policy, 2008-2012.* Seoul: Government of the Republic of Korea. Accessed May 25, 2015. http://president.leemyungbak.pa.go.kr/download.CD53186228128?volId=03AT0amfstDGJMPSV000.

Kim, Sung-young, and Elizabeth Thurbon. 2015. "Developmental Environmentalism: Explaining South Korea's Ambitious Pursuit of Green Growth." Politics and Society, May 2015. Accessed May 1, 2015. http://www.researchgate.net/publication/275647617_Developmental_Environmentalism_Explaining_South_Korea%27s_Ambitious_Pursuit_of_Green_Growth.

Lee, Myung-bak. 2008. "A great people with new dreams." A Presidential Speech presented at National Ceremony on Independence Day, Seoul, August 15.

Lee, Myung-kyoon and Jae-eun Ahn. 2015. "South Korea – Green Leapfrogging. Korea's Accelerated Transition Towards Green Growth." In *The Rise of the Green Economy – A New Paradigm for the Developing World? (forthcoming).*

MOSF (Ministry of Strategy and Finance). 2009. *The National Fiscal Management Plan (2009~2013).* Accessed May 25, 2015. http://www.mosf.go.kr/_upload/bbs/76/attach/09~13_fiscal%20plan.pdf.

OECD. 2011. *Towards Green Growth.* OECD Green Growth Studies, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/9789264111318-en.

Office for Government Policy Coordination. 2010. *Framework Act and its Presidential Decree on Low-Carbon Green Growth in Korea.* Last modified in April 14, 2011. http://elaw.klri.re.kr/kor_service/lawView.do?hseq=24639&lang=ENG.

Park, Jeong-won. 2013. "The Evolution of Green Growth Policy: An Unwelcome Intrusion on Global Environmental Governance?" *East Asian Economic Integration* 17(2):207-241.

PCGG (Presidential Committee on Green Growth). 2009a. *National Strategy for Green Growth (2009-2050).* Accessed April 17, 2015. http://www.greengrowth.go.kr/?page_id=2450.

PCGG (Presidential Committee on Green Growth). 2009b. *The Five-Year Action Plan for Green Growth (2009-2013).* Accessed April 17, 2015. http://www.greengrowth.go.kr/?page_id=2452.

PCGG (Presidential Committee for Green Growth). 2009c. "Road to Our Future: Green Growth National Strategy and the Five-Year Plan (2009-2013)." PCGG Brochure prepared for the National Ceremony on Independence Day, Seoul, August 15.

PCGG (Presidential Committee on Green Growth). 2009d. *Green Growth, Green Korea: A Lee Myung-bak Regime's Government Administration Documents*. Seoul: Government of the Republic of Korea. Accessed May 25, 2015. http://president.leemyungbak.pa.go.kr/paperView.ndex=2&srchKeyword=#03ATypZxYUDGJMPSV000.

PCGG (Presidential Committee for Green Growth). 2014. "Presidential Committee for Green Growth." Website of Presidential Committee for Green Growth. Accessed May 25, 2015. http://www.greengrowth.go.kr/.

Prime Minister's Office, Ministry of Strategy and Finance, Ministry of Education, Science and Technology, Ministry of Foreign Affairs, Ministry of Knowledge Economy, Ministry of Environment, Ministry of Land, Infrastructure, and Transport. 2008. *The First National Energy Basic Plan (2008-2030)*. Accessed April 17, 2015. http://energyjustice.kr/zbxe/48310.

Samans, Richard. 2013. "Green Growth and the Post-2015 Development Agenda." An Issue Paper for the United Nations High-Level Panel of Eminent Persons, Global Green Growth Institute, Seoul. http://www.greengrowthknowledge.org/sites/default/files/downloads/resource/GG_and_the_post-2015_development_agenda_Gggi.pdf.

Scott, Andrew, William McFarland, and Prachi Seth. 2013. "Research and Evidence on Green Growth." Overseas Development Institute for Evidence on Demand, London. DOI: http://dx.doi.org/10.12774/eod_hd064.july2013.scott.

Schmalensee, Richard. 2012. "From "Green Growth" to sound policies: An overview." Energy Economics 34:S2-S6.

Statistics Netherlands. 2013. "Sustainable Development and Green Growth: Comparison of the Measurement Frameworks at Statistics Netherlands." The Center for Policy Related Statistics, The Hague. http://www.cbs.nl/NR/rdonlyres/55CE8739-BA1D-4BBD-A0E3-B12DC270DEED/0/2013notaDZHGGmrt2013.pdf.

Stern Review. 2010. "Stern Review on the Economics of Climate Change." Report to the Prime Minister and the Chancellor of the Exchequer on the Economics of Climate Change, Government Economic Service, Cambridge. http://webarchive.nationalarchives.gov.uk/+/http:/www.hm-treasury.gov.uk/sternreview_index.htm.

The Economist. 2012. "Green Growth: Shoots, Greens, and Leaves." *The Economist, June 22. http://www.economist.com/node/21556*904.

UNEP (United Nations Environment Programme). 2010. "Overview of the Republic of Korea's National Strategy for Green Growth." UNEP Green Economy Initiative. Accessed May 25, 2015. http://www.unep.org/PDF/PressReleases/201004_unep_national_strategy.pdf.

World Bank. 2012. *Inclusive Green Growth: The Pathway to Sustainable Developme*nt. Washington DC: World Bank. Accessed May 25, 2015. http://siteresources.worldbank.org/EXTSDNET/Resources/Inclusive_Green_Growth_May_2012.pdf.

Global Green Growth Institute

Korea's Green Growth Experience: Process, Outcomes and Lessons Learned

Chapter 2: Low-Carbon Society

Summary

Despite being classified as a developing country with less responsibility to reduce emissions under international climate negotiations, the ROK is in fact one of the top emitters among the OECD countries. Thus, the government set an ambitious target of reducing emissions by 30% from BAU levels by 2020 based on scientific assessments and multi-stakeholder consultation. To honor this commitment, the government laid out a comprehensive institutional and legal framework to facilitate the implementation of mitigation strategies. An array of initiatives has been successful such as the establishment of the Greenhouse Gas Inventory and Research Center and the introduction of several emissions reduction programs targeting the public and private sectors. These initiatives provided the testing ground for the ROK's boldest mitigation action to date – the Korea Emissions Trading Scheme (K-ETS) – which still pushed through despite strong opposition from affected industries, and is expected to play a critical role in engaging heavy emitters to explore cost-effective mitigation measures and invest in low-carbon technologies. Currently, the ROK has not yet achieved substantial results in decoupling economic growth and GHG emissions. However, the government hopes to achieve more promising outcomes as it exerts more aggressive, even if unpopular, efforts to succeed in this goal.

1. Introduction

1.1 Overview

As the 47th country to join the United Nations Framework Convention on Climate Change (UNFCCC) in 1993, the Republic of Korea (ROK) was designated as a Non-Annex I country under the Kyoto Protocol, thus being excused from sharing the mandatory obligation of reducing GHG emissions. Although classified as a developing country with less historical responsibility based on the principle of "Common but Differentiated Responsibilities," the ROK is one of the top producers of GHG among the OECD countries. The government has emphasized that the country has a short 30-year history of economic development and is still in the process of growing, and thus has different conditions to follow on emissions reduction compared to the highly developed economies.

However, the mounting international pressure on developing countries to also shoulder the global responsibility of reducing GHG emissions has reshaped the ROK's climate change diplomacy toward a more proactive engagement.

The climate change diplomacy of the ROK is commonly divided into four phases: Observation Phase (1972-1988); Passive Response Phase (1989-1996); Proactive Response Phase (1997-2007); and Active Intervention Phase (2007-present). Similar to most developing countries, the government started off with passive and defensive diplomacy, as it was concerned that efforts to reduce GHG might affect the country's international competitiveness. Likewise, the industrial sector responded very sensitively to the government's efforts on climate negotiations.

For example, the industrial leaders have continuously sought to rationalize their inactions to reduce GHG emissions, pointing out how the U.S. withdrew from the Kyoto Protocol and how developed countries have tried to protect their own national interests during the negotiation process.

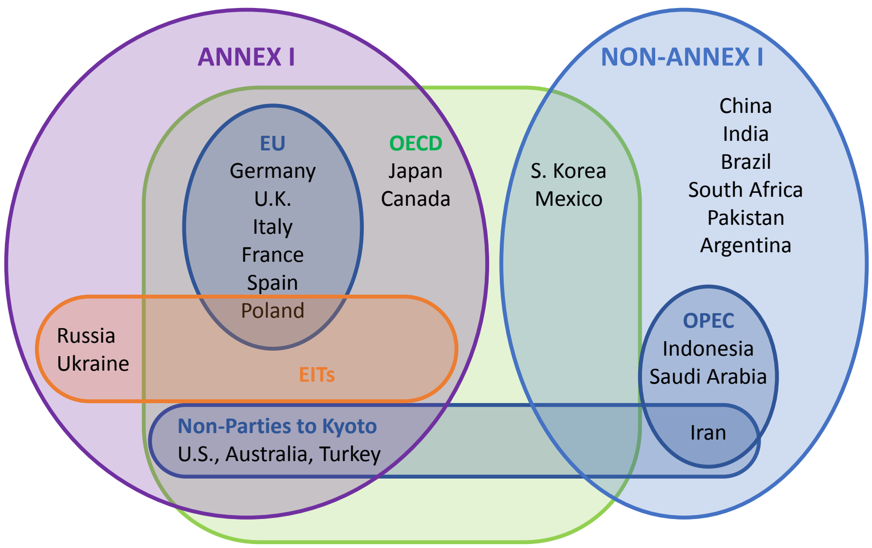
Given the immensity of the challenges posed by climate change, it is clearly evident that this global problem cannot be resolved without the full support of all leading GHG emitters. Thus, the ROK also felt the need to improve its national awareness of global warming. The ROK could have used its history of short and rapid industrialization with relatively lower "historical emissions per capita" as an excuse to spare itself from taking more responsibilities on emissions reduction. However, the country also faces tremendous pressure to exert more efforts and its status as a developing country (and thereby is not subject to mandatory emissions reduction) under the global climate change negotiations has been widely criticized.

When considering the size of the economy and the amount of GHG emissions, the "leading developing countries" – including the ROK, China, Mexico, and South Africa – have faced tremendous international pressure to take more responsibility. Heeding the call for global climate actions, former President Lee Myung-bak, who took office when discussions on the post-Kyoto Protocol started, announced low-carbon green growth as the country's new development strategy, thereby taking a more proactive stance on climate diplomacy.

1.2 Baseline Assessment

The ROK's economic development and GHG emissions have shown similar rates of growth. During the 15-year period of 1990-2005, the nation's economy achieved an annual GDP growth rate of 5.6%. The GHG emissions in the same period increased by an average of 4.7% per year, and as a result, the amount of emissions in 2005 increased by 99% compared to emissions in 1990. It is also worth noting that such level of increase in the given period was the highest among OECD countries and this is attributed to the ROK's economic structure, which is highly energy-intensive and dependent on fossil fuels.

Figure 1: Annex I and Non-Annex I countries under the Kyoto Protocol



* Note: EIT stands for Economies in Transition while OPEC means Organization of the Petroleum Exporting Countries.

Source: Kim, 2010

Root Causes of Challenges

The energy sector is the leading emitter of GHG in the ROK, accounting for 84.3% of the total emissions. Moreover, 11% of the emissions come from the industrial processes (e.g., semiconductor production), 2.5% from agriculture, and 2.2% from waste disposal. The GHG emissions in the energy sector, which comes primarily from fuel combustion, showed a 4.8% average annual increase and its share of the country's gross emissions grew slightly from 83% in 1990 to 84.3% in 2005.

The most notable increase in emissions during the 1990-2005 period took place in the industrial sector. As the primary source of national revenue, this sector represents manufacturers of various products such as semiconductors, display panels, steel, ships, and automobiles. The GHG emissions grew by an average of 9.3% a year, which corresponds to the continued increase in the amount of exported goods. The total emissions by the industrial sector increased by over 60%, boosting its share of the country's gross emissions from 6.7% in 1990 to 11% in 2005. In contrast, the share of total emissions by the agricultural sector decreased from 4.4% in 1990 to 2.5% in 2005 due to the reduction in farmland area, enhanced productivity of farming practices (e.g., use of nitrogen fertilizers), and decrease in the total number of livestock. Similar trends were also observed in the waste sector as its share in the nation's gross emissions decreased from 5.6% to 2.2% from 1990 to 2005, due to the introduction of recycling and waste incineration, as well as reduced amounts of waste in the landfills.

Table 1: ROK's GHG emissions responsibility index

Index	Period	Value	World Ranking
Amount of emission per capita (tons)	2005	9.3	28
Historical amount of emissions per capita (tons)	1900-2000	146.5	64
Gross emissions (million tons)	2005	448.9	10
Historical total amount of emissions (million tons)	1900-2000	7,041.7	23

Source: Oh, 2009

Table 2: GHG emissions in the ROK (1990-2005)

	1990	1995	2000	2004	2005	Annual Growth (%)
Gross Emissions (million tCO_2)	297.5	451.8	528.5	587.3	591.1	4.7
GDP (billion KRW)	320,696	467,099	578,665	693,996	723,127	5.6
Emissions per capita (ton/person)	6.94	10.02	11.24	12.21	12.24	3.9
Emissions/GDP	0.93	0.97	0.91	0.85	0.82	-0.8

Source: Yoo, 2008

Relevant Problems

Since the ROK imports 97% of its energy and has established an industrial structure that is energy-intensive and heavily reliant on fossil fuels, the country is extremely vulnerable to global oil price fluctuations. As such, binding agreements on curbing GHG emissions to be imposed in the future would lead to opposition from the energy and industrial sectors, as GHG reduction measures would have detrimental impacts on the national economy.

Generally, the level of a nation's energy consumption – which is the primary source of GHG emissions – increases proportionally with the national income, but the energy consumption per unit GDP tends to decrease as the economy advances. This trend also holds true for the ROK as its rate of increase in the CO_2 emissions per capita has remained relatively constant since 1990 and amounted to 10.9 tons in 2009. On the other hand, the energy use per unit GDP, which increased with national income until the mid-1990s, began to show marginal signs of stagnation from the year 2000 despite the continued increase in per capita income. This is a result of the growing efforts to improve energy efficiency and the increasing share of the less energy-intensive tertiary service industry. However, the underlying challenge for the ROK is how to curb its energy consumption per unit GDP, which is markedly higher than the developed countries.

Note that the decreasing trajectory of energy consumption per unit GDP (shown in Table 4) was followed by another steep increase in the late 1990s, raising questions on whether the country had actually come close to a breaking point. After having achieved remarkable economic growth through export-led industrialization, the ROK experienced a foreign exchange crisis in 1998, which took a toll on the economy and led to a major transformation of the country's economic structure. From this transformation, the tertiary sector grew steadily to take up the greatest share of the country's GDP, yet its growth rate was surpassed by the manufacturing sector. This suggests that the economic development

Table 3: GHG emissions of leading emission countries

Unit: million CO_2 tons

2005 Ranking		1990		2005		Changes during 1990-2005 (%)
		Emissions	Percentage (%)	Emissions	Percentage (%)	
World		21,024	100.0	27,136	100.0	29.0
Annex-I Countries		13,913	65.5	14,183	53.3	1.9
OECD Countries		11,092	53.3	12,910	49.4	16.4
1	U.S.	4,851	23.3	5,817	21.4	19.9
2	China	2,211	11.0	5,060	18.6	128.9
3	Russia	2,189	9.8	1,544	5.7	-29.5
4	Japan	1,058	5.1	1,214	4.5	14.8
5	India	588	2.8	1,147	4.2	95.5
6	Germany	968	4.6	813	3.0	-15.9
7	Canada	429	2.1	549	2.0	27.9
8	U.K.	558	2.7	530	2.0	-5.0
9	Italy	398	1.9	454	1.7	14.0
10	ROK	227	1.7	449	1.7	97.6

Source: IEA, 2007

of the ROK after the 1998 crisis was once again led by the energy-intensive manufacturing sector as most primary industries transitioned into the secondary manufacturing industry rather than into the tertiary service sector. This trend is unlike the case of developed countries that have constantly invested in environmentally friendly and energy-saving technologies as a means to nurture innovative industries with greater future value. The ROK's strengthened reliance on labor- and resource-intensive manufacturing industries could be problematic if the future climate negotiations were to put limits on the country's GHG emissions as this might trigger an economic slump or even lead to a much bigger economic crisis.

Another aspect of the climate negotiations that is important for the ROK is its potential impact on the international export market. Increasing numbers of climate change and environmental treaties have enforced strengthened regulations, whereby countries or businesses that fail to comply with the new standards have to deal with trade or tariff barriers. For example, the EU announced in 2009 the increase of GHG emissions standards for motor vehicles to 130 g/km as of 2012, and 95 g/km as of 2020. As penalties will be imposed on manufacturers that fail to meet the new standards, this policy will have a direct impact on the ROK, being the world's fifth largest automobile producer. Apparently, the outcomes of climate change negotiations are developing into specific regulations that set out new trade standards in the international market. Naturally, countries that are a step ahead in technology innovation would frame climate negotiations in such a way as to minimize the costs of reducing emissions and maximize the economic benefits of trading climate-related goods and services.

The future of the green energy market, which is expected to grow rapidly in the coming decades, will be greatly shaped by climate negotiations. Developed countries – especially those that have played a proactive role in climate deals – have been the early movers and dominated the market share for green products and services. Meanwhile, the so-called "second movers" – those with technological gaps to fill to become globally competitive – have struggled to benefit from the explosive growth of the green market. In other words, the reinforcement of environmental regulations acts as a barrier to these second movers while it offers opportunities to the early movers with advanced technologies. The ROK's sustained status as a Non-Annex I country under international climate negotiations has hindered the country's drive to stimulate its industries in building a competitive technological edge for entering new global markets for green goods and services. Upon enforcement of emissions reduction in the future, the ROK will have to deal with two major challenges:

(1) GHG emission reduction obligations to be imposed will be commensurate with those of developed countries as the ROK is likely to be recognized as an "advanced developing economy," and

(2) the manufacturing sector will lose its international competitiveness in the course of competing with the frontrunners of low carbon technologies.

Foreseeing these circumstances, the ROK government acknowledged the need to shift to a low-carbon growth path.

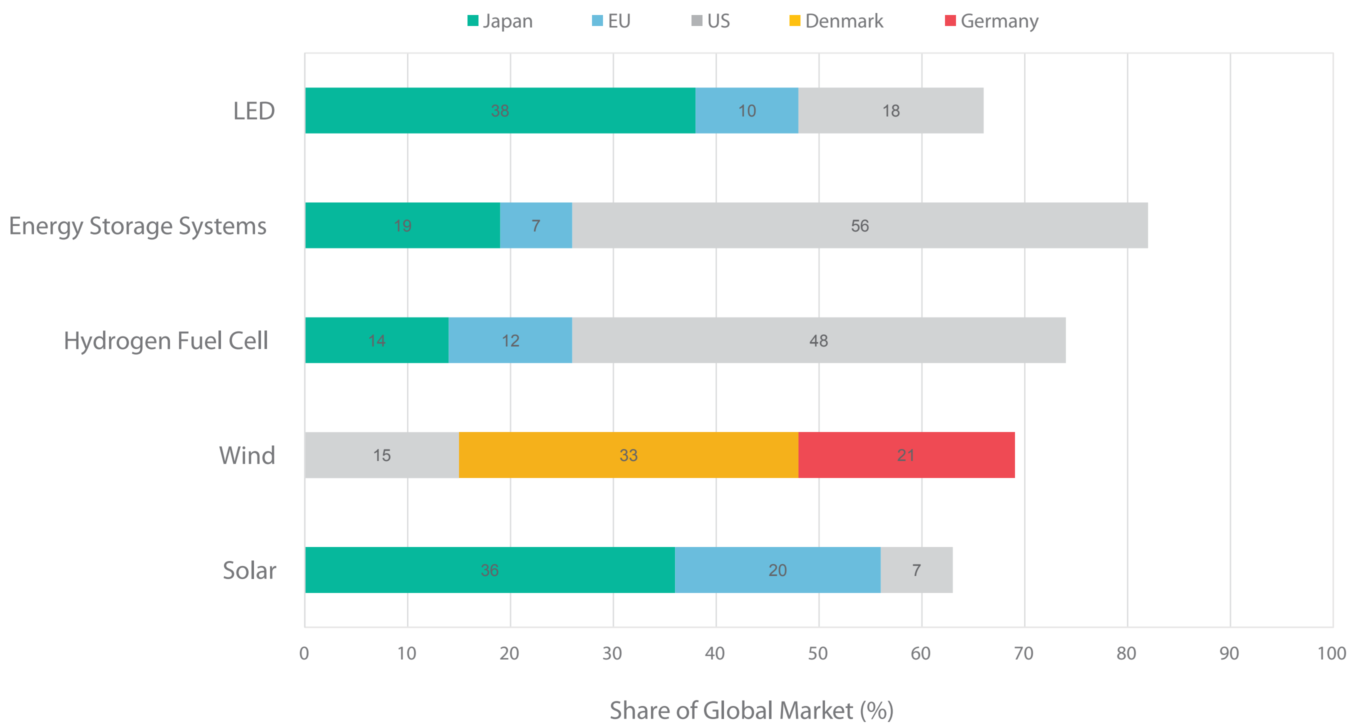
Aside from the issue of imposing global emission caps, the extreme impact of climate change on the Korean Peninsula is another triggering factor for the shift toward a low-carbon society. The average rise in temperature in six major cities (Seoul, Busan, Daegu, Incheon, Gwangju, and Daejeon) has been 1.50°C over the past century, which is far above the global average of 0.74°C. Rising seawater levels reveal similar trends – as of 2012, seawater levels in the Jeju region rose by 5.97 mm per year for the past 33 years, which is approximately three times the global average (1.8 mm/year) according to the Intergovernmental Panel on Climate Change (IPCC). The average annual rainfall (1996-2005) in the ROK increased by approximately 10% from the average of the past 30-year period (1971-2000), with rain being more concentrated in the summer season. The total amount of damage caused by weather-related disasters, such as typhoons and flash floods, amounted to 17.7 trillion KRW in the period of 1996-2005.

Table 4: Energy intensity of selected countries

	Energy Intensity								% change (2000-2008)
	1960	1970	1973	1980	1990	2000	2007	2008	
ROK			0.279	0.336	0.328	0.369	0.315	0.314	2.0
France	0.227	0.256	0.256	0.223	0.206	0.191	0.175	0.176	1.0
Germany	0.238	0.328	0.322	0.291	0.228	0.178	0.160	0.160	1.3
Japan	0.121	0.142	0.144	0.123	0.106	0.111	0.099	0.095	1.9
U.K.	0.290	0.282	0.265	0.226	0.180	0.152	0.120	0.117	3.2
U.S.	0.399	0.417	0.402	0.352	0.271	0.234	0.204	0.198	2.0
OECD			0.306	0.274	0.224	0.203	0.183	0.179	1.6

Source: KEEI, 2009

Figure 2: Share of developed countries in the world's green energy market



Source: MKE, 2008

Research on Public Awareness of Climate Change (June 2008)

A public survey was conducted by the Ministry of Environment (1,040 participants, 95% confidence- level, ±3.04% margin of error) to ascertain the level of public awareness on climate change. The results of the survey revealed that:

- Most of the respondents (88.1%) were aware of climate change and global warming caused by increasing use of fossil fuels. The majority (95%) considered the level of impacts as "severe."
- More than half of the general public (56.8%) considered that the central government should play a leading role in reducing the national GHG emissions, whereas their awareness of the individual and corporate responsibilities was relatively low.
- If the ROK were to cap its GHG emissions, the public believed that it should be imposed at a level that is either "close to that of developed countries (39.6%)" or "slightly higher than that of the developing countries (36.4%)."
- More than ninety percent (91.8%) of the respondents "supported" the government's strategies and actions to foster climate technologies and green industries as the nation's new growth engine.

Which entity plays the biggest role in preventing global warming?	Response (%)
Central Government	56.8
Individuals	13.8
Corporations	11.3
Local Governments	10.3
Civil Society	5.8
Academic Institutions	1.0
No response	1.1

Source: MoE, 2014f

Policy Options

After Lee Myung-bak was inaugurated as president in February 2008, the new administration decided to adopt a strategy that:

(1) mandates the government's proactive participation in international talks on climate change;

(2) ensures that the ROK's contributions toward the global climate agenda are commensurate with the nation's economic power and influence in the international arena; and

(3) enforces national actions of emissions reduction to the fullest extent that is deemed bearable in all sectors of the economy.

Accordingly, the government made plans considering the timeframe stipulated in the Bali Road Map, specifically targeting:

(1) the establishment of the nation's overarching strategy on climate change response and participation in climate negotiations by year 2008;

(2) presentation of the ROK's strengthened commitment through global climate negotiations in 2009, while at the same time carrying out diplomatic activities that help identify and maximize the nation's interests; and

(3) devise measures to prepare the nation for the post-2012 climate change regime.

In July 2008, President Lee announced that the ROK would establish a mid-term GHG reduction target by the end of the year, which became a major turning point signaling how the nation is to follow the new paradigm of low-carbon growth.

The "Transition into a Low-Carbon Society" is one of the 10 major policy agenda items under the nation's Five-Year Plan for Green Growth. This falls under the overarching national strategy of "improving climate change responses and energy self-governance." Relevant policies and implementation programs prioritize the needs for monitoring GHG emissions, establishing a comprehensive GHG emissions management system, improving public awareness on climate change, and realizing emission reduction in all sectors of the economy.

Figure 3: Government plans under the timeframe of the Bali Road Map

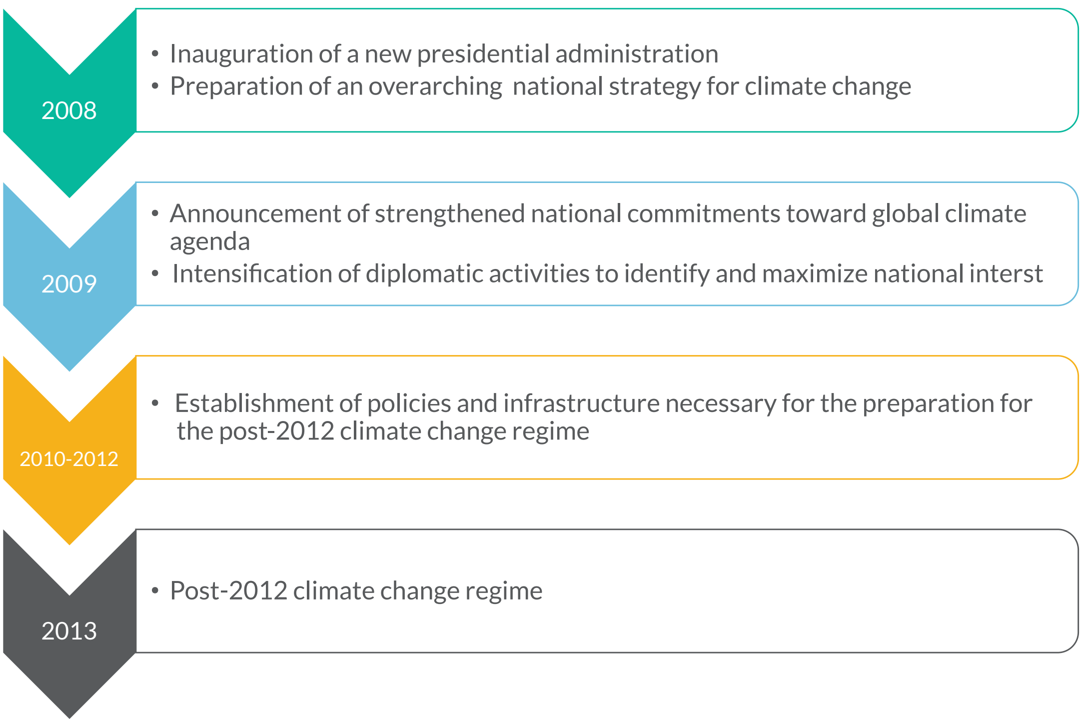
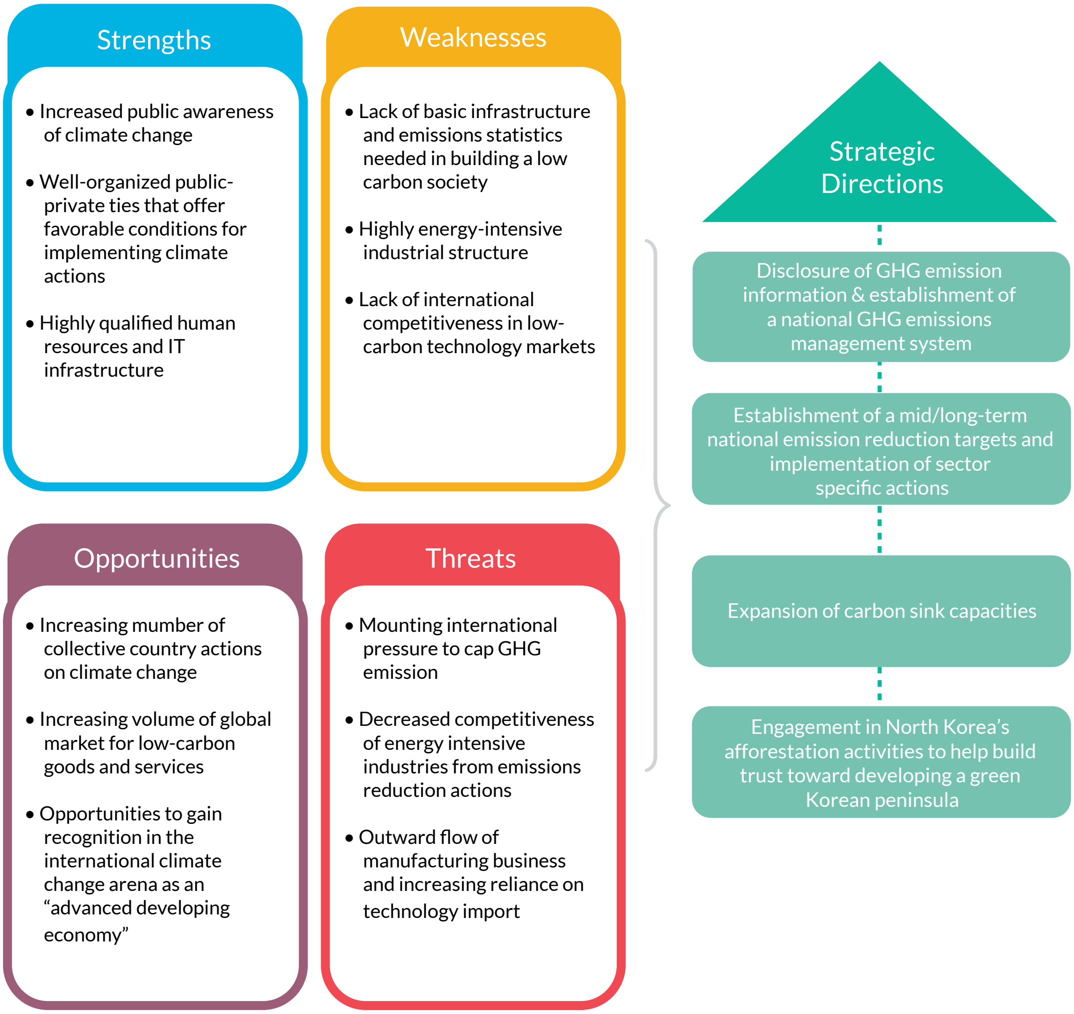


Figure 4: SWOT analysis conducted for the "low-carbon society" agenda



Source: PCGG, 2009a

1.3 Challenges and Opportunities for Green Growth

The ROK recognized actions to realize the "transition into a low-carbon society" as opportunities for simultaneously resolving multiple challenges: minimizing the nation's impacts from future climate negotiations, enhancing people's quality of life, and exploring new drivers of economic growth. This set of agenda evolved from the government's understanding of the need to advance into a less energy-intensive and more environmentally friendly stage of economic development. As a response, the government took proactive actions such as participating in global climate negotiations, setting GHG reduction targets, and continuously monitoring the outcomes from mitigation actions.

The nation's Comprehensive Basic Plan to Correspond to Climate Change, which was released in September 2008, identifies the first priority objective of responding to climate change as "fostering climate-friendly industries as a new growth driver." Climate-friendly industries include activities related to energy efficiency, renewable energy, and resource recovery, which all contribute to responding to the climate challenges and boosting the country's export performance. The ROK's low-carbon green growth paradigm perceives the transition into low-carbon society as an opportunity to innovate and add much value to the nation's industrial technology. Such pioneering efforts will hopefully empower the ROK to play a bridging role between the developed and developing nations amidst the post-2012 development regime.

Table 5: Specific tasks and actions under the low-carbon agenda

Tasks	Actions
1. Disclosure of GHG emissions data	a. Disclose and manage GHG emissions data b. Establish a national GHG emissions inventory and management system c. Nurture and develop MRV service industries and establish a global GHG emissions research center
2. Reduction of carbon emissions	a. Set national GHG emission reduction targets b. Establish sector-specific GHG reduction strategies c. Enable GHG reductions based on market principles
3. Carbon sink and uptake	a. Realize a low-carbon and resource-circulating society b. Expand carbon sink/sources in forests c. Foster ocean-based carbon sink and expand environmentally friendly agricultural practices
4. Greening of the Korean Peninsula	a. Support forest restoration activities in North Korea b. Establish an ecological and environmental belt across the Korean Peninsula and boost cooperation with North Korea in the energy sector c. Prepare a joint strategy for climate change adaptation and mitigation with North Korea

Source: PCGG, 2009a

2. Targets and Strategies

The setting of a nation's GHG reduction targets is a critical process as it determines the levels of mitigation actions and necessary investments to follow. The reduction targets have a significant impact on the national economy and the society at large since the government's existing regulatory and incentive measures need to be realigned toward the achievement of these targets.

The ROK pledged to the international community that the nation would set a GHG reduction target at the G-8 Summit in July 2008. In the following year, the government fulfilled this commitment, announcing that the nation would reduce its GHG emissions by 30% from business-as-usual (BAU) levels by the year 2020. It should be noted that this target is the most ambitious, based on the levels recommended by the IPCC for developing countries.

In response to the nation's mixed reactions toward the reduction targets, President Lee pointed out that "meeting these targets will place a burden on the national economy in the short term, but relevant measures are necessary for the nation's greater interest in the long term." He added that the "ROK's voluntary setting of reduction targets will encourage the international community to take more responsible actions against global climate challenges (Blue House, 2009)."

Although the Five-Year Plan for Green Growth did not specifically quantify the nation's reduction targets, it provided a detailed outline on how the government plans to set and manage them. Fundamentally, the stages in the development of the ROK's mid-term reduction targets were:

(1) assessment of the nation's GHG reduction potential in various sectors;

(2) development of GHG reduction strategies based on cost estimation of different mitigation measures;

(3) development of the nation's GHG reduction scenarios, which was followed by public hearing and consultation; and

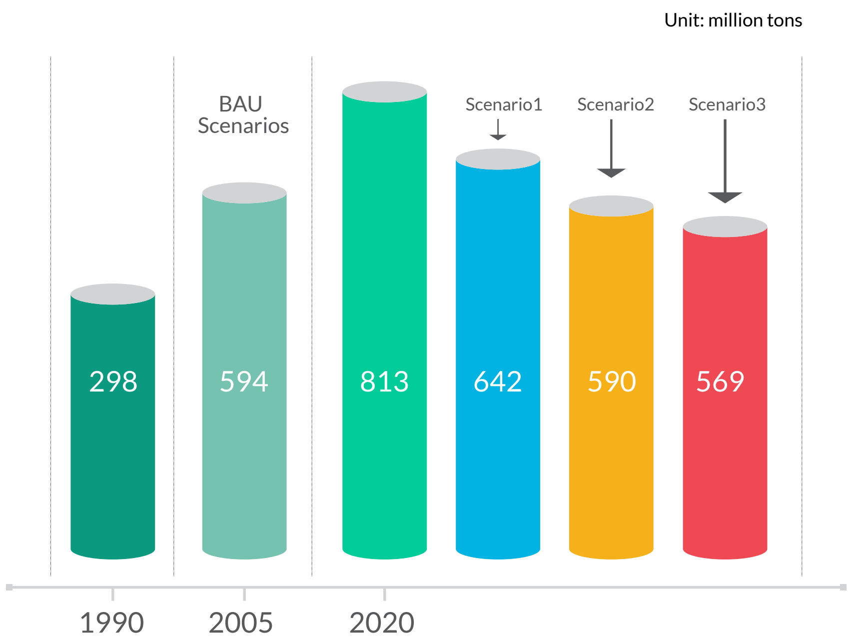
(4) proclamation of the nation's GHG reduction targets (PCGG, 2009a).

2.1 Setting of Mid-term Emissions-Reduction Targets

In the process of setting the national GHG reduction targets, the government conducted numerous assessments, held discussions with relevant experts, and went through public consultations as a means to build a strong social consensus and support. Immediately after the president declared that the nation would announce its mid-term GHG reduction targets in July 2008, the government created an ad hoc team of researchers (from relevant national research institutions) to come up with projections on the ROK's future GHG emissions. This team worked for a period of 10 months to draft the projections, which were then reviewed by an external committee. The external committee comprising a total of seven members (economists, energy and environment specialists) validated and supplemented the team's projections and identified various mitigation measures to help support three different national GHG emissions reduction scenarios in August 2009 (PCGG, 2009d).

Several different methods can be used in setting the GHG reduction targets, including the: (1) base-year approach (often adopted by developed countries); (2) BAU approach (often adopted by developing countries);, and (3) intensity-unit-based approach that takes into consideration the emissions per unit production (PCGG, 2009b). In devising the national targets, some recommended that the government should adopt the intensity-unit-based approach as it is deemed most favorable to the nation''s circumstances. However, the government eventually selected the BAU approach, which is fundamentally based on top-down assessments of a countrynation''s growth factors. After a series of closed-door assessments, validations, and discussions, the government finally announced three scenarios to the public, which were to cut emissions either by 21% (Scenario- 1), or by 27% (Scenario-2),or by 30% (Scenario-3) from BAU levels by 2020.

Figure 5: Emissions-reduction scenarios



Source: PCGG, 2009b

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Following the announcement of the BAU scenarios, the government began to assess public opinion, holding a total of 44 symposia and public hearings nationwide over a period of two months (August – September 2009). Throughout this process, the industrial sector expressed strong concern over the possible weakening of the ROK's industrial competitiveness, and insisted that the target should be set at 21% (Scenario 1) or lower levels. Industrial leaders emphasized that the government should consider the practicality of the proposed mitigation measures, relevant costs, and capacities of the industrial sector in planning and carrying out mitigation actions.

The industrial sector also stressed the fact that the ROK is still far behind in terms of developing and commercializing the mitigation technologies. Most importantly, several mitigation measures proposed by the government, such as the utilization of bio-fuels and green cars, were perceived not to result in the level of GHG emissions reduction. In addition, the estimated cost of abatement proposed by the government (50,000 KRW per tCO_2) was considered excessive in light of the nation's GDP level and economic growth rates. The ROK's industrial structure, composed primarily of energy-intensive businesses – steel, petrochemicals, and cement manufacturing – was also recognized as a major obstacle in meeting the ambitious reduction target.

On the other hand, the civil society claimed that the nation's GHG reduction target should be set at levels higher than Scenario 3 (30%), given the status of the ROK as the world's ninth largest GHG emitter and as a member of the OECD. Some groups based their suggestions on what is called the "Responsibility-Capacity Indicator," an index representing the level of the nation's responsibilities for the changing climate based on multiple factors such as income levels, the accumulated amount of GHG emissions, and population. The ROK ranked high (32nd) on the global list, stressing the need for the setting of ambitious mitigation targets.

The surveys conducted to collect public responses indicated a range of differing opinions. In a poll conducted by the PCGG immediately after the announcement of the three scenarios, the general public was supportive of Scenario 1, while experts in the fields related to climate change were leaning toward Scenario 2. However, in a survey conducted in October 2009 after the ROK successfully hosted the G-20 Summit, the general public changed its stance as the majority shifted to support Scenario 3.

This result was in conflict with a survey conducted over a similar period by the Korea Chamber of Commerce and Industry and the Federation of Korean Industries, where the respondents from the industrial sector once again confirmed their support toward Scenario 1. Given such conflicting views among different groups, the National Assembly's Special Committee on Climate Change held a forum on two separate occasions in an effort to mediate the

Table 6: Public support toward different reduction scenarios

Scenario	Target	Selection Criteria	Supporting groups based on public hearing
1	21% (171 million tons reduction from BAU)	Cost effectiveness	Industrial sector
2	27% (223 million tons reduction from BAU)	Reduction target to meet international levels	Academia/research institutions
3	30% (244 million tons reduction from BAU)	Highest reduction target recommended for developing countries	Environmental and civil groups

Source: Special Committee on Climate Change, 2009

Table 7: Milestones in the setting of national GHG reduction targets

Date	Milestone	Description
Jul. 2008	Government announced a plan to set the national mid-term GHG reduction targets	The ROK announced its mid-term GHG reduction targets in 2008 during the G-8 Extended Summit
Aug. 2008	Declaration of low-carbon green growth as national vision	President Lee proclaimed low-carbon green growth as the new national vision in his speech at the 60th anniversary of the founding of the ROK
Sep. 2008 – Jun. 2009	Analysis on emission projections and reduction potential	Conducted by an ad hoc research team composed of members of national research institutions
Jul. 2009	Establishment of a review committee	Establishment of a review committee consisting of seven experts from the environment, energy, and economy sectors to verify the reliability of projections and reduction potentials
Aug. 2009	Announcement of GHG reduction targets based on three scenarios	GHG emission-reduction targets of 21% (Scenario 1), 27% (Scenario 2), and 30% (Scenario 3)
Aug. 2009	Expert-opinion surveys	A survey conducted among 400 selected experts from the academia, research institutions industry, and civil society groups
Aug. – Sep. 2009	Public surveys	A public survey conducted on 1,000 citizens
Aug. – Sep. 2009	Symposia and public hearings	44 symposia and public hearings held nationwide

dispute. The discussions in the two fora eventually provided the momentum and consensus necessary for the government to push forward with the most ambitious reduction target (Scenario 3).

Methodology for Target Setting on GHG Reduction

In order to set the national GHG reduction targets, the government analyzed the GHG emission projections, reduction potential, and their macroeconomic impacts. The analysis followed a four-stage process. In the first stage, GHG emissions were projected based on the forecasts of multiple economic variables, such as oil prices, growth rate, industrial structure, and investment plans of the industrial sector.

The data on oil prices came from the U.S. Energy Information Administration (IEA), which expected that the price of oil would stand at US$98/bbl in 2008, US$84/bbl in 2010, US$70/bbl in 2020 and US$82/bbl in 2030. In terms of population, Statistics Korea (KOSTAT) forecasted that the nation's population would increase from 48.6 million in 2008 to 48.9 million in 2010 and to 49.3 million in 2020 and fall to 48.6 million in 2030. The annual economic growth rate was projected to reach 4.2% in 2008 and 4.75% in 2010 before falling to 2.24% in 2030 (PCGG, 2009c).

In the following stage, the GHG reduction potentials were analyzed using the MARKAL Model developed by the IEA. In the third stage, the macro-economic

Table 8: Examples of economic variables reflected in the GHG emission target setting

	2008	2010	2020	2030
Oil price (US$/bbl)	98	84	70	82
Population (million)	48.6	48.9	49.3	48.6
Economic growth rate (%)	4.2	4.75	3.66	2.24

Source: PCGG, 2009c

impacts of GHG reduction efforts on GDP and level of consumption were analyzed using the Computable General Equilibrium (CGE). Successfully, GHG reduction scenarios were developed in the fourth stage, taking into consideration different mitigation measures that can be realized (PCGG, 2009c).

Emissions Reduction Strategy

As mentioned above, the MARKAL model finds the least expensive combination of emission-control technologies to meet a given GHG reduction target. The ROK's three different GHG reduction scenarios thus draw upon different combinations of emission-control technologies. For example, Scenario 3 (30% BAU 2020) draws upon applying emission-reduction measures such as deployment of green cars (electric and fuel cell vehicles), expansion of the use of energy-efficient appliances, and implementation of strong demand-management policies, in addition to those selected for Scenario 1 and Scenario 2. Detailed reduction measures for different scenarios are presented in Table 9.

MARKAL Model

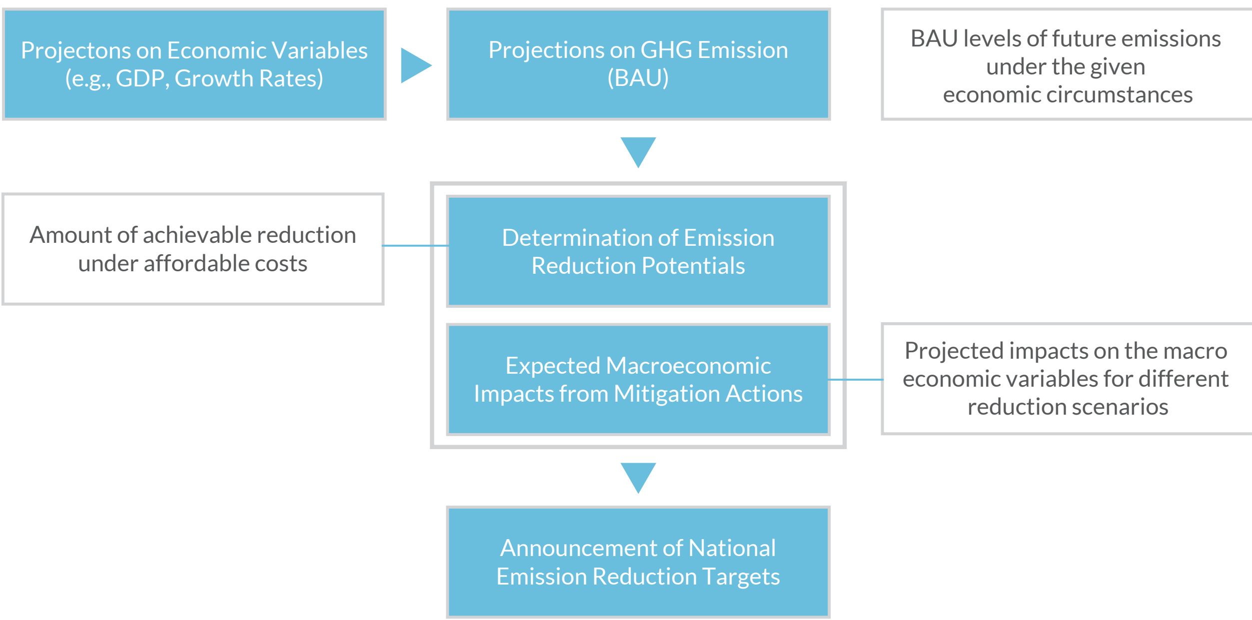
- MARKAL was developed in a cooperative multinational project over a period of almost two decades by the Energy Technology Systems Analysis Programme (ETSAP) of the IEA.

- The basic components in a MARKAL model are specific types of energy or emission-control technology. Each type is represented quantitatively by a set of performance and cost characteristics. A menu of both existing and future technologies is inputted to the model. Both the supply and demand sides are integrated, so that one side responds automatically to changes in the other. The model selects the best combination of technologies that minimizes total energy system cost.

- Some of the useful applications of MARKAL include identification of least-cost energy systems and cost-effective responses to restrictions on emissions.

Source: IEA-ETSAP, 2014

Figure 6: Economic variables reflected in the GHG emission target setting



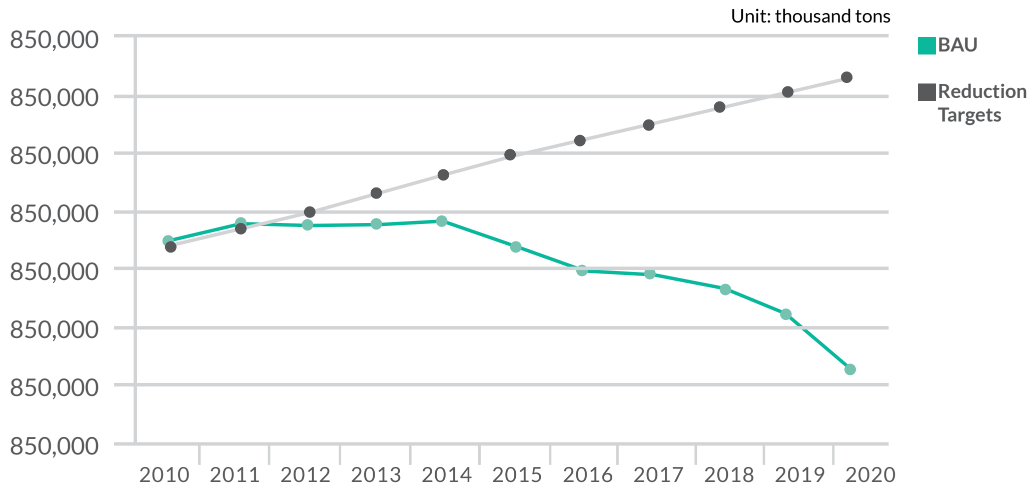
Source: PCGG, 2009c

Table 9: Examples of economic variables reflected in the GHG emission target setting

Scenario	Target	Emission-Reduction Measures
1	21% (171 million tons reduction from BAU)	• Green buildings and residential houses • Deployment of energy high-efficient manufacturing equipment and facilities • Low-carbon transport systems • Expansion of renewable and nuclear energy generation • Introduction of smart-grids
2	27% (223 million tons reduction from BAU)	• Measures for removal of fluorinated gases (F-gases) with high global warming potentials (GWP) • Increase of bio-fuel supply • Introduction of carbon capture storage (CCS) technologies
3	30% (244 million tons reduction from BAU)	• Deployment of green cars (electric and fuel cell vehicles) • Increase in the use of energy-efficient appliances • Strengthening of existing energy demand management policies

Source: PCGG, 2009d

Figure 7: GHG Reduction Trajectory



Source: Joint Work of Relevant Ministries, 2011b

2.2 Setting of Emissions-Reduction Targets by Sector, Business Types, and Year

In 2011, the strategies related to GHG reduction targets took a more concrete shape. After holding another series of public hearings and coordination meetings followed by consultative meetings within the PCGG, a plan outlining GHG emission-reduction targets by sectors, business types, and financial years was prepared and approved by the Cabinet in July 2011 (Joint Work of Relevant Ministries, 2011a). The plan estimated that the nation's emission levels will begin to fall after reaching their peak in 2014, realizing a decoupling of economic growth and GHG emissions in 2015, which is a result of low-carbon investments and the deployment of green technologies.

The GHG reduction targets by sector and business types released in 2011 are presented in Tables 10 and 11. The targets by sector are: 18.2% for industry, 34.3% for transportation, 26.9% for buildings, 15.2% for agriculture, forestry, and fisheries, 12.3% for waste management, and 26.7 % for energy conversion. The GHG reduction targets by business type were partially modified, reflecting stakeholders' opinions suggested at the industry leader gatherings, NGO-initiated workshops, and public hearings.

Table 10: Reduction targets by sector and business types (2020 BAU)

Unit: million CO_2eq

Sector	Sub-category		Baseline (2007)	BAU (2020)	Reduction Target		
					Amount of targeted reduction	Emissions after reduction	Reduction rate (%)
Industry	Refinery		12.8	17.1	1.28	15.83	(7.5)
	Mining		1.0	0.68	0.027	0.655	(3.9)
	Steel		86.0	121.35	7.88	113.47	(6.5)
	Cement		42.2	41.48	3.53	37.95	(8.5)
	Petrochemicals		50.7	63.47	4.77	58.7	(7.5)
	Paper and wood		8.7	7.73	0.55	7.18	(7.1)
	Textile/Leather		11.9	9.81	0.61	9.2	(6.3)
	Glass/Ceramics		4.5	5.50	0.22	5.28	(4.0)
	Non-ferrous metal		5.4	5.02	0.21	4.81	(4.1)
	Machinery		10.2	13.10	0.99	12.11	(7.6)
	Electrical /Electronics	Energy	9.7	12.09	0.96	11.14	(7.9)
		Non-energy	18.0	29.25	24.55	4.70	(83.9)
	Electronic display device		6.3	71.65	28.32	43.33	(39.5)
	Semiconductor		8.4	14.53	4.03	10.5	(27.7)
	Vehicle	Energy	6.7	8.72	0.68	8.04	(7.8)
		Non-energy	2.9	3.62	3.25	0.36	(90.0)
	Shipbuilding		1.8	3.79	0.25	3.54	(6.7)
	Other manufacturing		17.6	16.91	0.29	16.62	(1.7)
	Food and drinks		6.8	6.16	0.31	5.86	(5.0)
	Construction		2.5	3.22	0.23	2.99	(7.1)
	Sub-total		314.1	455.18	82.937	372.265	(18.2)
Transport	Passenger transport / Private vehicle		87.7	107.25	36.82	70.43	(34.3)
Building	Domestic		70.5	87.44	23.62	63.82	(27.0)
	Commercial		67.6	91.52	24.44	67.08	(26.7)
	Sub-total		138.1	178.96	48.06	130.9	(26.9)
Public	Public and others		16.2	18.85	4.70	14.15	(25.0)
Agriculture, forestry, and fishery	Agriculture, forestry, and fishery		30.0	29.10	1.52	27.59	(5.2)
Waste	Waste		17.1	13.83	1.71	12.13	(12.3)
Total			610	813	243.9	569.1	(30.0)

Source: Joint Work of Relevant ministries, 2011b

Table 11: Reduction targets by year

Unit: %

Category	Sub-category	2012	2013	2015	2020
Conversion	Power generation, city gas, and district heating	1.5	3.0	6.1	26.7
Industry	Refinery	0.4	0.6	2.8	7.5
	Mining	0.4	0.4	0.6	3.9
	Steel	0.1	0.2	2.1	6.5
	Cement	0.3	0.5	3.0	8.5
	Petrochemicals	0.4	0.6	2.8	7.5
	Paper and wood	0.4	0.5	2.4	7.1
	Textile/Leather	0.4	0.6	1.1	6.3
	Glass/Ceramics	0.4	0.5	0.7	4.0
	Non-ferrous metal	0.4	0.5	0.7	4.1
	Machinery	0.45	0.7	1.2	7.6
	Electrical/Electronics	0.2	2.2	32.3	61.7
	Electronic display device	2.4	3.4	26.3	39.5
	Semiconductor	1.0	1.8	17.3	27.7
	Vehicle	0.3	1.1	15.2	31.9
	Shipbuilding	0.5	0.6	1.3	6.7
	Manufacturing	0.2	0.2	0.3	1.7
	Food and drink	0.5	0.6	0.9	5.0
	Construction	0.2	0.5	3.2	7.1
Transport	Passenger transport / private vehicle	2.0	4.2	9.6	34.3
Building	Domestic	1.8	5.0	8.9	27.0
	Commercial	1.9	4.4	8.8	26.7
Public and others	Public and others	5.2	8.6	15.7	25.0
Agriculture, forest and fishery	Agriculture, forestry, and fishery	0.0	0.1	1.7	5.2
Waste	Waste	1.3	2.0	9.0	12.3
Total		1.6	3.3	10.0	30.0

Source: Joint Work of Relevant ministries, 2011b

For example, the short-term reduction rates set for the cement industry were lowered considering challenges involved in introducing mitigation measures in the short term (Joint Work of Relevant Ministries, 2011b). The accumulation of mitigation targets by sector and business types presents the nation's total cumulative reduction target by year, set at 1.6% in 2012, 3.3% in 2013, 10.0% in 2015, and 30% in 2020. As shown in Figure 7, the ROK aims to realize decoupling of economic growth and GHG emissions by 2015. It should be noted that the 2020 target is in line with what was announced in 2009.

The setting of emissions-reduction targets by sector and business types was an ambitious attempt by the government, considering how domestic industries were to strongly oppose the government's regulatory barriers. In the process, the industrial sector continuously raised issues on the importance of disclosure of the government's decision-making process, delivery of accurate information, and public consultations. Most importantly, the continued lack of sound communication between the government and business entities resulted in frustration and loss of trust among the industrial leaders. According to a survey conducted by the Korea Small Business Institute at the end of 2010, many SME respondents mentioned that they suffered from inadequate information, leading them to obtain information from personal networks rather than from the government authorities.

Such shortfall underlines the insufficient effort of the government to eagerly engage the public in setting the emissions-reduction targets. According to a survey on businesses conducted by the Ministry of Environment following the announcement of the reduction targets in 2012, majority of business leaders show low acceptability of the reduction targets, with suggestions that targets should be reset by the forthcoming administration.

As described above, the setting of GHG reduction targets is a sensitive issue to the government, industry, and the nation as a whole. If the target is set too high, it sparks opposition from the industrial sector as the targets would weaken the ROK's international competitiveness. However, if the target is set too low, it fails to provide strong market signals and justifications for mitigation actions, and damages the government credibility in the international community. The ROK's experience has demonstrated that the most critical element of national target setting is enabling coordination among stakeholders through clear disclosure of information and regular consultation to reach an agreement among different parties, and enhancing public acceptability of the agreed targets.

Legal Framework

The Korean government laid out a comprehensive legal framework to support the setting of the national emissions-reduction targets and implementation of mitigation strategies. Most importantly, the Framework Act on Low-Carbon Green Growth provided clear government directions under the Chapter titled "Realization of Low-Carbon Society." Article 38 (Basic Principles for Coping with Climate Change) states that the government shall:

(1) establish the state's medium- and long-term targets for reduction of GHG;
(2) promote the reduction of GHG efficiently and systematically by introducing cost-effective and reasonable regulatory systems based on market mechanism; and
(3) utilize high technologies and convergence technologies to reduce GHG.

Article 42 specifically details the government's obligation to establish medium- and long-term targets as well as the goals for each particular phase of follow-up actions. The reduction targets are to be established for each sector that shall prepare the necessary measures for accomplishing the agreed targets. The Framework Act articulates the needs for emission reporting (Article 44), establishment of an integrated information management system for GHGs (Article 45), and introduction of a Cap and Trade System (Article 46).

3. Policy Actions and Programs

Years before the ROK announced low-carbon green growth as its national vision, the government initiated a number of major policies and programs that provide incentives for voluntary mitigation actions. Among others, the Voluntary Agreement (VA) scheme and the Korea Voluntary Emission Reduction Program (KVER) played critical roles during this transitional period before the government started to enforce stricter regulations.

It is important to note that the voluntary mitigation efforts from the industrial sector helped improve public perception on the necessity and justification for the government's development and implementation of regulatory measures.

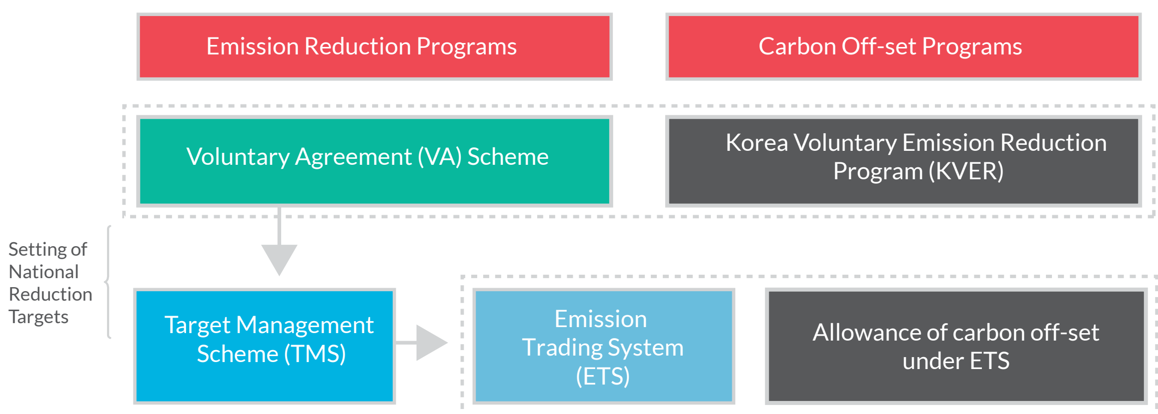
These initial efforts also helped lay the foundation for the necessary legal and institutional infrastructure required to meet the national reduction targets. In other words, the necessary foundation for the measurement, reporting, and verification (MRV), and the institutional framework that supported the implementation of the VA scheme and KVER enabled the government to introduce pre-emptive regulatory instruments such as the Target Management Scheme (TMS) and the Emission Trading System (ETS).

The VA scheme was initiated in 1998 when the ROK had limited understanding of and experience on how to effectively regulate GHG emissions. The purpose of the VA scheme was to facilitate energy-saving and GHG-reduction efforts in the industrial sector. Targeting energy-intensive enterprises with annual energy consumption greater than 5,000 TOE, the government signed agreements inviting businesses to voluntarily establish plans, implement actions, and report the outcomes of energy and/or GHG emission-reduction actions. What initially started with just 15 companies, including POSCO (a major steel manufacturer), developed into an active program supported by 1,300 companies by 2009. However, while the VA scheme helped in raising the awareness of business leaders on the necessity for the nation's collective mitigation actions, outcomes were limited as it was a compulsory scheme. The VA scheme eventually lost momentum when most of the companies involved were allowed to participate in the TMS when it was first introduced in 2011.

The KVER was launched in 2005 and led by the Ministry of Knowledge Economy, now known as the Ministry of Trade, Industry and Energy (MOTIE). As one of the nation's earliest programs aimed at emissions reduction, the procedures and requirements of the KVER were very similar to the UNFCCC's Clean Development Mechanism (CDM) initiative. Under this carbon offset program, the government certifies and provides incentives for emissions reduction achieved through energy-efficiency improvements and development of renewable energy. Carbon offset is a mechanism whereby a country, company, or individual invests in another party to reduce GHG emissions, in order to compensate for or to offset an emission made elsewhere. The mechanism allows actions to capture the low-hanging fruits of emissions savings – the easiest and cheapest "quick wins" – to balance out their own carbon footprints. Although KVER lost momentum in 2011 when the nation's major emitters were mandated to take part in the TMS, the program is expected to continue to serve as a carbon offset mechanism under the ETS, which came into force in 2015.

The ROK reached a turning point in its GHG reduction policies and actions in 2008 after President Lee declared low-carbon green growth as the new paradigm for national development.

Figure 8: Relationship between different GHG reduction schemes and carbon offset programs



Source: GGGI, 2014

In order to fulfill the national GHG emission targets, the government created the TMS, which requires companies emitting more than 15,000 TOE annually to set individual reduction targets in consultation with the government. Following these efforts, the government launched the ETS as a strengthened regulatory measure superseding the TMS in 2015.

3.1 Establishment of the GIR and National GHG Inventory

The MRV system emphasizes the importance of how mitigation actions should be taken in such a manner that they can be clearly measured, reported, and verified. The 2007 Bali Action Plan highlighted the importance of MRV system in order for each country to deliver concrete national actions on managing their respective national GHG reduction targets. As MRV is an effective tool to secure the transparency and consistency of information on national mitigation actions, establishing an MRV system is an essential and basic element of GHG reduction efforts.

Under the Kyoto Protocol, Annex I parties (developed countries) are required to report annually on inventories of GHG emissions and descriptions of key mitigation actions to the UNFCCC in a specified format. The guidelines for Annex I countries lead to consistency in what countries report, when they report it, and how they make such reports. In contrast, reporting requirements are less stringent for non-Annex I parties (developing countries) and allow for Nationally Appropriate Mitigation Actions (NAMAs).

There is thus an urgent need for developing countries to establish an accurate and consistent MRV system that can be used worldwide in order to ensure efficient mitigation actions and international support for GHG reductions. It is also necessary for them to draw up an inventory of GHG that is universally recognized to engage in the international carbon market. The ROK is not an Annex I party to the Kyoto Protocol but the country established the Greenhouse Gas Inventory and Research Center (GIR) in June 2010 to lead the preparation of GHG reduction measures.

Greenhouse Gas Inventory and Research Center (GIR)

After announcing the vision of low-carbon green growth in August 2008, there was much discussion about setting up a research institute for GHG reduction. As such, the GIR was established in June 2010 as an affiliated research institute of the Ministry of Environment (MoE) based on the Framework Act on Low Carbon, Green Growth (PCGG, 2010). At the Cabinet meeting held on November 17, 2009, it was thus decided to set up an "independent and permanent research institute" as a follow-up measure to ensure accomplishment of the national GHG reduction target. In April 2010, the ROK government enacted the Framework Act on Low Carbon, Green Growth and its Enforcement Decree. The principle and system of GHG inventory management and setting up of the GIR is specified in this law, and the establishment of a clear and effective National Greenhouse Gas Information Management System was realized (PCGG, 2010).

Table 12: Vision, goals, and functions of GIR

Category	Description
Vision	Serve as a think tank on global GHG mitigation
Goals	(Information Hub) – Manage GHG emission information efficiently (Accelerating Green Growth) – Respond to climate change through GHG mitigation (Global Networking and Outreach) – Develop a global collaboration system for GHG reduction
Six Functions	Operate a world-class national GHG management system Support the implementation of TMS and ETS Support the national and sectorial GHG reduction target setting Conduct research on domestic and overseas GHG reduction efforts Expand international cooperation for climate change response Prepare for linking up with international carbon markets

Source: GIR, 2014b

Under the Act, the MoE and the PCGG formed a team to lay the groundwork for the establishment of the GIR, which started to operate on June 15, 2010. As a leading research institute on GHG inventory and mitigation, it aims to control and manage GHG emissions at the levels set for developed countries.

With the vision of serving as a think tank on global GHG mitigation, the GIR set three main goals: comprehensive and efficient management of GHG information; acceleration of green growth by supporting the attainment of GHG reduction targets; and development of a global collaboration system for GHG reduction. It consists of three teams with distinct duties and responsibilities: the Planning and Management Team; the GHG Inventory Management Team; and the GHG Mitigation Research Team. Meanwhile, the MoE organized and now operates a consultative group to ensure efficient performance of the GIR, consisting of high-level government officials from relevant government agencies.

Since the performance of the GIR depends on its expertise and autonomy as a research institute supporting the accomplishment of national GHG reduction targets, the organization initially started with a minimum number of administrative officials (three), and focused on recruiting high-quality researchers (Enforcement Decree for the Framework Act on Low-Carbon Green Growth Article 36.3). Eleven researchers and ten professionals dispatched from relevant agencies secured the necessary expertise and independence of the GIR. Since its foundation, it has conducted diverse activities including the setting of the national GHG reduction targets, managing the targets by updating reduction potential, supporting GHG reduction, and drafting a roadmap. Also, it has been responsible for the management of TMS implementation; national GHG inventory update, refinement, and revision; setting up of an ETS registry; and initiation of international cooperation projects.

National GHG Inventory System

The GIR's main mission is to compile and maintain a transparent and reliable national inventory on GHG concentration. In this regard, the institute has implemented measures to improve the quality of inventory data and the GHG Management System (GIR, 2014c). In line with promoting transparency in government, anyone can now access GIR's online inventory data and look for participant entities of TMS (including entities subject to the ETS). The GIR's data collection provides a wide range of data – macro data such as national GHG emissions and emissions per capita, and smaller-scale data such as GHG emissions per company or facility.

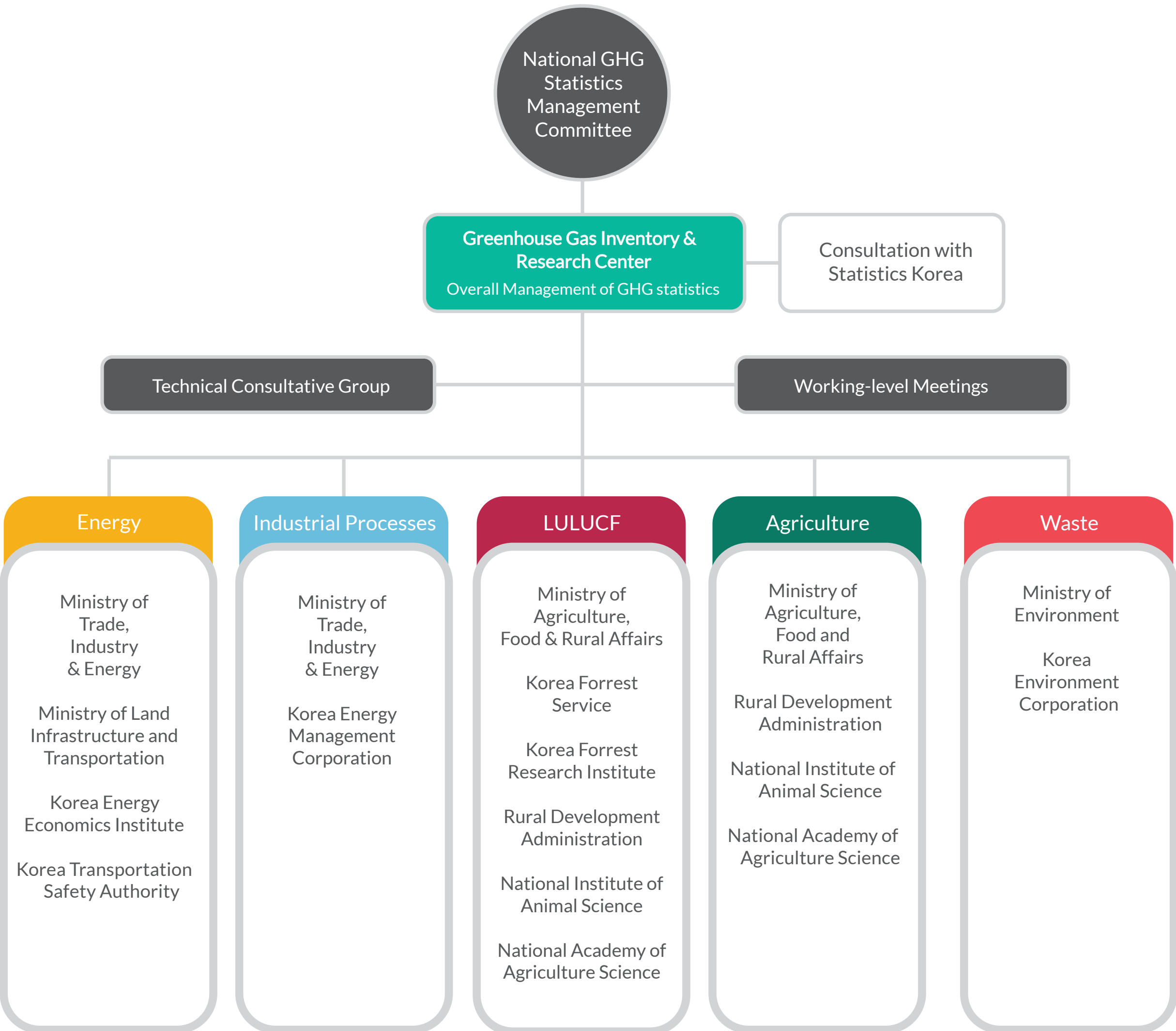
The institute is also in charge of reviewing GHG emissions data prepared by the heads of the relevant ministries and providing the National GHG Statistics Management Committee with the data for its review. The National GHG Statistics Management Committee led by the Vice Minister of Environment coordinates, deliberates, and decides on GHG inventory collected by the GIR. The preparation of the national GHG inventory is conducted in three stages:

(1) measurement and reporting;
(2) verification; and
(3) deliberation and decision-making (GIR, 2014c).

In accordance with Article 36 of the Enforcement Decree of the Framework Act on Low Carbon Green Growth, the GIR should provide guidelines for the MRV of the national GHG inventory (MRV5) to controlling ministries of each of the five sectors. In return, the ministries of each sector are to submit a final report of GHG inventory to GIR. The national GHG inventory covers the six main GHGs under the Kyoto Protocol, namely: Carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), and Sulphur hexafluoride (SF_6).

The National Inventory Report (NIR) prepared by the GIR is a national GHG emissions statistics report following the IPCC Guidelines for National Greenhouse Gas Inventories. The NIR covers quantitative data on GHG emissions and emission sources, including GHG emissions generated by the five sectors specified above. In the NIR, the base year is the first year when a country began calculating and analyzing its GHG inventory, and 1990 is the base year for most countries. Likewise, the ROK's NIR presents time series data on GHG emissions and GHG sinks for all years from the base year (1990) to the most recent year. For instance, the 2012 NIR

Figure 9: Institutional coordination for the national GHG inventory system



Source: GIR, 2014d

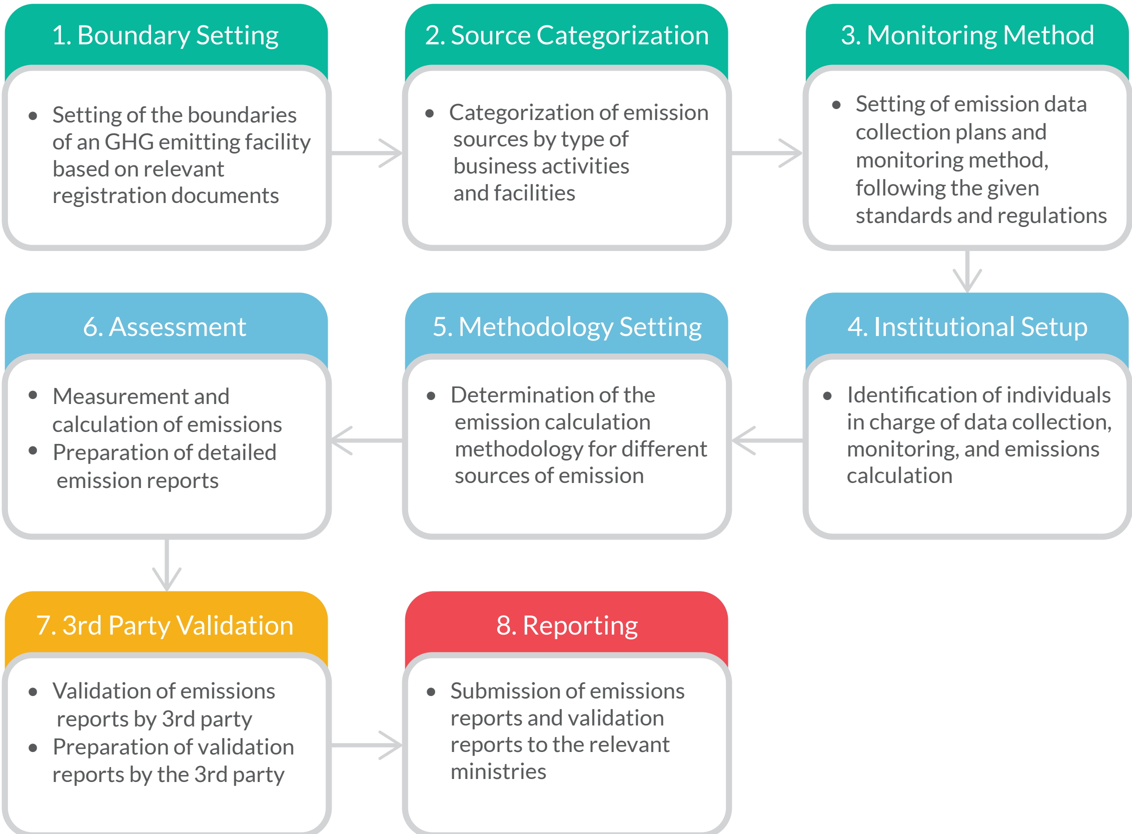
provides the statistical trends of ten years from 1990 to 2010 and the 2013 NIR covers 11 years, from 1990 to 2011.

3.2 Korea Voluntary Emission Reduction (KVER) Scheme

The Korea Voluntary Emission Reduction (KVER) Scheme, launched in 2005, is the nation's first major GHG reduction program. Under this scheme, business enterprises are required to voluntarily reduce GHG emissions by taking measures such as introducing energy-efficient equipment and enhancing manufacturing processes (GIR, 2014a).

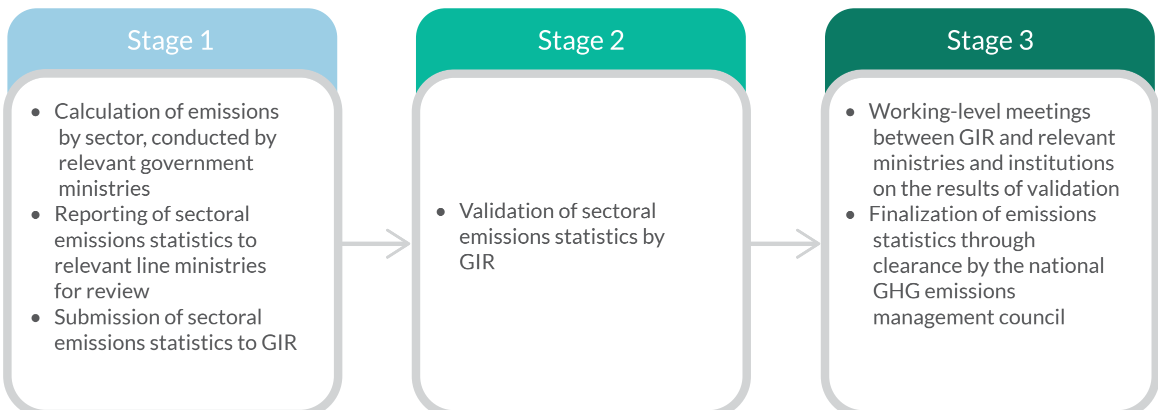
Upon assessment and verification of these attempts, companies receive certification for their GHG reductions. During the early years of implementation, the KVER scheme targeted all business enterprises operating in the ROK (Phase 1), but this was narrowed down to SMEs in 2011 (Phase 2) when the TMS was introduced. Even

Figure 10: MRV Procedures



Source: MoE, 2014f

Figure 11: National GHG inventory preparation process



Source: GIR, 2014c

though the TMS took over quite a large proportion of target participants of KVER, the latter maintains to cover SMEs, which are not obligated to reduce GHG emissions under the TMS.

KVER Phase 1

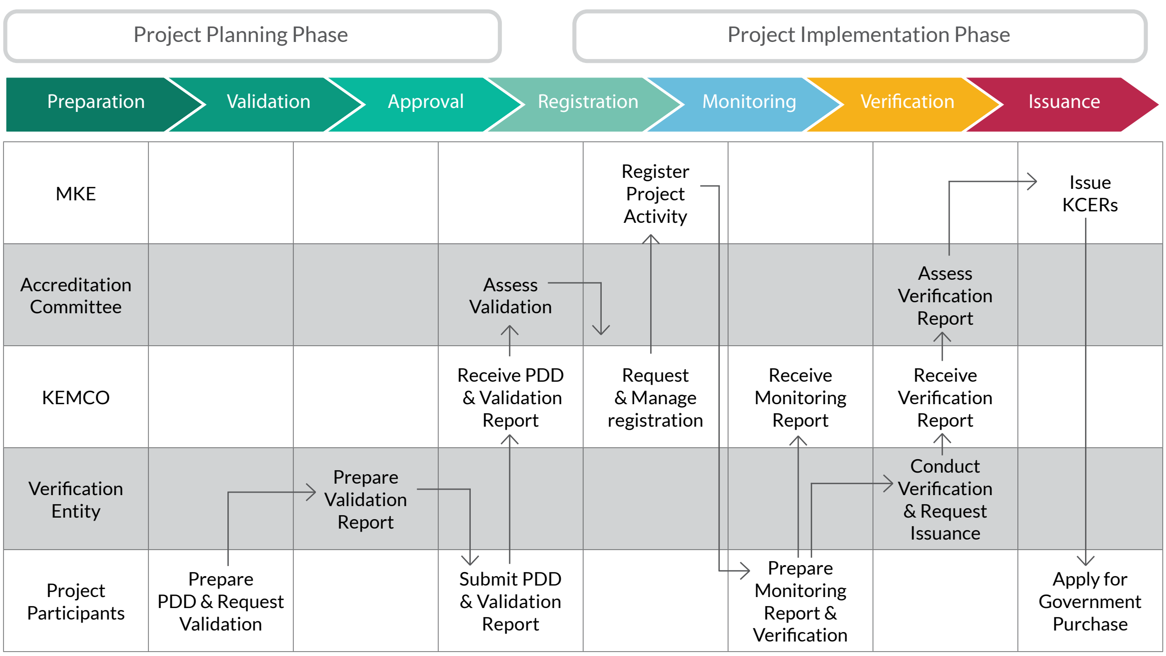
The KVER scheme's concept and activities are similar to the well-known CDM projects. Generally, six steps are required to obtain GHG reduction credits:

(1) project planning;
(2) validation;
(3) approval;
(4) project implementation;
(5) verification of GHG reductions by a third party; and finally
(6) certification of GHG emissions reduction and issuance of Korea Certified Emission Reduction (KCER).

The project developer prepares and submits the Project Design Document (PDD), in the initial stages of project conceptualization, to an accreditation institute for review. The verification institute is a third party qualified to assess GHG reduction potential, review implementation plans, and verify the actual reductions achieved. Once it drafts the validation report based on the findings from PDD, the Korea Energy Management Corporation (KEMCO) forwards all relevant documents for a final review to the accreditation committee before officially registering the project for implementation. After the project moves into the implementation phase, the GHG reduction activities and their outcomes are self-monitored by the project developer as stipulated in the PDD. As a matter of course, the verifying institute conducts the final verification process and drafts verification reports that specify the amount of reduction eligible for being recognized as reduction credits. Finally, the verification report is reviewed by the accreditation committee and KCERs are issued accordingly.

The Ministry of Trade, Industry and Energy (MOTIE) is the government institution in charge of issuing registration certificates for GHG emission-reduction projects. As described above, KEMCO is the supporting agency under MOTIE that registers projects, manages the outcomes of KVER projects, operates the accreditation committee, and provides all required assistance in project planning and implementation. The GHG verifying institute is a third party composed of relevant exports and is given the role to evaluate PDDs as well as monitor and verify the performance of GHG reduction

Figure 12: Implementation process of the KVER scheme



Source: Han, 2010

activities. KCERs are issued annually over the first five years of project implementation (starting from the year of PDD registration).

To encourage active participation of the industry, the ROK government has offered different incentive schemes, the most significant of which was the profit gained by participating companies in selling the KCERs. Since 2007, the government has periodically purchased KCERs at prices ranging between US$4 to US$6 per ton of CO_2 equivalent. The government decides on the unit prices of KCERs, based on the fluctuating prices of the European Union Allowance (EUA). Such government incentives encourage companies to actively engage in mitigation activities. The SMEs that are comparably less capable (both in financial and technical terms) of taking part in KVER were provided with additional government incentives. For example, in the project-planning phase, the government provided grants of up to US$2,000 to 4,500 per project as a means of supporting the costs necessary in developing PDDs. During the implementation phase, SMEs were also eligible to receive government grants (up to US$3,000 per year) to cover the costs needed in self-verifying the amount of GHG reductions.

Outcome of Phase 1

Table 13 below shows the number of projects and government purchases made over the Phase 1 period. The number of projects continued to increase until 2007 but drastically decreased in 2008 due to two major reasons: the depletion of potentially viable projects; and the capping of government budget for the purchase of KCERs. As of early 2010, there were 255 projects registered and heat recovery and utilization projects were found to dominate the total share of investments. Such efforts accounted for 86% of the total number of projects, while others such as electricity-efficiency enhancements and use of renewable energy cover the remaining share.

Table 13: Projects and government purchases under the KVER scheme

Unit: tCO_2

Year	Application for registration		Registered projects		Verified Projects		Government projects	
	No. of Projects	Expected KCERs	No. of Projects	Expected KCERs	No. of verification	Verified KCERs	No. of Purchases	Purchased KCERs
2005	26							
2006	68	7,079,666	41	1,043,474				
2007	171	8,767,476	60	983,750	38	941,307	37	940,602
2008	64	7,696,514	86	1,226,124	88	1,926,752	82	1,576,968
2009	70	7,467,908	65	1,260,822	161	2,720,353	141	2,229,080
2010	53	5,582,356	43	444,733	176	2,961,528	87	1,742,808
Total	452	43,524,716	295	4,958,905	463	8,549,940	347	6,489,458

Source: KEMCO, 2013

KVER Phase 2

After the launch of the TMS, the coverage of KVER was limited to SMEs and there was a slight modification of the operating guidelines. The Phase-2 KVER offered SMEs full support for administrative costs and guaranteed government's purchase of KCERs in order to encourage their voluntary GHG reduction activities. Among the SMEs, those that have operated new facilities for less than a year and whose facilities have GHG reduction potential exceeding 100 tCO_2 per year can apply for KVER projects. Once selected, project developers receive government grants necessary for the preparation of the PDD and certification of GHG emissions reduction. An entity that owns multiple facilities is allowed to apply for project registration separately.

One of the exemplary cases of GHG reduction projects by SMEs under the KVER scheme is a fuel switching project of Sampo Food Co., a Korean food distributor operating dozens of canneries. The company had a cannery in Chungju manufacturing canned products (e.g., vegetables, fruits, seafood) for both domestic and overseas markets. Before KVER, the Chungju cannery of Sampo Food Co. used oil burners to produce steam used in manufacturing. However, it succeeded in reducing GHG emissions by switching to LPG.

The second case is a waste heat utilization project of Cheongna Energy and Insun ENT (Environmental New Technology). Before KVER, Cheongna Energy produced hot water for a district heating system using LNG while Insun ENT, a construction waste disposable service provider located in nearby Cheongna Energy, released steam into the air. The released steam from Insun ENT was a by-product generated from waste boilers. However, the two companies succeeded in GHG reduction by agreeing to work together for KVER by utilizing Insun's steam as a fuel to produce hot water for Cheongna, instead of using LNG to heat up the water. By reducing Cheongna's consumption of LNG, both companies were successful in reducing GHG emissions.

Outcomes of Phase 2

As of September 2013, a total of 422 projects were registered for GHG reductions. The total GHG emissions amounting to 14,620,000 tCO_2 have been certified since 2007, and the government paid approximately 38 billion KRW to purchase 7,560,000 tCO_2. Statistics show that there was active registration between 2007 and 2009, but the number of registration and the amount of certified GHG reductions significantly decreased between 2011 and 2012. As described earlier, this was the result of limiting the KVER scheme's target to SMEs after the introduction of the TMS. To reverse this downward trend, KEMCO is taking measures to promote the participation of SMEs in GHG reduction projects.

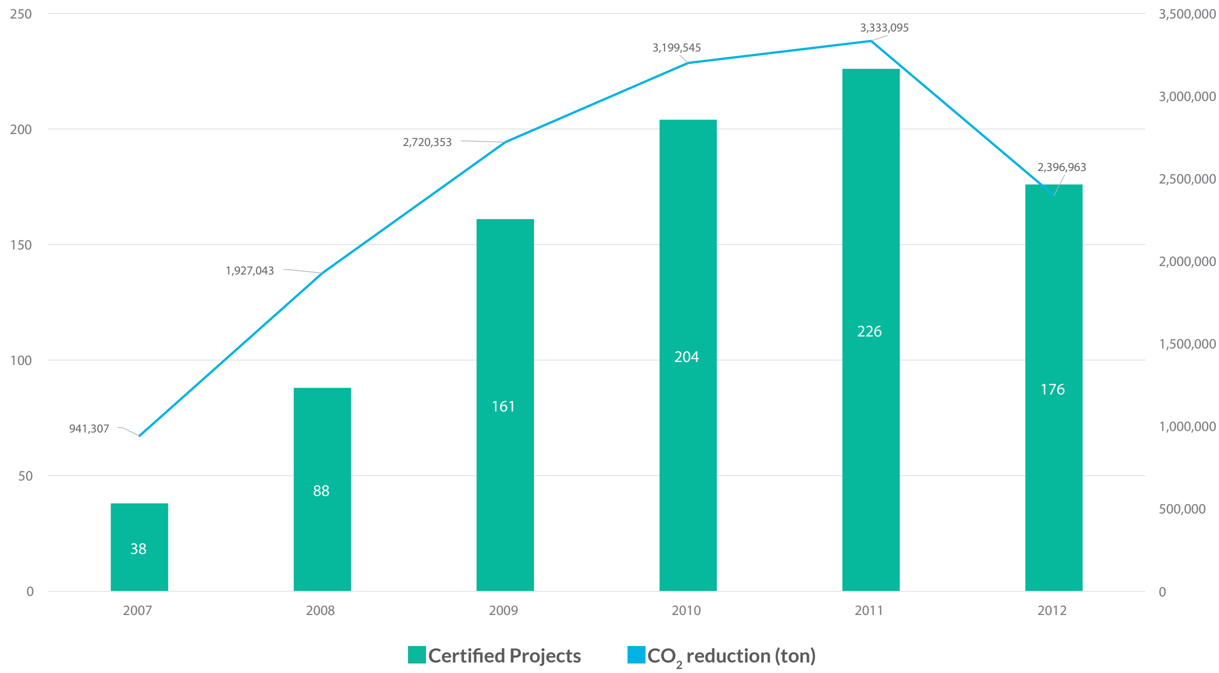
Table 14: GHG reduction case of Sampo Food Co.: Switching from oil to LPG

Category			Energy Consumption	Emission	Reduction
Outcome	Before KVER		222,000 L /year (Diesel)	644 tCO_2/yr	119 tCO_2/yr
	After KVER		181,732 Nm^3/year (LPG)	525 tCO_2/yr	
Investment Effect		Amount of investment	Energy cost savings	Government Support	Investment cost recovery period
		4 million (KRW)	56 million (KRW)	7 million (KRW)	0.1 (year)

Table 15: GHG reduction case of Cheongna Energy and Insun ENT: Utilization of waste heat

Category			Consumption	Emissions	Reduction
Outcome	Before KVER		222,000 L/year (Diesel)	8,723 tCO_2/yr	8,696 tCO_2/yr
	After KVER		9,860 L/year (LNG)	26 tCO_2/yr	
Investment Effect		Amount of investment	Energy cost savings	Government Support	Investment cost recovery period
		2.2 billion (KRW)	3 billion (KRW)	0.1 billion (KRW)	0.7 (year)

Figure 13: Number of certifications and volume of reduced GHG emissions



Source: KEMCO, 2013

For instance, a new program known as the "Support Program for Infrastructure Development to Promote Participation in GHG Reduction Projects" offers a package of supporting programs including: holding workshops to improve the understanding of climate change responses and KVER; offering educational and training programs; building GHG inventory to track GHG emissions and support new GHG reduction projects; and assisting in PDD preparation.

3.3 Target Management Scheme (TMS)[1]

The Industrial Greenhouse Gas and Energy Target Management Scheme (TMS) specifically aims to reduce GHG emissions and energy use by the industrial sector. Under the TMS, approximately 600 large-scale business facilities, which are responsible for more than 60% of the ROK's total emissions, are subject to setting GHG reduction and energy-saving

1 | Note that this section will primarily focus on the GHG emissions reduction function of the TMS.

targets. Compared to the Voluntary Agreement (VA), which emphasizes voluntary participation of companies in setting and achieving GHG reduction targets, TMS involves stronger and more stable policy enforcement.

The preparations for the official launch of TMS began in March 2010[2] . As a supervisory agency, the Ministry of Environment (MoE) led the preparatory work by creating a task force in April 2010, which developed the specific guidelines for TMS operations, monitoring, reporting, and verification (MRV) procedures, and criteria for the designation of participating entities. The benchmarking studies were conducted to ensure that the guidelines reflect the leading practices of similar standards and programs around the world (e.g., Rule for the Mandatory Reporting of Greenhouse Gases/US EPA), National Greenhouse and Energy Reporting Act of Australia, EU-ETS Monitoring and Reporting Guidelines, and Japanese Voluntary Emissions Trading Scheme/JVETS). Once the draft guidelines were prepared, the task force held focus group meetings, briefing sessions, and public hearings to gather feedback to make final adjustments before the official launch in March 2011.

Implementation

The TMS is implemented according to the following process:

(1) designation of participating entities (i.e. controlled entities);
(2) negotiations between ministries and controlled entities for setting GHG reduction and energy saving targets;
(3) preparation and submission of implementation plans;
(4) implementation of mitigation measures;
(5) preparation and submission of completion reports, GHG emissions, and energy use accounts; and
(6) evaluation of outcomes by relevant ministries.

(1) Designation of Controlled Entities

In the early years of operation, the controlled entities under the TMS were companies and facilities showing average emissions and energy use for the previous three years of above 125,000 tCO_2 eq. (GHG emissions) and 500J (energy use) for companies, or 25,000 tCO_2 eq. (GHG emissions) and 100J (energy use) for facilities. These criteria were made more stringent in 2012 and 2014 as shown in Table 18. As of 2014, the total number of controlled entities registered was 466, the majority of which belong to the petrochemical industry while the rest are from the power generation and manufacturing industries such as semiconductors, electronics, and cement.

(2) Setting of Targets

The emissions reduction and energy-saving targets are set on an annual basis (i.e., in terms of target allowances) and follows the "grandfathering method," which involves the setting of target allowances based on emissions in the baseline year.[3] As shown in Figure 16, the Greenhouse Gas

Table 16: GHG reduction case of Cheongna Energy and Insun ENT: Utilization of waste heat

Category	VA	TMS
Target setting	Self-setting by participating companies	By mutual consent of government and companies (controlled entities) through consultation
Implementation	Voluntary	Compulsory
Verification	Self-verification	Third party verification

Source: MOTIE, 2009

2 | The government began to pilot test the TMS on selected companies from 2009.
3 | The TMS was planned to replace the "grandfathering method" with "benchmarking method" in 2013. The benchmarking method involves setting of targets by using "benchmark intensity levels" for industrial processes or products (for example, the total GHG emissions for per unit of production). However, the plan was postponed due to concerns over the integrity of the set benchmark intensity levels.

Inventory and Research Center (GIR) initially makes top-down BAU projections of the total emissions from controlled entities under the TMS.

The pre-determined emission reduction rates for each sector (the values of which need to be met to stay on track toward achieving its reduction targets) are multiplied to their BAU emissions, which provide an estimate of the total amount of allowances to be made available for the controlled entities in the compliance year. Opposing to such top-town projections and target setting, the ministries responsible for different industrial sectors open negotiations individually with each of their controlled entity to agree on their BAU emissions (bottom-up approach; negotiations are based on the projected growth in business, and plans on facility expansion; refer to Table 19. The emission allowances of each entity are equivalent to the agreed BAU emissions multiplied by the reduction coefficient, which means that commensurate responsibility is shared among the entities under same industrial sector.

Figure 14: TMS implementation process

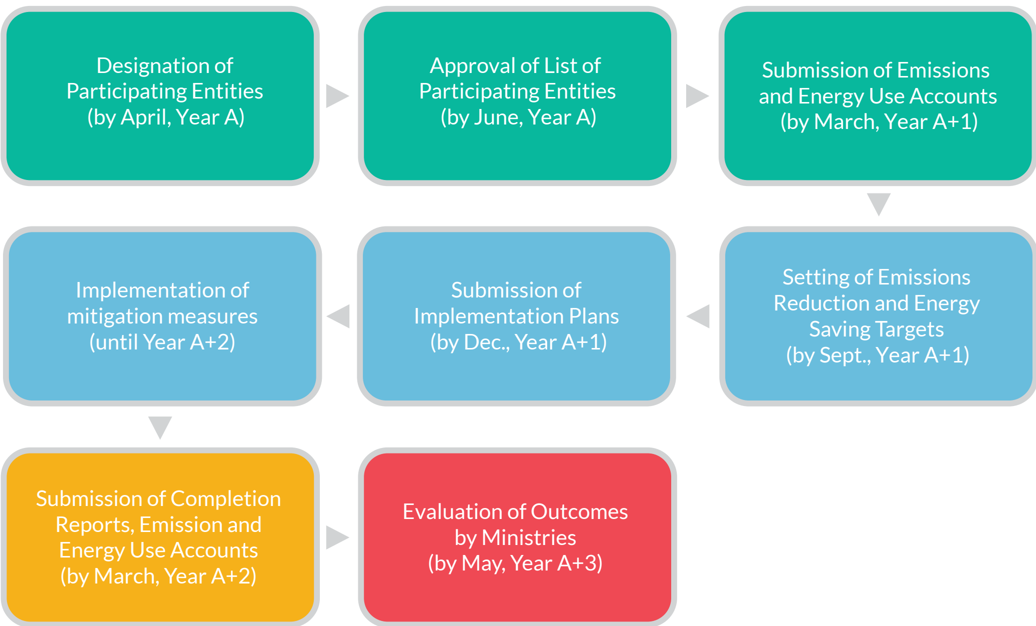


Table 17: Preparation process for TMS

Period	Description
April 19, 2010	Creation of the TMS Task Force
April 30, 2010	Development of guidelines for TMS operation
May 2010	Focus group meetings with selected CEOs from the power generation and manufacturing industries
July 2010	Program briefing sessions for candidate controlled entities
November 18, 2010	Public hearing on TMS guidelines

(3) Preparation of Implementation Plans, Completion Reports, and Emission Accounts

The controlled entities submit the Implementation Plans – outlining how the established targets are to be met – for approval by their relevant ministries. Upon carrying out mitigation activities, their outcomes are presented in the form of Completion Reports and Emission Accounts, which are verified by third party organizations (verification institutions) prior to submission to the heads of ministries. As of 2013, there are 25 verification institutions selected by the government that have been providing emissions verification services for the entities.

(4) Recognition of Early Actions

The TMS acknowledges the past emissions reductions achieved by the controlled entities, that is, those from measures that have been completed before the entities entered the TMS program are accepted to be part of their emissions account for the compliance year. However, only the reductions that have been fully verified and acknowledged by government-run programs such as KVER are recognized. The maximum amount of emissions reductions from early actions accepted for a given compliance year are not to exceed 10% of the annual allowance for each entity. The government has also placed a cap on the total volume of acceptable emissions reductions from early actions for a given compliance year, which is 1% of the total allowance for controlled entities.

(5) Measurement, Reporting, and Verification (MRV)

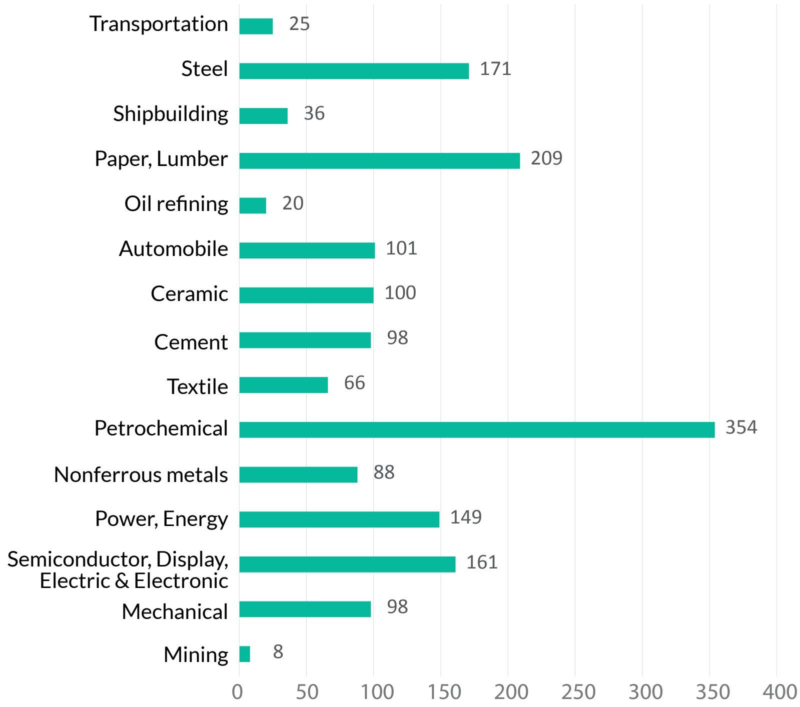
The procedures for MRV under the TMS are quite rigid, comparable to those of Japan (Standards on Reporting of CO_2 Equivalent GHG Emissions) and the U.S. (GHG Mandatory Reporting Program - Monitoring and Reporting Regulation/MRR). Most importantly, MRV procedure mandates third party verification to all emissions reduction achieved, which should strictly follow the guiding principles laid down by the government. The MRV process in essence can be divided into eight phases as shown in Figure 14.

Table 18: Criteria for designating the entities subject to TMS

Year	Company Standard		Facility Standard	
	GHG emission	Energy consumption	GHG emission	Energy consumption
2010~	125,000 tCO_2 eq or higher	500 TJ or higher	25,000 tCO_2 eq or higher	100 TJ or higher
2012~	87,500 tCO_2 eq or higher	350 TJ or higher	20,000 tCO_2 eq or higher	90 TJ or higher
2014~	50,000 tCO_2 eq or higher	200 TJ or higher	15,000 tCO_2 eq or higher	80 TJ or higher

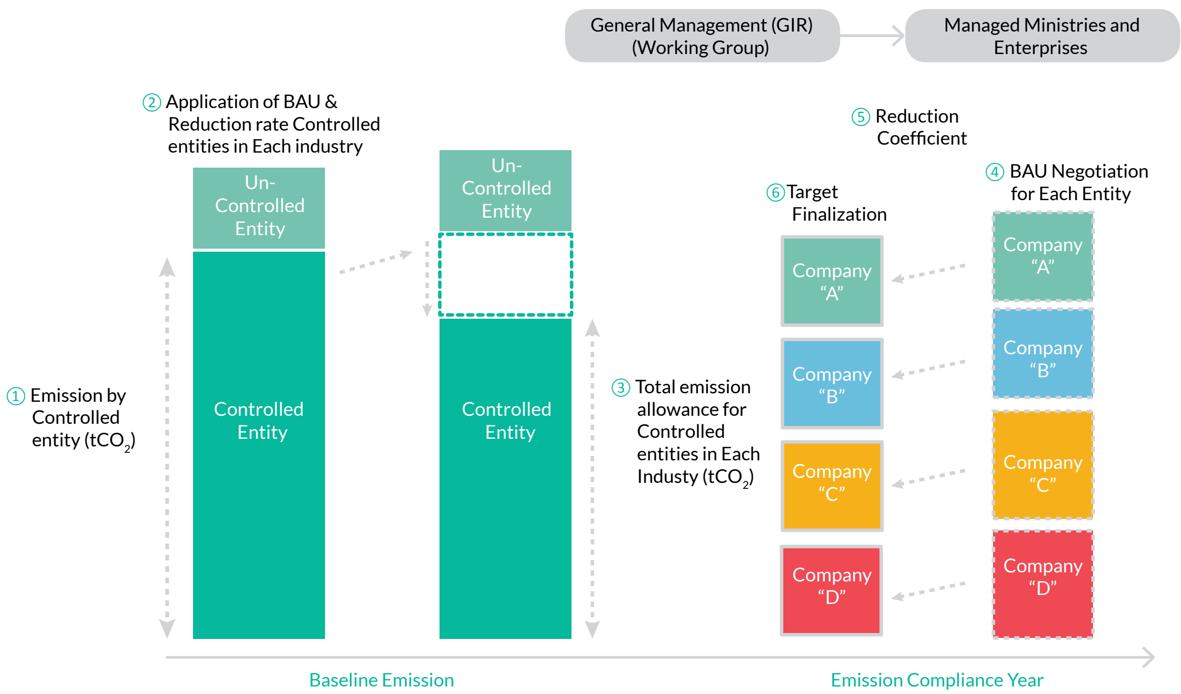
Source: MoE, 2014c

Figure 15: The number of controlled entities of TMS as of 2014



Source: MoE, 2014d

Figure 16: Target setting system for GHG reduction



Source: MoE, 2012f

Table 19: Calculation of emission allowance for controlled entities (bottom-up)

Emission Allowance = [Baseline Emissions x (100% + Expected Growth Rate in Business Activities) + Expected Emissions from New Facility Installation or Facility Expansion] x Reduction Coefficient
Baseline Emissions: Emissions of companies or facilities for the baseline year
Estimated Growth Rate in Business Activities (%): Estimated growth in emissions from the baseline year, based on projections of the rate of facility operations and volume of production
Emissions from a New Facility Installation or Facility Expansion: Amount of additional emissions expected from new facility installations or facility expansions that arise from the baseline year
Reduction Coefficient: Factor used to adjust the gap between emission allowance and the total projected emissions of controlled entities for a given industrial sector (i.e., equivalent to government-set allowances for each sector divided by the total amount of agreed BAU emissions from their controlled entities).

Table 20: Items to be included in the reports of the covered entities

Implementation Plans	Completion Reports and Emission Accounts
• GHG emission status by facilities • Information on the specific locations and methodologies for GHG emissions monitoring • Detailed targets and plans for mitigation actions by year • Plans for new facility installations and expansion of existing facilities • Plans for quality assurance and control • Plans for reflecting remedial measures suggested by the relevant ministry from the previous year	• Data on actual GHG emissions and energy use • Comparison between targets and actual results • Details on technology applications and investments made to reduce emissions • Outcomes of quality assurance/control activities • Implementation reports reflecting remedial measures

Source: MoE, 2014c

Table 21: Details of MRV procedures

Phase	Description
Phase 1: Boundary Setting	- Setting of boundaries for controlled entities
Phase 2: Determination of Emissions Source	- Review of facility list and past energy consumption data
Phase 3: Selection of Monitoring Method	- Selection and verification of monitoring method in comparison to the government's set guidelines
Phase 4: Establishment of Monitoring Framework	- Establishing framework (e.g., instrumentation and division of labor) for period monitoring of emissions
Phase 5: Assessment of Emissions by Facilities	- Calculation of emissions for each facility based on collected data
Phase 6: Preparation of Emission Accounts	- Preparation of Emission Accounts based on the assessments of Phase 5
Phase 7: Emissions Verification	- Third party verification of Emission Accounts
Phase 8: Submission of Emission Account	- Submission of Emission Accounts to relevant ministry

Source: MoE, 2014f

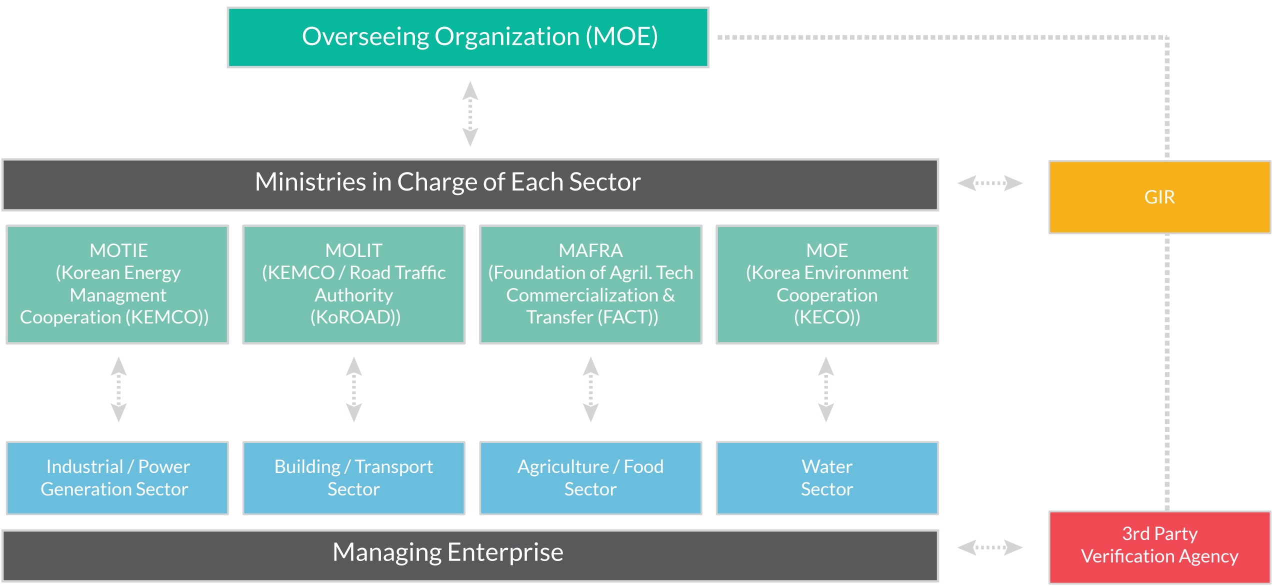
Institutional Framework, Incentives, and Penalties

The MoE supervises the process for TMS implementation outlined above, while the responsible line ministries manage the actions on the ground. The MoE is in charge of preparing and disseminating the key operational guidelines, as well as approving the list of participating entities. The MOTIE, MOLIR, MAFRA, and MoE are the supervising ministries responsible for negotiating reduction targets with the controlled entities as well as reviewing their implementation plans, completion reports, and emissions accounts upon submission. As an information hub for the national GHG emissions, the GIR supports the process of verifying the emissions accounts prepared by MoE and supervising ministries.

The TMS is a regulatory scheme that does not require budgetary support. However, the ROK government provides participating companies with institutional and financial incentives to ensure the efficient operation of the scheme. For example, the government rolled out a new financial program that offers low-interest loans for controlled entities that invest in energy-efficient facilities. In addition, government programs that grant financial incentives for consulting services related to meeting the target allowances (e.g., conducting on-site diagnosis to recommend potential mitigation measures) have also been initiated.

In terms of regulatory actions, the government penalizes the entities failing to meet the requirements, such as non-submission of completion reports or third party verifications, fabricating emission accounts, and failing to meet given target allowances. The amount of fines for negligence differs by types and number of relevant cases. Nevertheless, the government ensures that the

Figure 17: Institutional framework for TMS implementation



Source: GIR, 2014e

Table 22: Violations for failing to meet target allowances

Violation	Amount of fine (KRW)
When an entity fails to meet the target allowance and implements corrective actions:	
(a) First violation	3 million
(b) Second violation	6 million
(c) Third or more violations	10 million

controlled entities are given a chance to take corrective actions before the imposition of fines. It is important to note that the amounts of fines imposed are not in any way related to the actual amounts of GHG emissions exceeded.

Outcomes and Takeaways

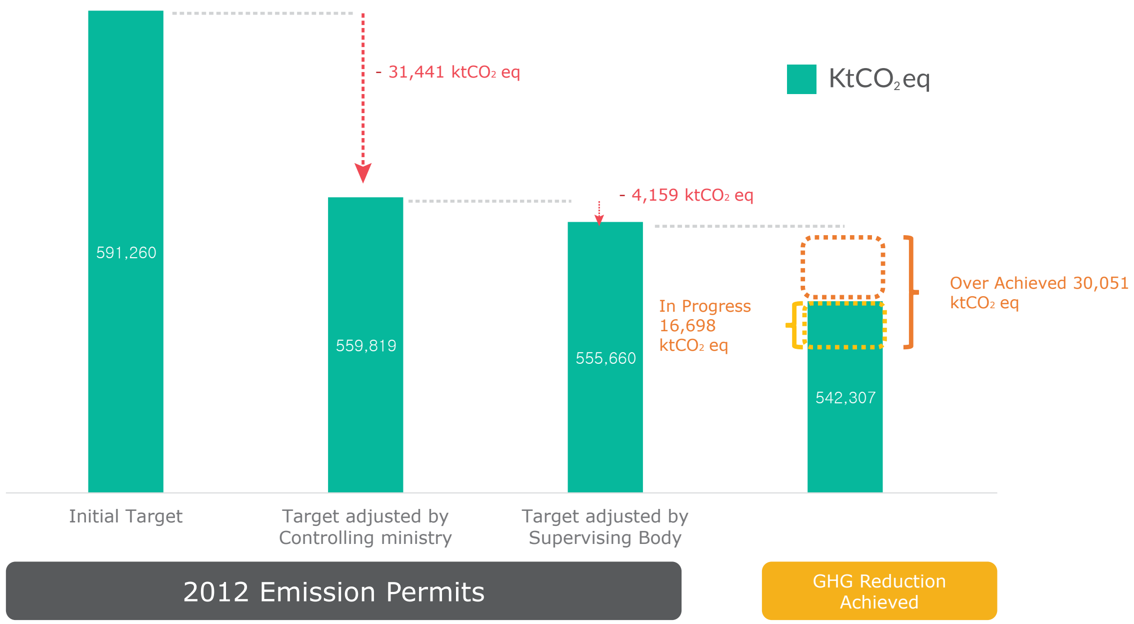
The results on actual emissions reduction achieved by the controlled entities of TMS have shown promising results. In 2012, as many as 434 entities contributed to 21.3 million tons eq. CO_2 reduction, which is approximately 3.8% of their total emissions; more than 90% of the total number of participating entities have achieved their targets. It is important to note that such outcomes are 2.7 times higher than the government's initially set targets for the year, which stood at 8 million tons eq. CO_2. Most of the emissions reductions came from the petrochemical (32.4%), steel (26.9%), and cement (18.2%) industries, which hold a large number of the controlled entities. The MoE reported that the emissions reduction achieved in 2012 was equivalent to 53.7% of the nation's estimated net carbon sink from forest reserves, or GHG emissions from operating ten 900 MW capacity thermal power stations providing district heating to 160,000 homes.

The TMS is gaining recognition for slowing the growth of GHG emissions in the industrial sector in the ROK. Although the scheme initially raised concerns that the controlled entities would need a significant amount of time to prepare for changing their operations, the outcomes achieved show that companies can take on the challenge in a cost-effective way. It is worth noting that public hearings held before the enforcement of TMS have conveyed strong signals to the industrial leaders that the government is fully committed in taking all necessary measures to enforce TMS. The government's provision of financial incentives in the form of grants and technical assistance (from energy service companies) to assist SMEs regarding emissions inventory and diagnosis was an important success factor. In addition, the contribution of third party verification institutions and the effective coordination between the MoE and the line ministries were critical in overcoming the obstacles to TMS implementation.

As of 2014, there were no recorded penalties imposed on controlled entities that failed to meet their requirements. The low levels of fines and the government's reluctance to impose penalties reflect the government's objective of making the policy less threatening to companies. Instead, the government tries to offer them opportunities to build solid technical and infrastructural capacity to undertake MRV, which is a prerequisite for the successful transition to the ETS. A 2013 survey for controlled entities of TMS confirmed that the scheme was successful in achieving this objective (Yoon and Won, 2013). Many responded that the TMS provided an exceptional opportunity to prepare for the ETS, especially in building corporate capacities in preparing for third party verifications and creating emissions accounts.

Inevitably, the effectiveness of TMS remains controversial as many of the controlled entities have shifted to take part in the newly introduced ETS in 2015. Still, the scheme has the potential to serve as an effective tool to manage GHG emissions targets for the energy producers and business entities that are excluded from ETS. As depicted by the Phase 2 outcomes of the KVER, the government must make systematic changes for the scheme to remain effective. As the TMS is no longer a stepping stone for making a transition to the ETS, stricter application of penalty rules is paramount in fulfilling its role as a regulatory tool. The government thus needs to assure the industry and the citizens that TMS is not a redundant regulation, but rather a scheme to complement the successful implementation of ETS.

Figure 18: Evaluation of achieved GHG reductions (2012)



Source: MoE, 2014f

Table 23: Examples of projects implemented by controlled entities in 2012

	Company A	Company B	Company C
Sector	Petrochemical	Cement	Oil Refinery
Mitigation measure	Facility retrofit (replacement of pre-heaters to energy efficient model)	Heat recovery from existing facilities	Switching of fuel (from bunker C fuel oil to LNG)
Investment cost (KRW)	1.4 billion	84.0 billion	20.3 billion
Emissions reduction (tons CO_2 eq.)	16,000	65,000	205,000
Projected savings in energy expenditures (KRW)	2 billion	10 billion	10 billion

3.4 Public Sector TMS

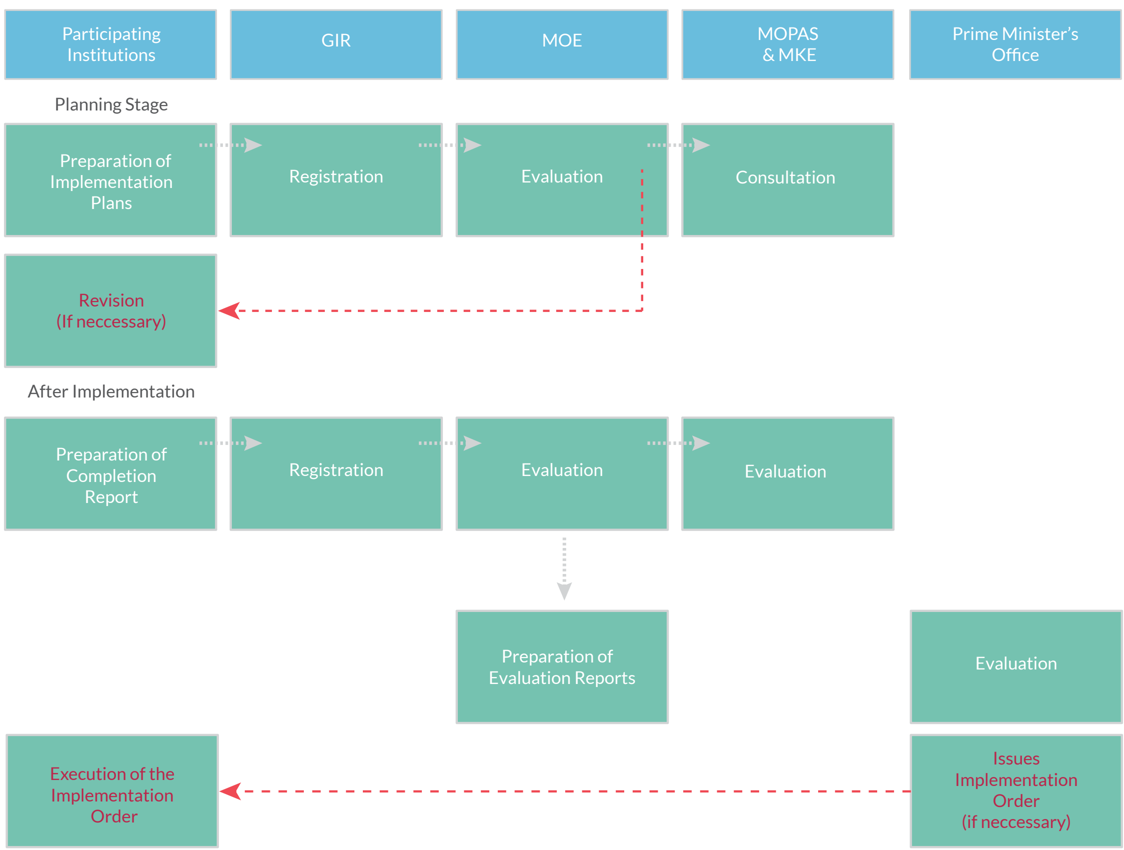
The public sector TMS shares the same objectives with the TMS described in the previous section, but is focused on regulating the GHG emissions and energy consumption of public institutions, including central administrative agencies, local governments, state-owned enterprises, and national and public universities. The ROK government recognized that placing the public sector at the forefront of mitigation actions is critical to set the bar high on GHG emission reduction for industries and individual households. In addition, the scheme facilitates government leadership and sharing of responsibilities in transitioning to a low-carbon society. In this light, the government set an ambitious target of reducing GHG emissions of public sector operations by 20% (relative to the average emissions in 2007-2009) by 2015.

Implementation

The implementation process for public sector TMS can be divided into the planning stage and implementation stage. In the planning stage, each participating institution prepares and submits an annual implementation plan for its registration at the GIR and evaluation of the MoE. The participating institutions set their own annual targets for each compliance year (2011-2015), but their proposals must ascertain the 20% reduction target by 2015. Flexibility is allowed as it is recognized that different institutions face different challenges, such as the number of corresponding facilities, mitigation potentials, and budgetary constraints.

Upon evaluating the feasibility of the proposed actions provided in the annual implementation plan and conducting consultations with the Ministry of Public Administration and Security (MOPAS) and the Ministry of Trade, Industry, and Energy (MOTIE), the

Figure 19: Implementation process for the public sector TMS



MoE may request the participating institutions to improve or supplement their plans, and the relevant institutions should submit their revised plans accordingly.

In the implementation stage, the entities take actions to achieve their GHG reduction targets and submit annual completion reports that verify their outcomes. During this process, they are mandated to keep the account books that provide data on energy consumption on a monthly basis. The data can be found in the National GHG Emission Total Information System (NGMS), which is developed and operated by GIR and periodically uploaded online. The annual completion reports are evaluated by MoE, with support from MOPAS and MOTIE. Consequently, evaluation reports are prepared by MoE for submission to the Prime Minister's Office, which then issues an order, if deemed necessary, to each participating institution.

Setting of Targets and GHG Emission Calculations

It is important to recognize that unlike the TMS – which mandates setting of reduction targets for both GHG emissions and energy consumption – the public sector TMS only mandates setting of reduction targets for GHG emissions. In addition, the public sector TMS sets targets on an absolute basis based on baseline emissions (average from 2007-2009), not BAU projections. Considering how the baseline emissions fail to take into account the likely increases in emissions in the future, the public sector TMS is often conceived as a stronger regulatory measure compared to the TMS.

However, in order to maintain the integrity and fairness of the target setting process, the following clauses have been applied:

- The participating institutions that have experienced annual fluctuations in GHG emissions greater than 2% during the baseline years (2007-2009) from expansion or closure of facilities are to use the average value computed for the years after such actions have taken place as the baseline emission.

- The participating institutions that have taken early actions leading to verified reductions in GHG emissions during the baseline years (2007-2009) are to use the average value computed for the years before the early actions have taken place as the baseline emission.

- The participating institutions that foresee a significant increase or reduction in emissions from expansion or closure of its facilities in the future are entitled to incorporate their impacts to the baseline emission.

The calculation of GHG emissions is an extensive process that involves preparing a list of relevant facilities and equipment, identifying their activities in relation to energy consumption, providing data on actual amount of energy consumed per activity in the given period, and translating energy consumption data into GHG emission data. Moreover, the emissions can be categorized into either direct or indirect emissions. Direct emission represents emissions from combustion of fuel for activities such as direct heating and running of motor vehicles. Indirect emission, on the other hand, is associated with the consumption of electricity or heat.

Table 24: Scope of emission activities

Emission	Category	Emission activity
Direct Emissions	Emissions from stationary combustion sources	Solid fuel combustion Gaseous fuel combustion Liquid fuel combustion
	Emissions from mobile combustion sources (e.g., motor vehicles)	Mobile combustion
Indirect emissions	Emissions from electricity and heat (steam) consumption	Consumption of externally provided electricity Consumption of externally provided heat steam

Translating energy consumption into GHG emissions thus involves the use of different equations, as given in the examples below. The participating agencies rely on the NGMS that performs the automatic calculations.

- The GHG emissions generated from the combustion of solid fuel such as anthracite coal are calculated by multiplying the amount of coal consumption, specific heat value of coal, the given emission coefficient of the consumption activity, and the global warming potential. The same method applies for the combustion of gaseous and liquid fuels.

- The GHG emissions generated from electricity consumption are calculated by multiplying the Indirect Emission Coefficient (IEF) to the amount of electricity use as provided by the regional utility company. Note that the consumption of electricity generated from New and Renewable Energy (NRE) facility owned by the participating institutions and electricity used for recharging electric vehicles are exempted from emissions calculations.

The public sector TMS mandates the participation of approximately 770 public institutions, including central administrative agencies, local governments, public organizations, state-owned enterprises, national hospitals, and public universities, along with their affiliates such as local government offices and regional offices. The target facilities for emissions reduction in participating institutions include the following:

- Building facilities or installations including streetlights and electronic display boards

- Facilities that are being used on a lease or rent basis, as well as facilities that are owned but have been entrusted to the private sector for operation

- However, special groups of facilities that are essential to national defense (e.g.,military facilities), public order (e.g., police vehicles), public safety (e.g., emergency vehicles, fire trucks), public education (e.g., elementary schools), and social welfare (e.g., homeless shelters) are excluded from the target setting. In addition, in order to improve the efficiency of implementation, small buildings (with floor area less than 100 m^2) and buildings on a short-term lease (less than one year) are also excluded.

Incentives and Penalties

The MoE once pledged to provide additional budgets for the effective implementation of the scheme, but such support has failed to materialize. Nonetheless, it has provided small-scale incentives and grants to participating institutions with proven outstanding achievements. In 2012, for example, the top-five participating institutions were rewarded with electric vehicles. Several other participating institutions that have exceeded their targets received small financial rewards. On the other hand, there are no regulatory standards for imposing fines on participating institutions that have failed to meet their targets. However, the TMS has been incorporated in the central government's performance evaluation system for public institutions since 2012, where both the quality of targets and level of achievement are evaluated.

Table 25: Examples of facilities eligible for target setting for a city government

Government Office Buildings	Waste Recycling Facilities	Branch Office (in another city)	Water Treatment Plant (WTP)
Public Parks and Restrooms	Public Museums and District Community Centers	Gasoline Vehicles	WTP-owned diesel cars

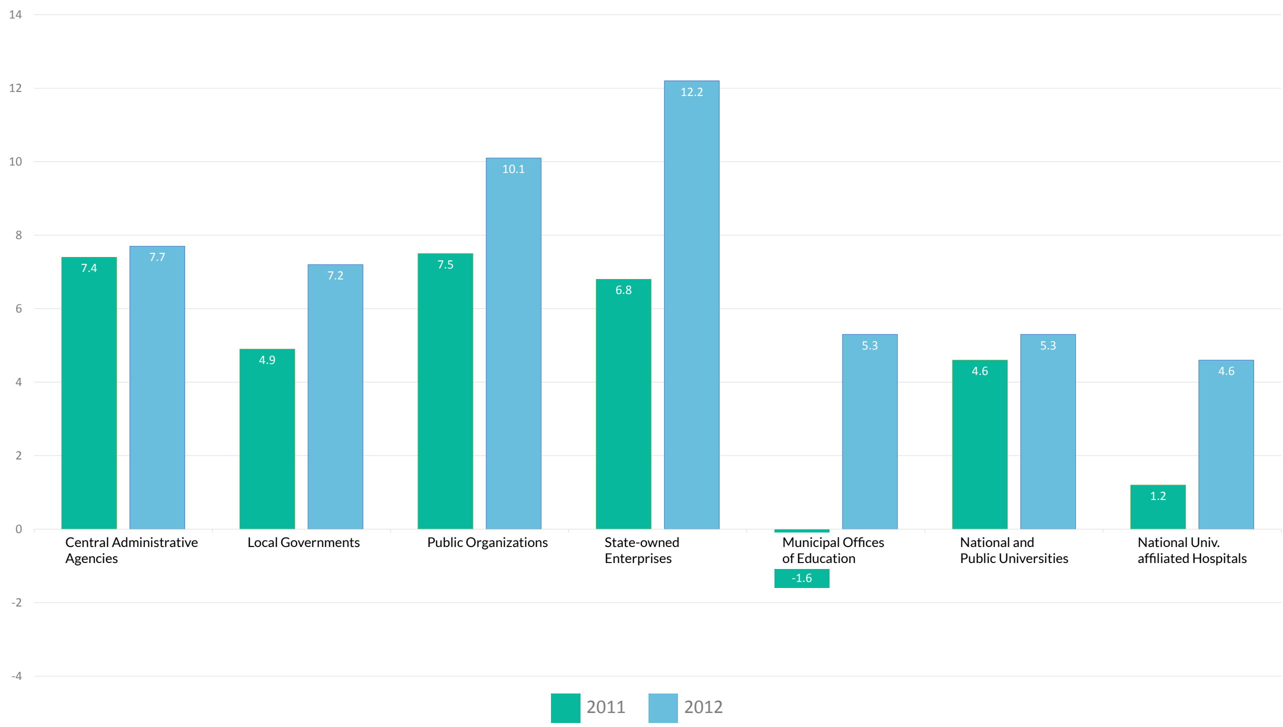
Outcomes and Takeaways

Due to the strong participatory efforts of public institutions, the MoE has reported that the public sector TMS has helped reduce approximately 400,000 tons CO_2 eq. of GHG emissions in 2012, based on an evaluation of 703 institutions that submitted their reports. The figure equates to 8.1% of the baseline emissions, which stood at 4.9 million tons CO_2 eq. This exceeded the MoE's target of 8% for 2012 and also higher than what was achieved in 2011 (5.7%). In terms of achievements by types of participating institutions, the regional public corporations achieved the highest average reduction rates (12.2%) followed by state-owned enterprises (10.1%), central administrative agencies (7.7%), local governments (7.2%), and national and public universities (5.3%). All types of participating institutions have managed to increase their average emissions reductions from the previous year.

An analysis of the GHG reduction method adopted by public institutions demonstrates that the most salient one was related to behavioral improvement (62.7%) - compliance with designated cooling and heating temperature and less frequent use of elevators – followed by facility improvement (6.9%), replacement of fleet vehicles with LNG cars (0.8%), and others (29.6%). It was also found out that most public institutions preferred to cut emissions through behavioral adjustments than facility improvement, as it entails less cost. However, these would not suffice to achieve the target of public TMS to reduce 20% of GHG emissions by 2015, thus urging more active efforts from stakeholders.

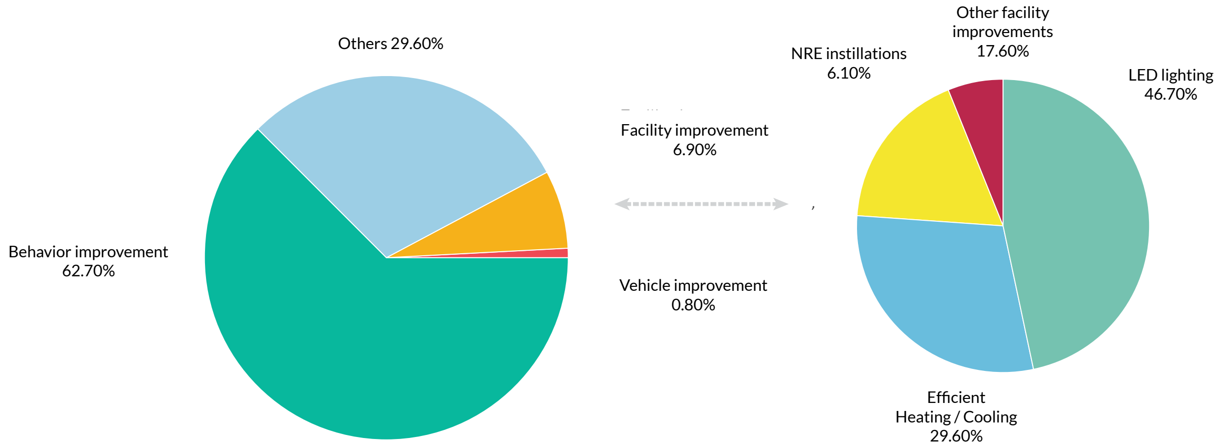
The public sector TMS has achieved positive results despite the lack of additional budget and incentives. Providing financial support to help participating institutions undertake more diversified GHG reduction activities remains a critical challenge. The absence of punitive regulations for non-compliance is another concern. If top performers are rewarded for their efforts, slackers should likewise receive disciplinary measures to enforce fairness in the pursuit of reduced GHG emissions.

Figure 20: Annual GHG reduction rate (%) of pubic institutions



Source: MoE, 2014e

Figure 21: *GHG reductions achieved by the public sector*



Source: MoE, 2014e

3.5 Korea Emissions Trading Scheme (K-ETS)

Korea embarked on a new journey to establish a domestic market for emissions trading by launching the Korea Emissions Trading Scheme (K-ETS) in January 2015. The legal basis for the implementation of K-ETS was provided through the enforcement of the Framework Act on Low Carbon, Green Growth in April 2010, which states that "the government may operate a system for trading emissions of greenhouse gases by utilizing market functions in order to accomplish the State's target reduction of greenhouse gases." Subsequently, the Act on Allocation and Trading of Greenhouse Gas Emissions Allowances (ETS Act) was passed with a near unanimous vote by the National Assembly in May 2012. It is important to recognize that this event marked a salient point in the nation's emission reduction policy; K-ETS fully secured a legal basis when it was passed as a law in 2012 (effective 2015) before the inauguration of the new president in 2013.

The ETS is a policy instrument that was first introduced by the European Union (EU) to tackle GHG emissions. It is basically a "cap and trade" system, whereby the emissions of all emitters participating in the scheme (i.e., controlled entities) are capped, but within specified limits; controlled entities are allowed to buy and sell allowances as much as they require through designated trading markets. The allowances are the trading currency of the market; controlled entities must seek to secure sufficient allowances to meet their actual amounts of emissions produced during given compliance periods. Creating an adequate scarcity of allowances in the market to ensure a meaningful carbon price is critical, as they send out price signals for investments in emission reduction activities.

The K-ETS is the second biggest carbon market after the EU's ETS. In an attempt to gain a firm foothold on the international stage as a green growth leader, the ROK adopted the scheme to prepare for future climate treaties and strengthen its negotiating power. Given that the existing TMS was part of the preparations for the introduction of K-ETS, it is fair to note that the ROK has finally entered a stage of full-fledged mitigation actions based on market-driven mechanisms. As shown in Table 26, ETS enjoys several advantages over top-down regulatory instruments such as TMS. Although the success of the newly launched K-ETS needs to be tested against time, this section seeks to provide information on the key components and design of the scheme, which is undoubtedly one of the most meaningful accomplishments under the nation's low-carbon green growth agenda.

Figure 22: Concept of the ETS

Table 26: Comparison of TMS and ETS

Description	TMS	ETS
Allocates emissions reduction targets (or allowances) based on the nation's GHG reduction tagets	Yes	Yes
Involves annual verification and reporting of emissions	Yes	Yes
Allows trading of allowances between participating entities	Yes	Yes
Allows carry-over or borrowing of emissions allowances	No	Yes
Recognizes offsets	No	Yes
Government penalties imposed are commensurate to the amount of emissions unmet by allowances	No	Yes
Incentives provided to a surplus of allowances	No	Yes

The basic principles and guidelines for the operation of the scheme are outlined by the ETS Act and its enforcement decree (issued in November 2011). The following documents provide the directions for successful planning for the implementation of K-ETS:

- The emissions allowances are to be allocated on a five-year (compliance years) basis – the so-called implementation periods. However, the first and second implementation periods shall involve three compliance years, in order to ensure that complementary measures are taken in a timely manner during the early years of K-ETS operation.

- The Basic Plan provides mid- to long-term (10 years) objectives and directions of K-ETS for each implementation period; the plan is to be established no later than one year prior to the commencement of each implementation period.

- The National Emissions Allowance Allocation Plan (Allocation Plan) provides information on the total amount of allocations that will be made available by sector and business types for the given implementation period, which are aligned with the nation's emission reduction targets.

- The plan also provides guidelines for K-ETS operation, which have been made flexible under the ETS Act and its enforcement decree. The Allocation Plan is prepared at least six months prior to the commencement of each commitment period.

- The six detailed guidelines serve as an additional guidance on allocation and trading of allowances, along with verifying the performance of controlled entities.

The Basic Plan for the first implementation phase (2015-2017) was released in January 2014. The document put forward the need for the government to take a phased approach in achieving the designed objectives of the K-ETS during the first 10 years of operation.

For the first implementation period, efforts are to focus on stabilizing the newborn market. Flexibility will be allowed for controlled entities, and allocations of allowances to all controlled entities shall be made free of charge. *Gratis* or free allocation is a practice whereby the government allocates emissions allowances to participant entities of ETS for free. Auctioning allocation is a method whereby the government holds an auction to sell emissions allowances to entities in need. Obviously, the controlled entities face significant financial burdens under the auctioning of allocations that strictly follows the polluter-pays principle.

The second implementation phase (2018-2020) of K-ETS is to focus on enhancing the performance of controlled entities on emissions reduction, as the period's last compliance year marks the nation's mid-term emission reduction targets (30% from BAU by 2020). The government will seek to widen the criteria for the selection of controlled entities, and allocate about 3% of emission allowances through the auctioning process. During the third implementation phase (2021-2025), the government will further expand the share of allowances allocated through the auctioning process to derive more active engagement and investments in mitigation activities. In addition, appropriate measures shall be made to ensure that K-ETS helps the controlled entities to be prepared for the post-2020 climate agreements.

Institutional Framework for K-ETS

The K-ETS is supervised and coordinated by the Ministry of Environment (MoE), which is responsible for preparing the National Emissions Allowance Allocation Plan. This plan is reviewed by the Allocation Committee composed of coordinating line ministries (e.g., MOTIE, MOLIT, and MAFRA). In addition, MoE is responsible for the designation and notification of controlled entities, reporting and certification of emission accounts of controlled entities, operation of the offset scheme, and imposition of penalties. The Greenhouse Gas Inventory and Research Center Korea (GIR) and Korea Environment Corporation (KECO) support MoE at the working level. As an affiliated organization of MoE, the GIR manages all data and information related to national GHG emissions, sets "benchmark emission intensity levels" of industrial processes, and conducts assessments and evaluation studies that provide directions for effective operation of the scheme. On the other hand, KECO provides supervision services (e.g., reviewing, monitoring, evaluating) to ensure appropriate allowance allocation, trading, MRV, and reporting of performances by controlled entities.

The Ministry of Strategy and Finance (MOSF) is responsible for preparing the Basic Plans and supervising the operation of the allocation trading platform (i.e., Korea Climate Exchange), which was established under the Korea Exchange (KRX), which is the sole securities exchange operation of the nation under the authority of MOSF. Unlike the TMS, where coordinating ministries (MOTIE, MOLIT and MAFRA) having the authority over controlled entities actively engage to supervise their activities, the MOSF is the sole organization in charge of all such responsibilities. However, the coordinating ministries of the TMS are invited to take part in the Allocation Committee and the Certification Committee, which are consultative groups that approve the Allocation Plan and emission accounts of controlled entities.

Key Components of ETS Operation

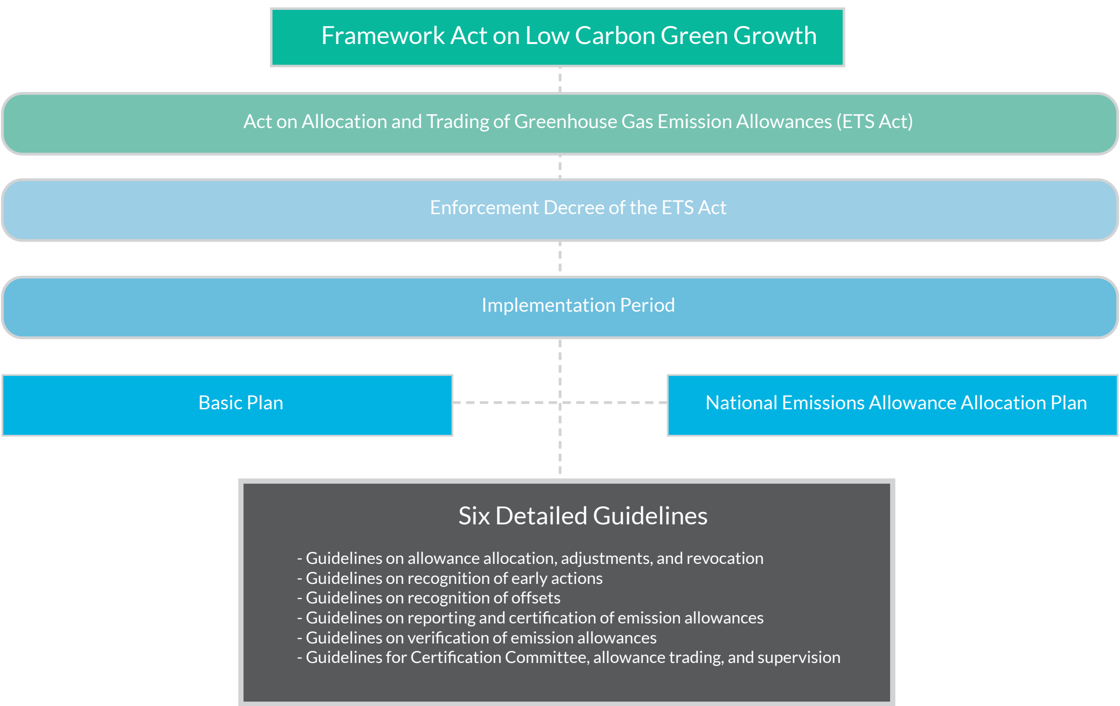
(1) Selection of Controlled Entities

The controlled entities under the ETS policy are businesses with average annual emissions greater than 125,000 CO_2 eq. and facilities with average annual emissions greater than 25,000 CO2 eq. The average emissions for the first three years, out of the past four years from the starting year of the given implementation period, are considered as the average annual emissions of businesses and facilities. For example, the average annual emissions for 2011-2013 provided the basis for the selection of 526 businesses (including businesses that own facilities eligible as controlled entities) for the first implementation period (2015-2017). It should be noted that these controlled entities are responsible for approximately 66% of the nation's total emissions.

(2) Allocation of Emissions Allowances and MRV

The allocation of emissions allowances under K-ETS takes place through a process similar to the TMS. The National Emissions Allowance Allocation Plan lays out the total allowances to be allocated to controlled entities by sector for the given implementation period, based on the nation's BAU projections and annual reduction targets (30% from BAU by 2020). For example, approximately 1.69 billion KAUs[4] are to be made available for

Figure 23: Structure of the legal framework and implementation plans for ETS



Source: MOSF, 2014

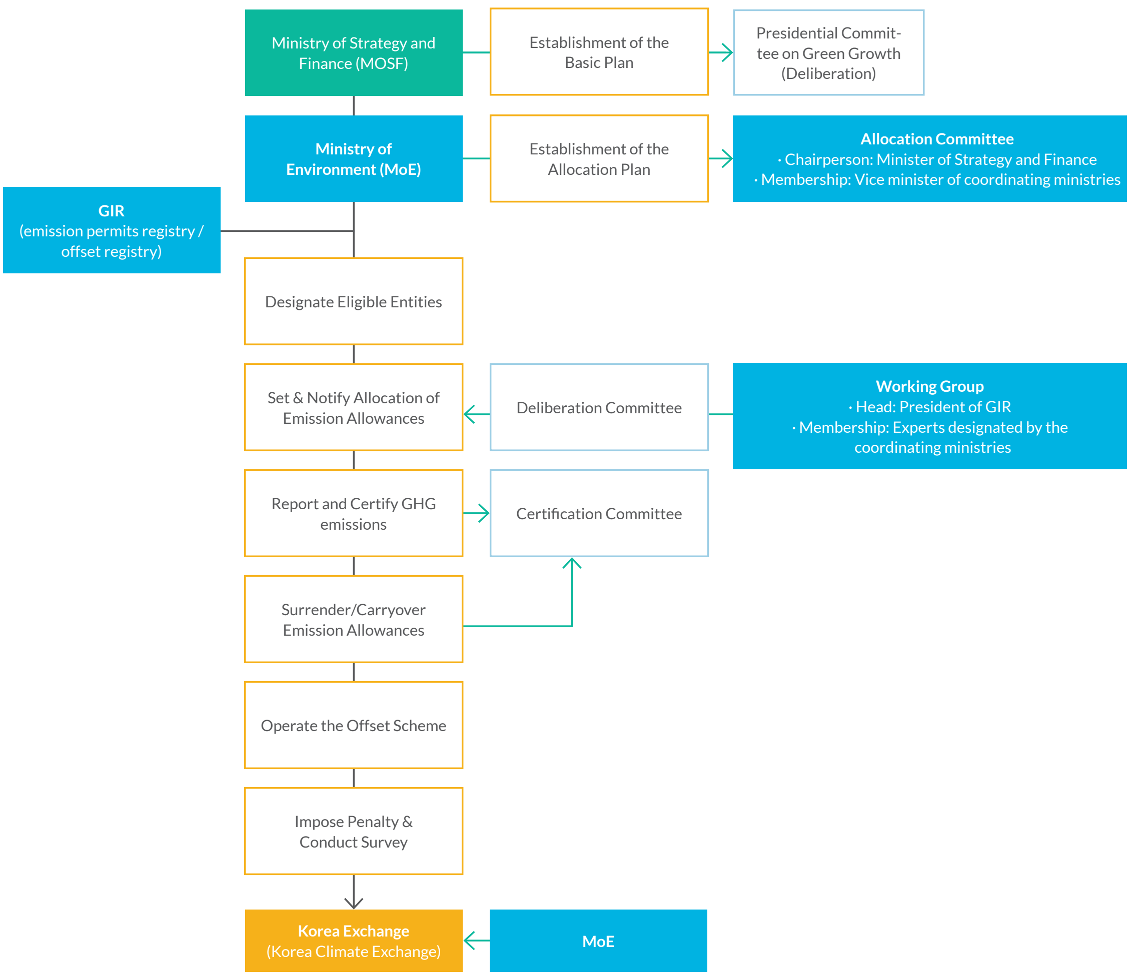
4 | Considering how K-ETS is likely to be linked to the existing (EU-ETS) and newborn international carbon markets, the emissions trading unit was named the Korean Allowance Unit (KAU). One KAU is equivalent to 1 ton of CO_2 eq.

allocation during the first implementation period, 5.2% of which are contingency KAUs for controlled entities that may justify additional allowances during the implementation period. Annual allowances are allocated into 23 types of businesses.

The sum of bottom-up "micro-allocation" of allowances for each controlled entity in a given sector must ideally be within the total amount of allowances for the sector provided by the top-down "macro-allocation" process (described previously). The K-ETS fundamentally adopts the grandfathering method (identical to the TMS) in making micro-allocations for the first implementation period, which determines emissions allowances of controlled entities based on their past emissions performances. However, benchmarking method applies for the controlled entities in the cement, aviation, and oil refinery industries, which are the areas where "benchmark emission intensity levels" have been made readily available. This decision to apply the method on a selective basis was envisioned as the first step toward expanding the application of a benchmarking method in the future. Compared to the benchmark method, the grandfathering method is often scrutinized for how it disproportionately favors entities with high emissions records in the past.

Based on calculations using the aforementioned methods, the controlled entities submit their application for allocation four months before the beginning of the implementation period. In addition to their three-year average baseline emission, the application provides justification on the factors (e.g., facility expansion) that affect their BAU projections, which form the basis for the allowance amount applied.

Figure 24: Institutional Framework for ETS



Upon review by the Working Group (composed of experts from academia, research institutes, and private sector who are appointed by coordinating ministries), the allocation plan is approved by the Deliberation Committee headed by the Vice Minister of MoE and composed of high-ranking officials of the relevant coordinating ministries. As mentioned previously, the allocated allowances are granted free of charge for the first implementation period.

(3) Trading of Emissions Allowances

The fundamental difference between the ETS and TMS is the "tradability" of emission allowances. Unlike the TMS, the controlled entities of K-ETS can either generate profits or losses by selling or buying emissions allowances under the trade market. Trading takes place on the KAU trading platform called the "Korea Climate Exchange," where all controlled entities are automatically given trading accounts. As the sole securities exchange operator of the nation, the Korea Exchange (KRX) competed with the Korea Power Exchange (KPX) to host the Korea Climate Exchange.

The KRX was selected on the grounds that it has well-established operations systems to support large-scale trading activities, and is better positioned to promote the newborn market. All trade events that take place in KRX are to be validated by trade agreements and reported to competent government authorities on an electronic basis.

(4) MRV and Surrendering of Allowances

The stages involved in MRV under K-ETS are identical to those under the TMS. Unlike the TMS where controlled entities are annually evaluated (after the MRV process) on whether they have met their reduction targets on the basis of emissions and energy consumption accounts, controlled entities annually submit the "Application for Surrendering of Allowances" under K-ETS. It provides information on the controlled entity's total emissions for the given compliance year, along with registration number of their allowance accounts. Upon review and confirmation that the application is in order, the MoE transfers (or surrenders) the KAUs equivalent to the controlled entity's recorded emissions out of the allowance account. Should the controlled entity fail to retain a sufficient amount of KAUs in its account for surrendering, the government imposes a penalty commensurate to the purchase for unmet KAUs, at three times the average market price recorded for the compliance year. However, the penalty imposed for 1 KAU shall not exceed 100,000 KRW (approximately US$ 90).

Table 28: Total available KAUs for the first implementation period

Sector	Types of Business	Allowance (million KAUs)
Energy Conversion (1)	Power Generation/Energy	735.8
Industry (17)	Mining, Food and Beverages, Textiles, Lumber, Paper, Oil Refining, Petrochemical, Glass/Ceramic, Cement, Iron and Steel, Non-Ferrous Metal, Machinery, Semiconductor, Display, Electrical/Electronics, Automobile, Shipbuilding	808.7
Building (2)	Building, Communication	20.9
Transportation (1)	Aviation	3.8
Public Waste (2)	Water Service, Waste	28.5
Contingency		88.8
Total		1,686.5

Source: MoE, 2014b

Design Requirements and Considerations

(1) Borrowing and Carryover of Emission Allowances

If a controlled entity falls short of emission allowances, it has the option to borrow from the following compliance years, but only within 10% of the total KAUs to be surrendered in the compliance year. While allowances can be borrowed from any of the following compliance years, they cannot be borrowed from a different implementation period.

On the other hand, a controlled entity that holds surplus emission allowances can carry over the surplus to the following compliance year of the same implementation period, or to the first compliance year of the following implementation period. Although there is no limit to the amount of carry over, allowances can only be carried over on a yearly basis.

(2) Recognition of Early Actions and Offsets

Much like the TMS, K-ETS recognizes emissions reductions that have taken place by controlled entities from early actions (before joining the K-ETS) by means of providing additional emission allowances. However, the amount of additional allowances is not to exceed 3% of the total allowances given for the implementation period (this applies only for the first implementation period). In addition, only reductions that have been acknowledged by government-run programs (i.e. KVER and TMS) are eligible for recognition. Note that the only the portion of emissions reduction that exceeded the given targets, and those that have not been accounted for under the TMS are eligible to be recognized as early actions.

The K-ETS also recognizes carbon offsets as eligible assets for compliance with the given emissions caps of controlled entities. Carbon offsets refer to emissions reductions made in order to compensate for, or to offset, an emission made elsewhere (outside the boundaries of the facilities of controlled entities). In the first implementation period, only up to 10% of the total emissions allowances to be surrendered in a given compliance year can be recognized; in addition, not more than half of these recognized carbon offsets shall be from overseas activities.

(3) Market Stability Reserve (Contingency Allowances)

In order to control possible unusual hike in allowance prices, the government has stocked up stability reserve of allowances (contingencies) to be supplied to the market. The government may provide up to 25% of its reserve allowances, when one or more of the following conditions is triggered by the market:

- Market price of emission allowance exceeds, for six consecutive months, three times the average market price of the preceding two years.
- Trading volume substantially increases in a short period due to a rapid increase in demand.
- Average trade volume of the latest one month is more than twice of the same month of the immediately preceding two years, and the average trading price of the latest one month is more than twice of the same month of the preceding two years.
- Market stabilization measures are needed to maintain order in emission trading markets or to protect public interest.
- Average price of emission allowances for the latest five months is less than 60% of the average price of the preceding two years.

(4) Government Support for Industrial Entities

The ROK government is coming up with measures to support the industrial entities to ease their burden of participating in the K-ETS. Most importantly, the government has decided that allowance allocations for all sectors and business types shall be made free of charge in the first implementation period (2015-2017). In addition, only 3% of total allowance allocations are planned to be made subject to auction in the second implementation period (2018-2020); steel and semiconductor industries with high trade dependence and mitigation costs are to be exempted from auction. The government is also discussing the possibility for controlled entities to own emissions reduction certificates (acquired through external programs such as the CDM) to be converted into KAUs eligible for trading in K-ETS.

Takeaways

Since the adoption of the Kyoto Protocol in 1997, the ROK has implemented a range of policies for climate change response and GHG reduction. Among these policies, the ETS had to overcome intense opposition from the industrial sector even before its implementation. The main arguments surrounding ETS are anchored in the necessity to pursue the policy to enforce the ROK's position in global climate negotiations as well as the readiness of both the government and controlled entities to successfully operate the scheme.

(1) Justification for the Launch of ETS and its Effectiveness

The chasm between the government and participating entities regarding the enforcement of the ETS has continued throughout the process of drafting the ETS Act and even after its promulgation. The government argues that the introduction of the scheme is an unavoidable choice in preparation for the post-Kyoto Protocol regime. It also insists that early adoption of the ETS is the best option to meet a possible mandatory reduction in the future given the limitations of existing policies in achieving GHG reduction targets. The industrial sector in general, however, is at odds with the government, saying that the ROK's early actions will increase the international community's expectation toward the nation in 2020. Most importantly, the industrial leaders claim that there is no reason to initiate the system at a time when the ROK's competitors like Japan and the U.S. have postponed the nationwide implementation of the ETS or are not even considering adopting the policy. It reckons that early enforcement of the ETS would instead weaken the international competitiveness of domestic industries.

The disparate views on ETS could hamper its successful implementation in 2015. Although the effectiveness of the scheme is yet to be tested, the bottom line is that K-ETS has significant potential to bring about positive changes, as supported by the government:

- **Reducing Costs.** One of the key justifications for the ETS is the low compliance costs on emissions reduction; gains from emissions trading are substantial as they help cut down the costs of reducing emissions. The IPCC has reported that a majority of studies highlighted that full emissions trading would halve the compliance costs (IPCC, 2001). Through the Climate Change 2010 Synthesis Report, the IPCC further validated that the EU has successfully reduced the marginal abatement cost from US$ 20-655 to US$ 14-135 per ton CO_2 eq. by introducing the EU-ETS. Similar reports have also been made in the ROK as the PCGG reported that assessments conducted by the Korea Environment Institute (2010), the Samsung Economic Research Institute (2009), and the Korea Energy Economics Institute (2011) have shown that K-ETS will reduce the compliance costs by 44%, 60%, and 68%, respectively, in comparison to the TMS (PCGG, 2011).

- **Promoting Technology Innovation.** An underlying objective of the ETS is to drive innovation in new low-carbon technologies by setting a price on carbon, which incentivizes low-carbon investments and reduces return of investment on carbon-intensive products and processes. Although it is unclear as to how far the EU-ETS has been successful in achieving this objective, emissions trading has undoubtedly had positive impacts on increasing the market volume and spreading of low-carbon goods and services, which eventually stimulates innovation.

- **Fostering Green Industries.** In addition to driving emissions reductions, the ROK government uses the ETS as a critical tool to accelerate the reaping of commercial benefits and creation of new jobs from green industries. The experience of the EU-ETS has shown that the scheme has supported European firm's dominance of the global export of renewable energy products, thus maintaining Europe's supremacy in the production of renewable energy.

(2) Readiness for Enforcement

Strong government leadership and commitment enabled the successful launch of the ETS in the ROK. In terms of laying the legal foundation for this policy, the government's efforts toward setting the national emissions reduction target and the enactment of the Framework Act on Low Carbon, Green Growth played critical roles. Building the institutional capacity and infrastructure for a credible and consistent MRV system was made possible through the accumulation of experiences from the KVER and TMS.

However, it is important to recognize that K-ETS went through a lengthy and painful process of consultations before the launch in January 2015. The following is a summary of some key decisions drawn in various points of disputes:

- During the process of finalizing the K-ETS bill in 2011, the government postponed its launch from January 2013 to January 2015. However, further delays did not take place despite the continued pleas of the industrial leaders insisting that the scheme should only be launched when the post-2020 climate agreements are already in place.

- Industrial leaders have continuously questioned the credibility of the BAU emissions projections made by the government, which determines the top-down allocation of emission allowances. They argue that the government's projection has been too conservative, which has led to underestimation of the nation's emissions for 2020, so a decreased amount of allowances are to be made available in K-ETS. Despite the controversy, the government has continued to stick to the initial BAU projections. In September 2014, however, the government did agree that necessary revisions should be made in the future.

- The government's guidelines on the provision of free allowances provoked a heated debate among industrial leaders. The draft ETS Act (November 2010) indicated that the government may allocate a maximum of 10% through the auctioning process for the first implementation period, while all allocations are to be made through the auctioning process for the third implementation period. However, the government eventually agreed to relax this initial proposal and additionally promised free allowance allocations to business sectors of high trade-dependencies that are most vulnerable to the impacts of emissions capping. The ETS Act has also eased other regulations compared to its original draft, such as the criteria on the selection of participating entities, carry-over of allowances, and imposition of fines.

- Identical to the TMS, the K-ETS caps indirect emissions, in addition to direct emissions that arise within the boundaries of facilities of controlled entities. In other words, indirect emissions related to the use of electricity and steam are subject to capping. Industrial leaders have objected to this function of K-ETS saying it is a double standard; emissions are regulated twice, through capping emissions of industries that generate electricity and heat, and capping emissions of industries that use them upon purchase. Despite these concerns, the government insisted on the need for regulating indirect emissions as it helps improve efficiency in energy consumption.

- In response to the request for reducing the burden of the controlled entities during the first implementation phase, the government decided to provide additional allowances (10%) from the amount stipulated by the Allocation Plan. In addition, the government decided to control the market price of allowances, specifically to be maintained under 10,000 KRW per KAU (approximately US$9) by providing additional allowances should the average market price of the past three months exceeds this value. Such decisions made in September 2014 were the countermeasures against the requests from the industrial sector to further postpone the launch of K-ETS.

Launching K-ETS was a bold move taken by the ROK government, considering how the nations in direct competition (e.g., Japan and Taiwan) have decided not to push through immediately due to competitiveness concerns. Experiences from the EU-ETS also indicate reservations on the effectiveness of carbon trading as an effective policy tool.

The event has successfully built the momentum for establishing market-based solutions around the international climate agreement set to be agreed at the end of the year. However, the ROK government has taken steps to come to terms with the industrial opposition. Most importantly, the government's decision to provide additional allowances for the first implementation period has enabled controlled entities to maintain their emissions levels of 2013-2014, raising questions on the need for making a complicated programmatic shift. In addition, government arrangements on capping the market prices of KAUs have restricted

K-ETS from developing into a full blown market-based mechanism. Such developments illustrate how the ROK has struggled to deal with the issue of cost containment while not compromising the ambitions of the scheme.

Securing agreement with the industrial leaders remains a critical challenge for K-ETS. The government should thus continuously seek to earn public support by ensuring fairness and transparency in emissions allowance allocations. In addition to securing the stability of the newborn market in the short term, the government must adhere to its original commitment of ensuring that the carbon price of K-ETS has an impact on investment decisions. Given how the nation has a relatively small domestic market, linking K-ETS to other carbon markets will be an important factor in this process. Linking K-ETS with other cap-and-trade schemes will not only help stabilize the market and provide additional opportunities to reduce costs for cutting of emissions but will also ensure that K-ETS promotes a "level playing field" of global regulation, which is a prerequisite for the ROK's mitigation actions to gain a firm foothold on the international stage.

4. Assessment

4.1 Quantitative Assessment

The ROK's total GHG emissions, which stood at 503.1 million tCO_2 in 2000, have continued to increase each year (excluding 2009), reaching 688.3 million tCO_2 in 2012. This trend cast doubts on the effectiveness of the ROK's strategies and regulatory programs for GHG reduction. However, some positive implications should not be overlooked.

First, the figures for gross national emissions and emissions per capita have displayed clearer signs that national emissions are reaching a tipping point, despite the continued increase in national GDP. From the perspective of economic productivity, it is important to note that GHG emissions per unit of GDP once again peaked in 2011. The comparison of the nation's GDP growth rates and the changes in GHG emission levels of entities that have participated in the TMS also provide some positive signs for the future emissions from industrial activities.

As shown in Figure 25, the growth rate of GHG emissions from entities regulated by TMS was found to be lower than the nation's GDP growth rate for the first time in 2012. The government's strengthened management of emissions through the implementation of TMS has made small but steady progress.

Nevertheless, the government's plan to peak gross emissions by 2014 is most likely unachievable if the ROK's economy is to be on track for a sustained recovery. Note that the actual total GHG emissions in 2011 exceeded the government's targeted emissions levels for the year 2014 set at approximately 691 million tons of CO_2 equivalent. Most importantly, emissions from the energy sector – which accounted for 87.2% of gross national emissions as of 2012 – has continued to grow, outpacing the GDP growth rate. The trends in gross emissions after the 2008 global economic crisis indicate how future emissions may follow the trajectory observed in 1998-2008, the decade following the 1997 Asian financial crisis. The recovery of the economy, which was fundamentally based on increased revenues of highly energy-intensive industries, has once again jeopardized the nation's emissions performance, raising questions on whether the ROK is getting any closer to decoupling economic growth and GHG emissions.

In summary, the nation's emission statistics indicate that the ROK has not yet achieved satisfying results in terms of sharpening its mitigation policies and practices. Although there are several positive signs, the underlying challenge for the ROK is still in the levels of energy consumption per unit GDP, which remain markedly higher than those of developed countries, as illustrated in Table 30. Even by taking into fair consideration the share of the manufacturing sector in the nation's total GDP, the ROK is still lagging behind compared to the global leaders such as France and Germany.

4.2 Qualitative Assessment

The ROK's efforts to set stringent national emission targets (30% below BAU in 2020) was most appropriate, given the nation's growing level of GHG emissions and economic standing in the international community. Although there were shortfalls in the process of convening the major emitters to reach consensus on reduction targets, full credit should be given to the government's follow-up actions in allocating reduction targets by sector, business type and years, as well as securing public budget to help meet these targets. Without doubt, the proactive drive from the central government encouraged regional governments and industrial leaders to identify opportunities in reducing and managing their GHG emissions. The government's regulatory emissions reduction programs (TMS and ETS) also played a critical role in convincing heavy emitters to explore the cost effectiveness of available mitigation measures, develop emissions management strategies, and invest in low-carbon technologies.

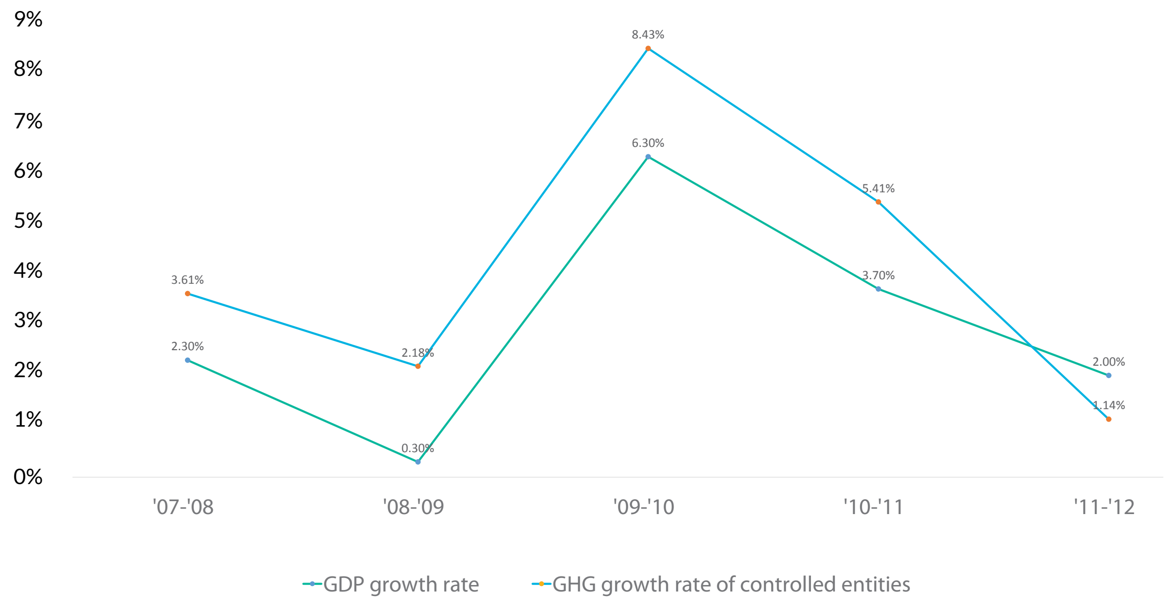
As of 2011, the ROK was the world's seventh largest GHG emitter, with emissions reaching approximately 610 million tCO_2. As described in the previous section, the ROK will need more time to decouple economic growth and GHG emissions, especially if its economy will continue to grow at its current pace and maintain its industrial structure. However, the ROK's mid-term GHG reduction targets should not simply be criticized as being too ambitious, just because the nation is unlikely to have peaked emissions as planned in 2014. In fact, the targets were set based on solid analysis of mitigation potentials in major economic sectors, using an internationally acknowledged model (MARKAL). The reasons for sustained growth in GHG emissions should be sought by assessing the effectiveness of the government's mitigation strategies, especially on whether the mitigation measures – as planned

Table 29: Changes in GHG emissions between 1990 and 2011

Indicator	1990	2000	2008	2009	2010	2011
Gross GHG emissions (excludes LULUCF, in million tons CO_2-eq.)	295.7	511.3	604.1	609.2	667.8	697.7
Net GHG emissions (includes LULUCF, in million tons CO_2-eq.)	269.5	470.2	565.4	565.6	624.0	654.7
Emissions per capita (in ton CO_2-eq./person)	6.9	10.9	12.3	12.4	13.5	14.0
Population (in thousand persons)	42,869	47,008	48,949	49,182	49,410	49,779
GHG emissions per unit GDP (in ton CO_2-eq./billion KRW)	801.3	737.1	617.4	620.5	639.8	644.8
GDP (in trillion KRW)	369.0	697.6	978.5	981.6	1,043.7	1,082.1

Source: GIR, 2014c

Figure 25: Annual growth rates of national GDP and GHG emissions from controlled entities of TMS



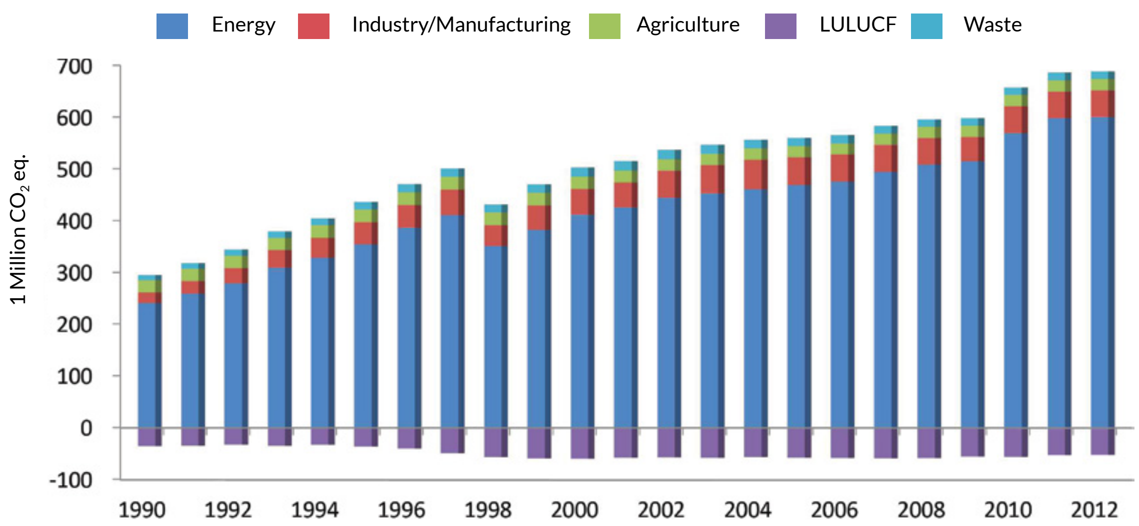
Source: MoE, 2014a

in the target-setting process (e.g., deployment of green cars, increase in the use of energy-efficient appliances, introduction of CCS technologies) – actually took place in full scale and generated tangible results. As argued by the industrial leaders during the setting of the nation's reduction targets, it is critical that the selection of mitigation measures validating reduction targets are supported by substantial evidence, regarding technical and cost feasibility, as well as the capacities of the private sector to mobilize actions on the ground.

Setting of the GHG reduction target: BAU vs Baseline

During the COP 15 in Copenhagen in 2009, when President Lee announced that the ROK would reduce its GHG emissions by 30% relative to the BAU scenario by 2020, the baseline emissions (for 2020 BAU) were projected to be 776 million tCO_2.[5] However, this projection was revisited multiple times following the president's announcement. The government plan released in August 2009 estimated the baseline emissions to be 813 million tCO_2, and the Cabinet Meeting held in September 2009 approved this value

Figure 26: Changes in the ROK's national GHG emissions by sector during 1990-2012



Source: GIR, 2014c

Table 30: Energy intensity of selected countries as of 2012

	Energy Intensity				Manufacturing Share (% of GDP)
	2005	2010	2011	2012	2012
ROK	0.56	0.55	0.56	0.55	31
France	0.18	0.16	0.15	0.15	11
Germany	0.29	0.26	0.24	0.25	22
Japan	0.26	0.24	0.26	0.26	18
U.K.	0.23	0.20	0.18	0.19	10
U.S.	0.44	0.40	0.38	0.36	13
OECD	0.36	0.33	0.32	0.31	-
Non Annex-I Parties	1.16	1.09	1.09	1.08	-

Source: IEA, 2014

as the basis for the nation's mid-term reduction target. In 2013, GIR suggested 763 million tCO_2 as the baseline emission and the Second Basic National Energy Plan released in January 2014 projected the baseline at 804 million tCO_2. Witnessing such discrepancies in projections by different institutions, the government initiated a formal working group in May 2013 to validate the emission projections. As a result, the government decided to support the initial estimate of 776 million tCO_2 as the baseline for 2020, and reflected this value in the National Emissions Reduction Roadmap released in January 2014. Although the details of the validation and decision-making process were not disclosed to the public, this roadmap briefly states that "776 million tCO_2 was selected through the validation process as the proposed value similar to the initial estimate given in 2009." The government also noted that adhering to the initial estimate is important to uphold national integrity in the international community.

The BAU emissions projection is generally made from a comprehensive assessment of multiple factors including economic growth rate, oil prices, population growth rate, industrial structure, and energy demand projections. As it is an assessment based on data that are currently available, uncertainties can lead to a significant overestimation or underestimation of BAU projections. For this reason, it is inevitable that different government institutions indicate different figures; the data utilized as well as assumptions made must have varied considerably by institutions. Thus, the government initiated a formal working group to validate the emission projections, which was successful in clarifying the nation's targets. However, the fundamental problem remains unresolved: the credibility of BAU projections and its possible implications. In order to avoid such circumstances, target setting can be based ideally on past emissions data (e.g., national emissions in year 2005) rather than future projections. Germany and Japan are good examples of countries where this has taken place; the nation's emission-reduction targets are provided in percentages of past emission levels (year 1990).

Selection of mitigation measures

The regulatory measures for emissions reduction in the ROK may need more time to have a substantial impact and achieve decoupling. Although the government set aggressive targets, there are limitations inherent in any regulatory measures; substantive gains are difficult to achieve within a short timeframe. However, what remains critical is whether the government's selection of GHG reduction measures (as well as their projected impacts) was appropriate, especially as they provided the basis for setting the national reduction targets. Recent trends in emission growth for different sectors indicate otherwise, as there were significant gaps in government considerations made on different reduction measures.

In the setting of the mid-term GHG reduction targets, the government proposed different sets of reduction measures to support different scenarios. For example, Scenario 1 (21% reduction from BAU) was supported by transportation system reforms and the expansion of renewable energy use. The more aggressive Scenario 2 (27% reduction from BAU) and Scenario 3 (30% reduction from BAU) included additional measures, such as introducing CCS technologies and deployment of green cars. Unfortunately, the ROK failed to make enough progress in developing and commercializing green technologies to realize emissions reduction as planned from the selected measures. A good example is the deployment of green cars, a market that accounted for only 30% of the total domestic car sales (40 trillion KRW) in 2012. High market prices, limited travel range, long battery charging time, and scarcity of publicly available charging stations were some of the limiting factors for the deployment of green cars. The recent development of more advanced electric vehicles (e.g., hybrid electric vehicles, plug-in hybrid electric vehicles) has deterred consumers from making immediate purchases of what is currently available in the market (MOTIE and KIETE, 2013). The government's unattractive incentive scheme has also delayed the commercialization of environmentally friendly technologies by the automakers. This experience demonstrates the importance of underlying assessments on which national reduction targets are

5 | The 2020 BAU of 776 million tCO_2 was based on the unofficial data provided by the Presidential Committee on Green Growth.

to be based. Assessments must provide clear and convincing evidence for technological readiness and market-growth opportunities.

Carbon-reduction programs

Despite its status as a non-Annex I party to the Kyoto Protocol, the ROK has taken proactive actions to reduce GHG emissions. The government's determination to implement plans through programs such as the KVER and TMS has led to positive achievements, although there is still room for improvement. It is without doubt that ROK's efforts under the agenda of "establishing a low -carbon society" have provided momentum for the nation's industries to reduce their energy consumption and invest in low-carbon technologies. With the implementation of the K-ETS in 2015, the ROK is expected to enhance its readiness to cope with the Durban Platform and better position itself in global climate negotiations.

The Korea Voluntary Emission Reduction (KVER) program, which was launched in 2005, is now targeting SMEs that are excluded from the obligatory participation in TMS. Credit should be given to the government's decision to extend and modify the program to help meet the demand of the SMEs. However, KVER alone is limited in actively engaging SMEs, as the scheme does not provide immediate finances but rewards the outcomes of successful investments. Given the long recovery period and high front-end capital costs, the availability of budget is a significant barrier to SMEs, despite the decreasing technical risks in emission-reduction measures and government promises for a fair profit margin. Therefore, the current KVER scheme should seek to introduce incentives based on a forward contract and advance payment method, whereby SMEs can secure front-end capital guaranteed by the proceeds of future KVER offerings.

The TMS was designed in a way to ensure that leading emitters are made accountable for their share of emissions reduction. The scheme is a regulatory measure that requires controlled entities to achieve pre-agreed reduction targets and imposes penalties for failure. One may view this program as being retrogressive, especially given the ROK's strategy toward deregulation and endorsement of market mechanisms. Nevertheless, it is noteworthy that TMS has successfully raised the awareness of private sector entities on the need for emissions reduction. Most importantly, the program has made significant contributions to GHG mitigation. Thanks to the strong commitment of the controlled entities, the emissions reduced in 2012 were 2.7 times larger than what was initially targeted. An important element of TMS that deserves to be emphasized is the process of target setting, which opens the way for negotiations between the government and the controlled entity. It was collaborative governance, not top-down decision making, which helped TMS take root in the ROK.

Another aspect of TMS is that it was initially designed to serve the purpose of preparing the private sector for the forthcoming ETS. It was on such account that the government permitted flexibility in TMS implementation. For example, the setting of reduction targets and penalties imposed upon failure were not as stringent as one would normally expect from an average government law or regulation. Recognizing such gaps, the TMS must be revised to serve a different purpose in the future, preferably to create synergies with the ETS. One proposal would be to redesign the TMS into a program that solely regulates energy consumption

Table 31: 2020 BAU estimates

	Presidential Committee on Green Growth		GIR	Second Basic Energy Plan	GHG Reduction Roadmap
Release Date	Early 2009	Aug. 2009	2013	Jan. 2014	Jan. 2014
2020 BAU (million tCO_2)	776	813	763	804	776

Source: Kim, 2014

of energy-intensive industries (moving away from control of GHG emissions).

The ETS is a market-based incentive scheme aimed to save emissions at the lowest cost point. Although the ETS is viewed by many in the ROK as an additional step toward acceleration of technological innovation and fostering of climate-friendly industries, its outcomes are still in question. Despite high expectations from the government and NGOs, events that took place during the preparation stage revealed that the ROK would need a significant amount of time before the new system makes steady headway. The persistent opposition by industrial leaders, bureaucratic conflicts over which ministry will run the scheme, and varying opinions among the members of the National Assembly eventually delayed the preparatory work and decision-making processes. As a result, the National Emissions Allowance Allocation Plan – a document with critical implications for both the efficiency and impacts of the ETS – was released only several months ahead of the launch, triggering yet another round of debates over the feasibility and effectiveness of the ETS operation. Despite the sufficient time for the government to gain acceptance from the private sector entities (as ETS was mandated by law in 2012 to be launched by 2015), government actions still leave much room for improvement. As learned from the experiences of the EU-ETS, it is imperative that the principles of allocation of emissions are clearly communicated with participating entities right from the start.

Investment in green technology

Technological innovation is key to successful emissions reduction. TMS and ETS may provide solid platforms on which to build actions and investments, but without a technological enabler, emission cuts simply become a costly practice to businesses. Even though the ROK invested 108.7 trillion KRW in financing green growth actions under the Five-Year Plan, its outcomes in terms of commercializing emission-reduction technologies have been limited. Failure to make available technological options may have been the primary bottleneck – particularly to SMEs with low technological capabilities – to realizing emission-reduction targets in the ROK. The government's future policies should recognize that technologies offer the potential to dramatically reduce the costs of emissions reduction and seek ways to accelerate the implementation of innovative solutions.

5. Takeaways and Recommendations

Climate change poses a fundamental threat to economic development and poverty alleviation, especially in developing countries with limited capacities and financial resources to respond effectively. Recognizing that climate change is a global problem with international causes and transboundary effects, developing countries are being actively supported by developed country partners and international organizations to establish low-carbon green growth strategies. Based on the ROK's experiences, several recommendations can be derived to help policymakers, planners and practitioners in setting effective emission-reduction targets and implementing actions to realize a low-carbon society.

With regard to establishing a systematic foundation to support mitigation actions, the importance of collecting and managing emissions data to compile a comprehensive national emissions inventory, and creating an organizational framework, the importance of linking up different sectors to support this process cannot be over-emphasized. In the ROK, the Greenhouse Gas Inventory & Research Center (GIR) was established in 2010 to specifically fulfill this role. The GIR compiles emissions data that is dispersed amongst multiple numbers of stakeholders and government organizations, serving as a centralized information hub. Timely disclosure and accumulation of emission statistics helps the government track the nation's potentials, capacity, and performance on lowering of emission levels. It also enables policymakers to derive optimum strategies for designing national mitigation programs.

Given the circumstances of developing countries in entering a stage of rapid economic growth, there are limitations in adopting the policies and programs of the developed economies with expectations of duplicating their success. Developing countries should take a step-by-step approach whereby government efforts place a greater emphasis on strengthening the mitigation capacities of different entities rather than trying to carve out emissions in the short term. In the build-up of the ROK's carbon trading market that was launched in January 2015, the government conducted numerous assessments based on experiences accumulated from operating several different mitigation programs. As described in the previous section, the ROK government engaged with the industrial sector to voluntarily reduce their GHG emissions even before preparation of the National Strategy for Green Growth. In addition, the Target Management Scheme (TMS) helped ensure private sector acceptance of strengthened regulatory actions.

Throughout this process, the energy-intensive industries of the private sector invested in low carbon technologies, gradually gaining knowledge, experience, and confidence needed in taking additional steps to help meet the nation's reduction targets. Likewise, developing countries should avoid immediate adoption of stringent regulatory measures and continuously seek to design and strengthen mitigation programs that can be well accepted under the circumstances of a country's capacities and available resources.

Needless to say, the fundamental solution to achieving emission reduction is to reduce the demand and supply of fossil fuels through technology diffusion. There are simple and low-cost actions that can lead to immediate emission reduction, but sizeable and long-lasting mitigation is most likely to be achieved through technological innovation. Green technologies enable businesses to decrease their dependence on fossil fuels, but it is equally important to understand that they can also contribute to enhancing the competitiveness of existing economic activities by reducing costs, optimizing production processes, and improving product quality. Developing countries should seek to exploit such opportunities to resolve the dilemma of development and mitigation. Given the technology gaps that exist between developed and developing countries, technology diffusion is one area in which international aid is needed to provide better support.

National mitigation strategies should be established in a balanced manner so as to prevent creating blind spots. For example, the KVER scheme of the ROK was revised to target SMEs, after the heavy emitters migrated from the KVER scheme to take part in the newly introduced TMS in 2010. Given the capability gaps of SMEs in comparison with large companies, the framework and implementing regulations of the KVER scheme were redesigned in a way that minimizes the financial obstacles in actively engaging in mitigation actions. Such efforts have enabled collective actions from private companies of all sizes, ensuring that there are no such blind spots in the given roles of the different actors.

The sustainable forest reserves and land use in many developing countries (especially in Southeast Asia) determines in essence the economic sustainability of low-income households as well as the environmental sustainability of the nation as a whole. Although the ROK's policies on forest conservation in the 1970s did not recognize forests as carbon store or carbon sink, the strengthening of forest management practices and community-based rehabilitation actions, which started during the stages of rapid industrial development, helped the nation sustain a solid foundation for pursuing economic growth. Endeavors to expand the forestry resources have been carried out not only for the sake of protecting the environment, but also to contribute to improving the income of households in the agricultural sector (Kang et al., 2014). Carbon benefits that forest reserves have to offer underscore the need for developing countries to actively engage in conservation, sustainable management of forests, and enhancement of forest carbon stocks.

References

Blue House. 2009. "The National Reduction Target for Greenhouse Gas Emissions for 2020 is Confirmed to be Reduced by 30% Compared to the Business-As-Usual Estimate." Paper presented at the press call, Seoul, November 17.

Energy Use Rationalization Act. 2014. Republic of Korea Statutes Act No. 12298.

Enforcement Decree for the Framework Act on Low-Carbon Green Growth. 2010. Republic of Korea Statutes Presidential Decree No. 25456.

Framework Act on Low-Carbon Green Growth. 2010. Republic of Korea Statutes Act No. 11965.

GGGI (Global Green Growth Institute). 2014. KSP-Joint Consulting with IOs.

GIR (Greenhouse Gas Inventory and Research Center of Korea). 2014a. "Support for the Operation of the Target Management Scheme." Website of Greenhouse Gas Inventory and Research Center of Korea. Accessed September 1, 2015. http://www.gir.go.kr/home/index.do?menuId=24.

GIR (Greenhouse Gas Inventory and Research Center of Korea). 2014b. *Business Report 2014*. Seoul: GIR.

GIR (Greenhouse Gas Inventory and Research Center of Korea). 2014c. N*ational Inventory Report 2013.* Seoul: GIR.

GIR (Greenhouse Gas Inventory and Research Center of Korea). 2014d. "Organizational Structure of GIR." Website of Greenhouse Gas Inventory and Research Center of Korea. Accessed September 1, 2015. http://www.gir.go.kr/home/index.do?menuId=30.

Han, Taek-hwan. 2010. "Green Growth Climate Change." *In National Research Council for Economics, Humanities, and Social Sciences* 10-02-04 (3). Seoul: NRCS.

IEA (International Energy Agency). 2007. *CO2 Emission Combustion.* Paris: IEA.

IEA (International Energy Agency). 2014. *IEA Statistics 2014: CO2 Emissions from Fuel Combustion Highlights 2014.* Paris: IEA.

IEA-ETSAP (International Energy Agency - Energy Technology Systems Analysis Programme). 2014. "MARKAL Model." Website of IEA-ETSAP. Accessed October 25, 2015. http://www.iea-etsap.org/web/Markal.asp.

IPCC (Inter-governmental Panel on Climate Change). 2001. *IPCC Third Assessment Report*. Geneva: Intergovermental Panel on Climate Change. Accessed October 25, 2015. https://www.ipcc.ch/ipccreports/tar/.

Kang, Sung-Jin, Soo-jung Kim, Yoo-kyung Kim, and Ji-hwan Kim. 2014. "Experiences and Lessons of Green Growth." Knowledge Sharing Program: Development Experience Modularization Project 2014-12, KDI School of Public Policy and Management, Sejong.

KEEI (Korea Energy Economics Institute). 2009. "Website of Korea Energy Economics Institute." Accessed September 1, 2015. http://www.keei.re.kr.

KEMCO (Korea Energy Management Corporation). 2013. "Website of Korea Energy Management Corporation." Accessed September 1, 2015. http://www.kemco.or.kr/.

Kim, Hyun-mi. 2014. "Parliamentary Inspection of the Administration in 2014." Paper presented at the press call, Seoul.

Joint Work of Relevant Ministries. 2011a. "The Blueprint for the National Greenhouse Gas Emissions Reduction will be Presented." Paper presented at the press call, Seoul. June 28.

Joint Work of Relevant Ministries. 2011b. "The Targets are Confirmed for Greenhouse Gas Emissions Reduction by Sector, Type of Business and Year." Paper presented at the press call, Seoul, July 12

Joint Work of Relevant Ministries. 2012. *The Second Five-Year Plan for Green Growth (2014-2018).* Accessed April 17, 2015. http://www.greengrowth.go.kr/?page_id=2452.

MKE (Ministry of Knowledge and Economy). 2008. "The Roadmap to Achieve Low-Carbon Green Growth 2020." Paper presented at the press call, Seoul.

MOSF (Ministry of Strategy and Finance). 2014. *Greenhouse Gas Emission Permits Basic Plan.*

MOTIE (Ministry of Trade, Industry, and Energy). 2009. *Implementation Plan for Energy Target Management Scheme in Industries.*

MOTIE and KIETE (Ministry of Trade, Industry and Energy & Korea Institute Energy Technology Evaluation and Planning). 2013. "Outlook on the Domestic Energy Technology Market 2013-2014."

MoE (Ministry of Environment). 2014a. "2012 Greenhouse Gas Emissions Reduction Target for the Target Management Scheme has been Exceeded." Paper presented at the press call, Seoul. January 23.

MoE (Ministry of Environment). 2014b. *Allocation Plan of National Greenhouse Gas Emission Permits.*

MoE (Ministry of Environment). 2014c. *Greenhouse Gas-Energy Target Management Scheme Operation Guidelines.*

MoE (Ministry of Environment). 2014d. *A Reference Manual on Greenhouse Gas-Energy Target Management Scheme Operation Guidelines.*

MoE (Ministry of Environment). 2014e. "Public TMS." Website of Ministry of Environment. Accessed September 1, 2015. http://mobile.me.go.kr/m/mob/board/read.3QM8lhPM9467zi79922D7ayFDnPHTSOw5a.meweb2vhost_servlet_orgCd=&boardMasterId=1&boardId=185205.

MoE (Ministry of Environment). 2014f. "Website of Ministry of Environment." Accessed September 1, 2015. www.me.go.kr.

Oh, Jin-Gyu. 2009. "The GHG Mitigation Strategies and Role of Korea in the Post-2012 Regime." KEEI Basic Research Report, Korea Energy Economics Institute, Seoul.

PCGG (Presidential Committee on Green Growth). 2009a. *National Strategy for Green Growth (2009-2050).* Accessed April 17, 2015. http://www.greengrowth.go.kr/?page_id=2450.

PCGG (Presidential Committee on Green Growth). 2009b. *The Five-Year Action Plan for Green Growth (2009-2013).* Accessed April 17, 2015. http://www.greengrowth.go.kr/?page_id=2452.

PCGG (Presidential Committee on Green Growth). 2009c. "The Plan to Establish the National Mid-Term (Year 2020) Target for Greenhouse Gas Emissions Reduction." Paper presented at the press call, Seoul. August 8.

PCGG (Presidential Committee on Green Growth). 2009d. "Methodology of Setting the National Mid-Term (Year 2020) Target for Greenhouse Gas Emissions Reduction." Paper presented at the press call, Seoul. August 8.

PCGG (Presidential Committee on Green Growth). 2009e. "Three Scenarios are Presented for Setting the National Mid-Term (Year 2020) Target for Greenhouse Gas Emissions Reduction." Paper presented at the press call, Seoul. August 4.

PCGG (Presidential Committee on Green Growth). 2010. "The Greenhouse Gas Inventory and Research Center of Korea, a Greenhouse Gas Think Tank of Global Standard, is Officially Launched." Paper presented at the press call, Seoul. June 16.

PCGG (Presidential Committee on Green Growth). 2011. "PCGG has presented comprehensive economic analysis on the effect of introducing ETS." Paper presented at the press call, Seoul. February 7.

Prime Minister's Office, Ministry of Strategy and Finance, Ministry of Education, Science and Technology, Ministry of Foreign Affairs, Ministry of Knowledge Economy, Ministry of Environment, Ministry of Land, Infrastructure, and Transport. 2008. *The First National Energy Basic Plan (2008-2030).* Accessed April 17, 2015. http://energyjustice.kr/zbxe/48310.

Special Committee on Climate Change. 2009. "The Sourcebook for the Conference for Setting the National Greenhouse Gas Emissions Mid-Term Reduction Target." A publication prepared for the National Greenhouse Gas Emissions Mid-Term Reduction Target Setting Conference, Seoul.

Yoon, Soon-jin and Won, Gil-yeon. 2013. "A Study on Regulations for Greenhouse Gas-Energy Target Management Scheme Target Participants." In *KAPA(The Korean Association for Public Administration) Spring Conference 2013* :618-637.

Yoo, Seung-jik. 2008. "Current status, prospect, and potential amount of reduction in GHG emissions." Korea Energy Economics Institute, Accessed October 23, 2015. http://www.kdi.re.kr/upload/8547/s2-1.pdf.

Global Green Growth Institute

Korea's Green Growth Experience: Process, Outcomes and Lessons Learned

Chapter 3: Energy Efficiency & Renewable Energy

Summary

Given the ROK's heavy dependence on oil imports, the energy security challenge would suffice as the major factor why a green growth transition on a national scale is necessary. But green energy solutions – reducing energy demand, improving energy efficiency, and deploying renewable energy – aim not only to deal with vulnerability to oil price shocks but also to improve environmental performance and shift to a leaner, cleaner economic structure built on new growth engines. From 2009-2013, considerable progress was achieved in prioritizing demand-side management (promoting the rational and effective consumption of energy resources), which challenged the traditional principle that stable energy supply is the panacea for energy security. The targets for energy intensity and NRE deployment provided a strong signal for boosting investment and technological innovation. Despite the positive progress, the ROK's efforts toward greening the economy still have a long way to go as its flagship industries remain highly energy-intensive and delayed reforms in energy pricing hamper energy intensity improvements. The ROK's experience demonstrates how government's regulatory efforts can be kunuted without the support of robust energy-pricing policies.

1. Introduction

1.1 Overview

Alongside its economic growth, the ROK has seen a dramatic increase in energy consumption. The total primary energy consumption, which stood at 45.7 million tons of oil equivalent (TOE) in 1981, increased six-fold to 278.7 million TOE in 2012. Energy consumption per capita also jumped to 5.57 TOE in 2012, up from 1.18 TOE in 1981, exceeding that of Japan and many European countries with national incomes two or three times higher than the ROK's.[1]

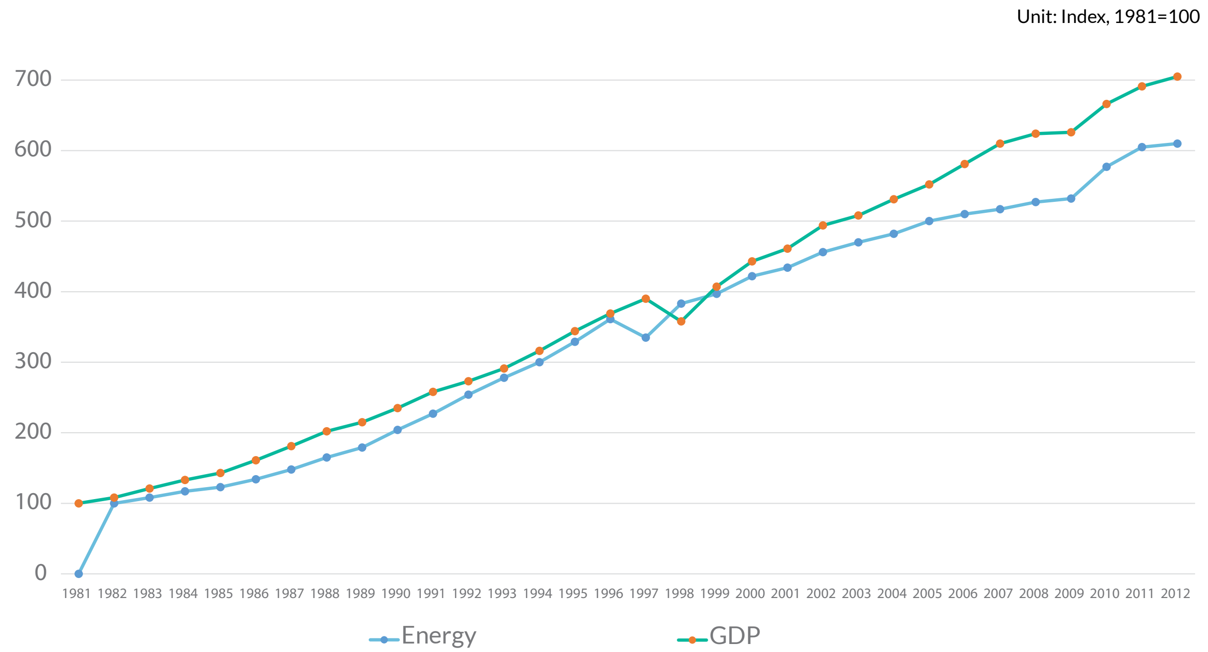
From the late-1980s to the early-2000s, the ROK's energy consumption kept pace with economic growth, as illustrated in Figure 1. Such rapid growth of energy consumption is typical for a developing country in transition to an advanced economy.

The growth in energy demand often outpaces the growth in production during the initial stages of industrialization; energy elasticity decreases only when an economy reaches a stage of increasing share of tertiary industries and emergence of technology-intensive industries. It is also typical to observe a continued increase in end-user energy consumption until a certain level of income is achieved. Along with the rise of income, energy demand tends to make a qualitative shift toward advanced or more efficient energy sources.

During the period of rapid economic growth, the industries promoted by the government – particularly the heavy and chemical industries (steel, cement, and petrochemicals), as well as the automobile and ship building – led to the steep increase in energy consumption in the ROK.

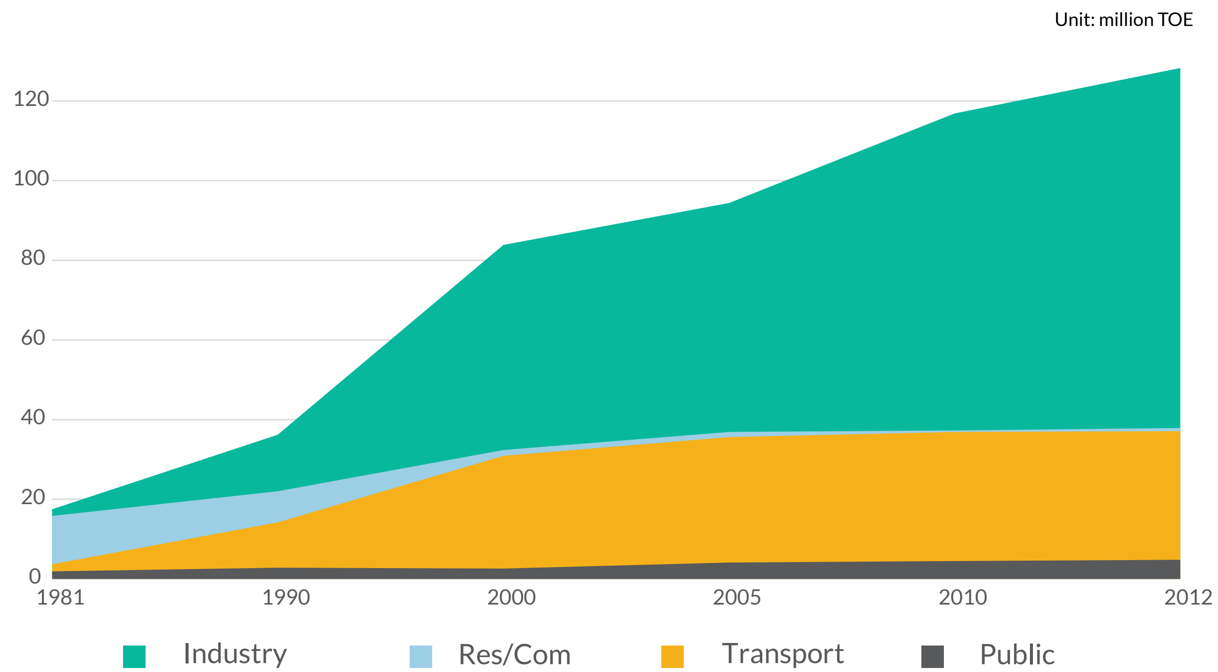
1 | The energy consumption per capita of major economies in 2011 (in TOE) includes the following: France - 3.81, Germany - 3.88, Japan - 3.61, Canada - 7.30, U.S. - 7.02, and OECD average - 4.28.

Figure 1: The ROK's economic growth and energy demand



Source: KEEI, 2014

Figure 2: Energy demand by sector



Source: KEEI, 2013b

However, it is important to recognize that this trend remains prevalent today to a considerable degree; as shown in Figure 2, the growth of energy consumption is driven strongly by the industrial and transportation sectors. As of 2012, the industrial sector accounted for 61.7% of the nation's total energy consumption, followed by the transportation sector (17.8%) and residential-commercial sectors (18.2%). As a result of the continued expansion of the heavy and chemical industries, industrial energy consumption has increased 3.5 times since 1990, reaching 128.3 million TOE in 2012. Energy consumption in the transportation sector has risen 2.6 times to 37.1 million TOE during the same period due to the increasing number of vehicles. Meanwhile, the residential-commercial sectors showed relatively moderate growth, which was accompanied by the shift from traditional fossil fuels such as coal and firewood to highly efficient forms of energy such as gas and electricity.

1.2 Baseline Assessment

Root Causes of Challenges

Korea's energy challenge is rooted in the country's limited natural resources. Specifically, its indigenous energy resources including anthracite coal, hydropower, and renewable energy have low economic feasibility. As such, the ROK has to rely heavily on energy imports to meet the constantly growing energy demand. As of 2012, domestic energy production from indigenous sources was 11.1 million TOE, accounting for only 4% of the total primary energy supply.

- The nation's coal resources consist of low-quality anthracite, which is only adequate for household heating and small boilers. The ROK has also limited reserves of coal and its production dropped annually to 1.03 million TOE by 2012 in response to the government's promotion of the Coal Industry Rationalization Policy.[2]

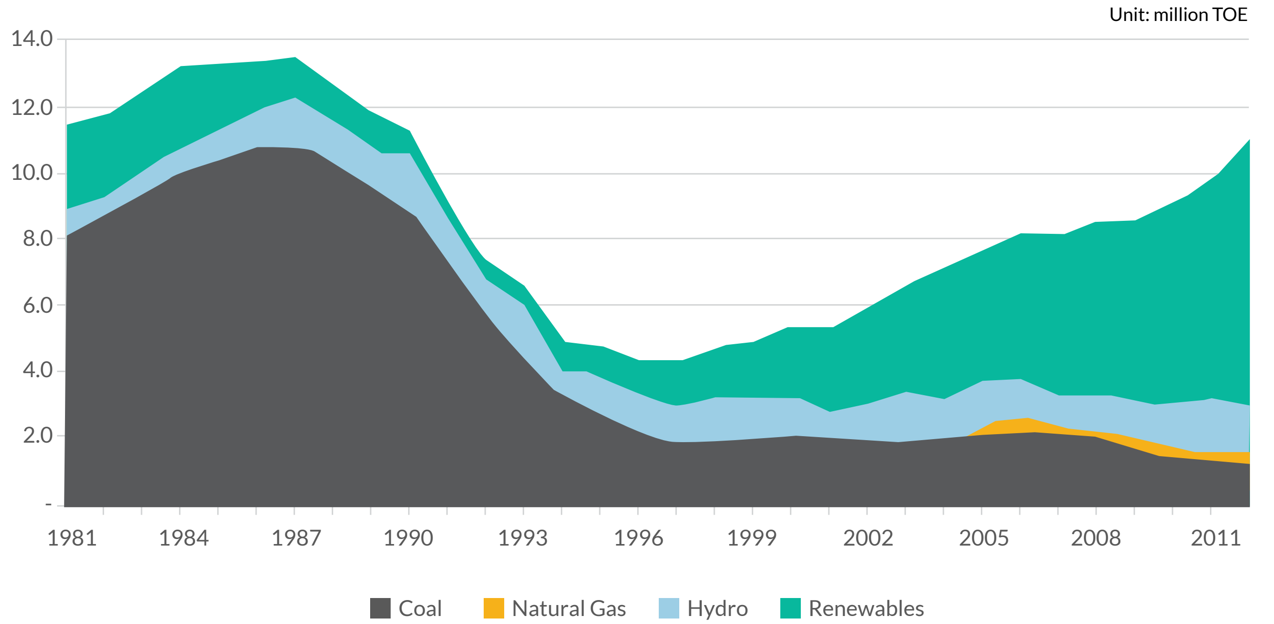
- The ROK has a long history of hydropower development. Many of the large hydropower stations that operate today were built during the 1970s to 1990s, when the government engaged in a flurry of dam construction to secure water supply and meet the increasing demand caused by rapid economic growth. However, the nation's highly restricted land area and the growing concerns over the environmental impacts of hydropower expansion have hampered the deployment of hydropower energy since the late 1990s. Currently, hydropower makes up for only 8% of the ROK's total power-generation capacity.

- Renewable energy has gained the attention of the government as it was identified as a solution to the fossil fuel dependency and energy insecurity. While the initial potential to harness solar, hydropower, geothermal and bioenergy in the ROK appears promising, it is restricted by the difficult geographical conditions (i.e., 70% of total land area comprises hills and mountains divided by steep river valleys), extreme seasonal variations, and high population density. While the volume of renewable energy use has grown to 8.04 million TOE, increasing more than ten-fold over the past 20 years, this figure is still minuscule compared to other countries like Japan (18.9 million TOE), Germany (32.8 million TOE), and France (19.8 million TOE).

It is obvious that the increasing energy imports to meet the domestic energy demand places a heavy burden on the economy and weakens national competitiveness, especially when the balance of payments is hampered by high global energy prices. In the 2000s, the ROK spent over 20% of the total national revenues on importing energy. In 2012, for example, the nation's spending on energy imports reached US$184.8 billion, making the ROKas the world's fifth largest oil importer and third largest importer of coal and liquefied natural gas (LNG) after China and Japan.

2 | Public preference for energy-efficient sources brought about the serious weakening of competitiveness of the coal industry by the end of the 1980s. The declining profitability due to the reduced demand for coal aggravated its level of production. In response to this, the government implemented the Coal Industry Rationalization Policy in 1989 with the aim of reforming and improving the structure of the coal industry. As a result, the number of coal mines was reduced from 332 in 1989 to just 5 in 2010 and coal production dramatically decreased from 24.3 million tons in 1988 to 2 million tons in 2012.

Figure 3: Indigenous energy production by fuel type



Source: KEEI, 2014

The ROK is one of the top global exporters of petroleum products, with three of the ten largest crude oil refineries in the world. It is interesting to see how a nation that relies almost entirely on imports to meet its energy needs has fostered an industry that adds value to fossil fuels. The government strategically supported the oil refinery industry as a priority sector for development under the First Five-Year Economic Development Plan (1962). As a result, the total export revenues generated by the refinery industries increased substantially over the years and covered more than 9% of the nation's total exports by 2011.

Although it is true that the ROK's oil refinery industry has a role to play in tackling the nation's energy crisis – since oil refineries are critical to stabilize the supply of petroleum products – they have had a limited impact in terms of resolving the nation's fundamental challenge of resource scarcity as their primary activities do not span across "upstream sectors" of overseas oil exploration and production, but simply focus on the downstream sectors of processing and purifying crude oil.

The ROK has had limited engagements and success in the development and acquisition of overseas energy reserves as a means of improving the nation's energy self-sufficiency.

Relevant Problems

Given the inherent constraints regarding energy resources, the nation's energy plans have undergone significant changes over the past 40 years. During the early stages of economic development and amid the global oil crisis in the 1970s-1980s, the government's priority agenda was stable and cost-effective supply of energy imports to fuel economic development. In this context, the diversification of energy sources was strategically undertaken by the government.

The nation was to move away from being fully dependent on petroleum-based fossil fuel imports from the Middle East and introduced natural gas and coal as new sources of energy by opening channels via Southeast Asia and North America. Such diversification of energy supply sources was intended to minimize the risks involved in single energy source dependency, enabling the economy to become much more flexible in responding to the fluctuations in the global energy market and other related contingencies.

Despite the government's efforts, petroleum-based fuels remained a major energy source even in the 1990s due to the promotion of the heavy and chemical industries. It was only when electricity consumption started to grow exponentially in the late 1990s that the share of petroleum-based fuels in the total primary energy consumption began to fall substantially (to less than 50% in the 2000s and even 38% in 2012). The share of LNG, which was introduced in the late 1980s, increased to 18% in 2012 following a significant annual growth of 20% in the 1990s. As for bituminous coal, the cement industry began to use it as a major energy source in the early 1980s, followed by other industries including paper, chemicals, textiles, and food. Although the government's heavy interventions for diversification of energy sources helped improve the nation's energy security, it is also true that such positive outcomes continuously reinforced the excessive exploitation of energy resources. The government's strong intervention in the process also led to the weakening of the energy industry's competitiveness and reduced market functions.

Consequently, structural reforms to increase the efficiency of energy industries formed part of the government's key energy policies in the late 1990s. Such efforts were in line with the government's strategic directions toward removing deep-rooted inefficiencies in the economic structure. To this end, the government amended the Petroleum Business Act in 1995, which eased or abolished regulations on market entry, energy pricing, facility development, and import/export in an effort to fully liberalize the energy industry. The restructuring of public utility companies was also undertaken; for example, the Korea Electric Power Corporation (KEPCO) was split into six subsidiary companies with further plans for privatization. Prior to the reform, KEPCO enjoyed a monopoly over power generation, transmission, distribution, and sales. Newly established in 2001, the Korea Power Exchange (KPX) seeks to operate a competitive electric power market by purchasing electricity from individual power producers to meet the nation's electricity demand at the lowest cost.

However, much of the ROK's energy problems today are rooted in the failure of the government to fully establish the principles of free competition in the energy utility market during this period. The government's actions to bring about a full-scale reform ceased in the early 2000s, when it was concluded that a competitive market runs the risk of undermining the importance of meeting the nation's energy demand, especially as the nation has no neighboring country from which to import electricity. The decision underlines government's concern over possibilities on monopolization of the energy industry by a selected number of private companies over which they would have no direct control.

As a result, natural gas and electricity businesses are still firmly in the hands of public enterprises,

Table 1: Energy mix in the ROK

Unit: million TOE, share in %

	1981	1990	2000	2005	2010	2012
Coal	15.2 (33.3)	24.4 (26.2)	42.9 (22.2)	54.8 (24.0)	77.1 (29.2)	81.0 (29.1)
Petroleum	26.6 (58.1)	50.2 (53.8)	100.3 (52.0)	101.5 (44.4)	104.3 (39.5)	106.2 (38.1)
LNG	(0.0)	3.0 (3.2)	18.9 (9.8)	30.4 (13.3)	43.0 (16.3)	50.2 (18.0)
Hydro	0.7 (1.5)	1.6 (1.7)	1.4 (.7)	1.3 (.6)	1.4 (.5)	1.6 (.6)
Nuclear	0.7 (1.6)	13.2 (14.2)	27.2 (14.1)	36.7 (16.1)	31.9 (12.1)	31.7 (11.4)
Renewables	2.5 (5.5)	0.8 (.9)	2.1 (1.1)	4.0 (1.7)	6.1 (2.3)	8.0 (2.9)
Total	45.7 (100)	93.2 (100)	192.9 (100)	228.6 (100)	263.8 (100)	278.7 (100)

Note: Numbers in brackets indicate the share in total energy supply

Source: KEEI, 2013b

namely the Korea Gas Corporation and subsidiary companies of KEPCO. Individual power producers were responsible for only 12% of the total electricity generation capacity of the ROK in 2007. Under the government advocacy for more and cheaper energy as the route to sustained economic growth, public energy utilities have been suffering from snowballing debts while struggling to remedy the nation's economy-crippling power shortages. The government continues to maintain until today a strong will to keep energy prices low and avoid situations of insufficient energy supply that are likely to impede economic growth. In short, the government's reluctance to run the risks of full-fledged market reform has not been accompanied by an alternative solution to overcome the nation's low energy self-sufficiency, high dependence on fossil fuels, and low efficiency of energy systems.

Moreover, the ROK's relatively small land area is reaching its physical limits for constructing new power plants and transmission facilities. The nation also struggled to contain air pollution and smog generated by fossil fuel combustion. Particulate pollution has become a chronic phenomenon during the winter season in the main cities. For example, high-PM10 episodes, defined as days in which the 24-hour mean PM10 concentration exceeds 100 $\mu g/m^3$, occurred 254 times during the period 2001–2008 in Seoul. The concentration of nitrogen dioxide, which comes principally from emissions by automobile exhausts and industrial boilers, was found to reach 0.034-0.038 ppm in Seoul during the 2008-2010 period, which is 50% higher than the average in major cities in OECD countries.

Energy Classification in the ROK

Energy sources can be classified into two groups:
(1) fossil fuels: such as coal, natural gas, and petroleum
(2) non-fossil fuels: such as wind and solar.

However, energy sources can also be divided into renewables and non-renewables: renewable resources regenerate as fast as they are consumed and are continuously available such as wind and solar while non-renewable resources are those that can be depleted such as fossil fuels and nuclear energy.

The ROK adopted the concept of "New and Renewable Energy (NRE)," which includes a total of eight renewable energy sources and three "new energy sources." Energy classification/specification is important as it determines the technologies acceptable within the government's climate change policies and programs. For example, unlike the ROK's classification and specifications on renewable energy sources, the International Energy Agency (IEA) does not recognize energy generated from combustion of non-renewable municipal waste (non-biodegradable part of municipal waste) as renewable energy.

The specific energy classifications of the ROK are shown below:

- Renewable Energy: solar heat, photovoltaic power, biomass, wind, small-hydro, geothermal, marine, and waste
- New Energy: fuel cell, coal liquefaction and gasification, and hydrogen energy

Policy Options

The concept of environmental sustainability has not been well integrated into the government's energy policies since the national strategy was primarily structured around improving the nation's energy security. Nuclear power was sought as the only viable option to address the energy shortage. Thus, it is recognized by the government as an affordable, clean, and environmentally sustainable form of energy. Despite the highly debatable environmental implications of nuclear energy, its cost competitiveness (i.e., direct costs in comparison with fossil fuels) and contribution toward energy independence have made its deployment an attractive policy for the government. After being introduced in 1978, a total of 23 reactors now provide approximately one-third of the nation's electricity.

The exponential rise in global oil prices in the early 2000s compelled the ROK to take a step back and adopt a wider perspective on the issue of energy security. The explosive growth of energy demand in emerging nations such as China and India poses a new risk to the ROK's energy security. The rising global competition over natural resources has heightened the nation's uncertainty on fueling its economic growth under the existing energy-intensive industrial structure. In addition, the possible enforcement of the nation's contributions to the global treaty on GHG emissions reduction was another issue to consider in addressing the energy crisis.

Under the evolving circumstances, the government observed rapid changes in the energy market, especially in terms of technology. For example, mass production and market competition were driving renewable energy systems to be increasingly competitive against conventional energy generation. Non-traditional energy transformation technologies were breaking the notion that high efficiency in energy generation can only be achieved by large-scale systems. The entry of highly efficient small-scale facilities that can avoid the environmental impacts of large-scale deployment was expected to change the existing patterns of energy production and consumption.

The technologies that allow a systematic communication between energy suppliers and consumers enable energy demand to better adapt to the supply during low-cost energy periods.

Acknowledging the fact that it is impossible for the nation to immediately cut down its use of fossil fuels, the government presented a practical and coherent proposal under the Five-Year National Plan for Green Growth in 2009, which was once again anchored on resolving the nation's energy insecurity. However, unlike its past interventions, the government was to focus on reducing GHG emissions through effective demand-side management and deployment of NRE systems.

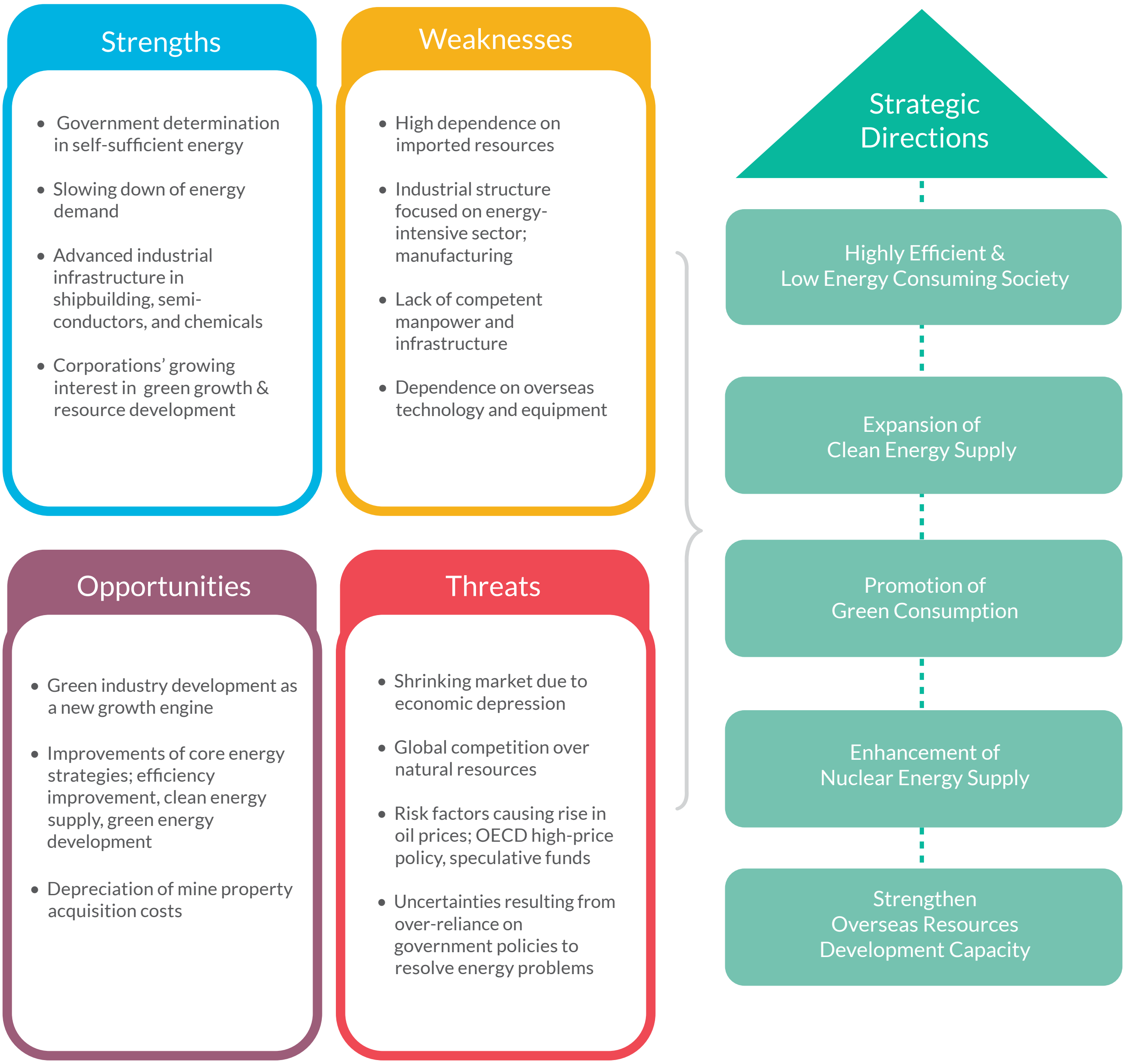
The technological innovation needed to deliver such outcomes was expected to unleash new engines of economic growth. For example, the industries engaged in manufacturing of components for renewable energy facilities and IT-based energy monitoring and control systems could lead the nation's export-driven economy.

1.3 Challenges and Opportunities for Green Growth

As one of the most resource-deprived countries, the energy security issue has long been at the center of the ROK's economic development plan. In an era of global market integration where countries share the implicit motive to gain greater possession of natural resources, the growing competition over fossil fuels became an imminent threat to the very existence of the nation. It is fair to say that the energy security challenge in the ROK is enough to be singled out from many other reasons as to why nationwide engagement for a green growth transition was necessary.

However, it is important to recognize that the proposed green energy solutions – reducing energy demand and deploying NRE systems – are aimed not only at providing a desirable buffer against rising energy prices and improving the nation's environmental performance, but also at transitioning to a leaner, cleaner economy built on new engines of growth. The improvements in energy efficiency would enhance the cost-competitiveness of the products manufactured in the ROK, and fostering NRE industries would help create new technology-intensive items for export.

Figure 4: SWOT analysis for greening the ROK's energy sector



Source: PCGG, 2009b

“Reducing the use of fossil fuels and enhancing energy self-reliance” is one of the ten agenda items presented in the Five-Year Plan. It is composed of four action plans:

(1) establishment of a society that consumes less and enhances energy efficiency;

(2) deployment of clean energy systems;

(3) expansion of nuclear energy generation capacity; and

(4) engagement in the development of energy sources overseas. This chapter focuses on how the ROK government delivered plans and established programs under the first two action items as well as the evaluation of the outcomes to date.

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Table 2: Action plans for the ROK's energy sector

Tasks	Actions
1.Promotion of less energy consumption and high energy efficiency	a. Ensure technological innovation in energy efficiency b. Promote innovation in energy demand management by sector c. Manage the energy demand by source and supplier d. Introduce and distribute highly energy-efficient appliances
2. Expansion of clean energy supply	a. Facilitate the industrialization of new and renewable energy b. Introduce market mechanisms
3. Building of capacity to supply nuclear energy	a. Enhance the reliability of nuclear energy b. Increase the share of nuclear energy c. Become a leading exporter of nuclear technology
4. Strengthening of capacity to develop overseas resources	a. Overhaul the overseas resource development system b. Ensure strategic promotion of overseas resources c. Rebuild and expand infrastructures for resource development d. Develop unconventional energy sources and natural resources

Source: PCGG, 2009b

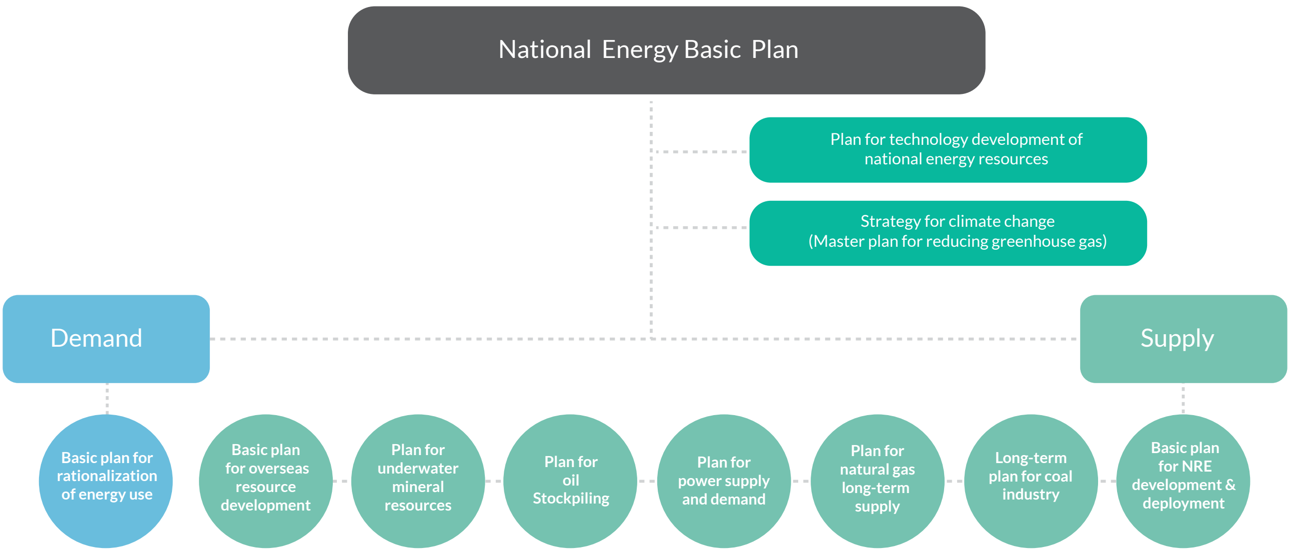
2. Targets and Strategies

The ROK's endeavor to make a robust shift toward enhancing energy efficiency and employing clean energy sources was anchored in the First National Energy Basic Plan (2008-2030) released in August 2008, which was later incorporated into the Five-Year Plan for Green Growth. Subsequently, the strategic directions under this plan were reflected in the various associated plans within the existing energy policy framework.

The action plans for the demand-side management were embodied in the Fourth Basic Plan for the Rationalization of Energy Use (2008-2012) while the action plans for the supply-side reforms were laid out in the Third Basic Plan for the Deployment of Renewable Energy (2009-2030) and the Fourth Basic Plan for Electricity Supply (2008-2022).

Figure 5: Structure of energy planning in the ROK

The ROK's energy policies take the form of various plans formulated and implemented by the government. The overriding plan is the National Energy Basic Plan, with a 20-year timeframe, which encompasses all energy-related sectors and aims to present the basic principles, strategic directions, and overall goals. Its associate plans with shorter timeframes (5-20 years) are divided into the energy supply-side and the energy demand-side, respectively. The supply-side plan specifically covers the development of particular energy sources including renewables, while the demand-side plan seeks to promote the rational and effective consumption of energy resources while minimizing the related environmental impacts to help improve public welfare and sustain economic growth.



2.1 The First National Energy Basic Plan (2008-2030)

The First National Energy Basic Plan is the ROK's first comprehensive plan that lays out the nation's long-term principles, strategic directions, and overall goals in the energy sector. Fundamentally, the plan was designed to ensure that all energy plans under the existing policy framework are well aligned and interconnected.

However, the underlying intention of the government of putting in place a new overarching plan in 2008 was to ensure that the nation's future energy plans coherently respond to the challenges stemming from climate change and global resource scarcity. Accordingly, the plan naturally served as a blueprint for achieving low-carbon green growth in the energy sector. Under the three pillars of energy security, energy efficiency, and environmental sustainability, the plan set out four agenda items, each with quantitative targets.

The rationale behind the plan is the belief that the ROK needs to break away from focusing on the energy supply side and should rather pay more attention on the demand-side management to achieve a sustainable and optimal energy mix. The specific strategies of the four-point plan are the following:

- **Low Energy Consuming Society**. In order to better respond to the fluctuating oil prices and increasing climate change risks, the ROK is to implement stringent policies that regulate energy consumption and improve energy efficiency, which can ultimately reduce energy demand by 7.6% and 12.4% compared to BAU projections by 2020 and 2030, respectively. Based on this goal, the energy intensity (TOE per million KRW) is expected to improve from 0.341 in 2006 to 0.185 in 2030.

- **Energy Independence.** As a means of improving energy security, the nation is to actively engage in overseas energy development to expand its resource base and maximize the use of indigenous renewable energy sources. In addition, the nation will seek to promote clean use of non-petroleum products such as LNG, coal, and nuclear power to achieve an optimal energy mix. The targeted reduction in petroleum dependency for energy is from 43.4% (2007) to 33% (2030), and the targeted increase in the share of renewable energy in meeting the nation's total energy consumption is from 2.4% (2007) to 11% (2030).

- **Green Energy Industry as a New Engine of Economic Growth.** The ROK also aims to support R&D activities to foster technologies and industries relevant to energy efficiency and renewable energy systems. Specifically, the government will double its budget for R&D in green technologies, which will not only accelerate the commercialization of green technology but also generate new jobs in the sectors relevant to green growth. The targeted level of domestic technologies in the green energy sector in comparison to the global leaders (which stood at approximately 60% as of 2007) is 100% by the year 2030. Achieving these targets will successively help enhance the ROK's share of global renewable energy markets.

- **Energy Welfare.** In order achieve social integration and social inclusion, the government will put in place various policy measures (e.g., expanding the supply of low-cost energy to impoverished communities, adjusting the energy pricing structure, etc.) to ensure that all citizens can meet their basic energy needs regardless of income. The government seeks to reduce the share of households with energy spending that exceeds 10% of their total income from 7.8% in 2007 to 0% by 2030.

2.2 Energy Demand Management

In the wake of the oil crisis in the late 1970s, the ROK government enacted the Energy Use Rationalization Act and established the Korea Energy Management Corporation (KEMCO) as a leading implementer of its energy conservation policies. Since the early 1990s, the government has been formulating the Basic Plan for Rationalization of Energy Use every five years, making efforts to systematize its energy conservation policies. In addition to the fourth Basic Plan for the Rationalization of Energy Use (2008-2012) that was released soon after the government proclaimed low-carbon green growth as the new national vision in 2008, the government formulated an additional plan called Demand Management Measures to Cope with High Oil Prices to ensure that the paradigm shift (from stable supply to demand management) leads to rapid results on the ground.

The Fourth Basic Plan for Rationalization of Energy Use (2008-2012)

The plan was jointly formulated by relevant ministries as a five-year action plan for the demand-side management. The most prominent feature of this plan is the doubling of the energy consumption reduction target compared to the past average target as well as its sufficient budget allocation of 18.3 trillion KRW. Such target is necessary to stay on track toward reducing the energy intensity to the level of advanced countries (0.185 TOE per million KRW) by 2030, as committed by the National Energy Basic Plan (2008). Specifically, energy intensity was expected to be reduced by 11.3% by in 2012 (0.297 TOE per million KRW) compared to the 2007 levels. The total amount of savings from the reduced energy consumption (34.2 million TOE) was estimated to reach approximately 9.5 trillion KRW.

It should be noted that in addition to the direct measures for immediately cutting down energy consumption, technological improvement, market creation, and institutional arrangements that generate enabling conditions for energy providers and consumers to deliver energy efficiency were identified as areas of critical importance. While the government was to exercise stringent control over large firms and public institutions with sufficient resources and capabilities, voluntary participation was applied to smaller business entities, households, and individuals. In addition, the government sought to strengthen the price signals in order to achieve energy-demand reductions.

To this end, the plan set out four detailed implementation strategies as summarized below:

- **Development and Deployment of Energy-Efficiency Technologies**. The government planned to invest 1.2 trillion KRW in technology development for the seven core sectors over the five-year period – building an energy management system, energy IT systems, energy storage systems, green vehicles, LEDs, energy intensive systems, and energy-efficient appliances. These technologies would play an important role in curbing energy consumption. Moreover, the energy-intensive systems include equipment with high potential to enhance energy efficiency such as boilers, electric motors, and air conditioning systems. The details on how the government funding for these technologies was channeled to R&D activities of public, private, and academic entities are provided in Chapter 4 (Green Technology and Innovation).

- **Creation of Energy Efficiency Markets and Promotion of Market Transition.** In an effort to fundamentally change the consumption patterns of end-users, the government sought to create and stimulate markets for the production and distribution of products with high energy efficiency. To this end, various regulatory and

Table 3: Sample action plans in the Fourth Basic Plan for the Rationalization of Energy Use

Sector	Measures
Industry	• Tax levies on energy-efficiency investments • Free energy diagnosis for SMEs by government institutions • Launch of cooperative platforms where large enterprises help SMEs adopt energy-efficient technologies • Negotiation of agreement schemes between the government and large energy-consuming companies (or facilities) to set and meet energy saving targets (i.e., Target Management Scheme discussed in Chapter 2)
Transportation	• Strengthening of vehicle emission standards • Tax exemptions on the purchase of hybrid cars • Expansion of Bus Rapid Transit (BRT) and Intelligent Transportation System (ITS) infrastructure • Expansion of bicycle roads
Buildings	• Strengthening of energy regulations and standards for buildings • Expansion of district cooling and heating infrastructure • Subsidies for investments in energy-neutral homes • Expansion of energy certification schemes for buildings
Public Sector	• Requiring all public buildings to meet the highest energy- efficiency level • Mandating all public institutions to increase their procurement of energy-efficient goods • Launch of energy-saving programs such as weekly car-free days, eco-driving campaigns, and limiting elevator and escalator use in commercial buildings

Source: MKE, 2008c

incentive schemes were implemented to enable a sustained market transition. Some of the major schemes proposed include the following:

- Phase out all energy inefficient incandescent light bulbs from the market by 2013
- Require home appliance manufacturers to ensure that the average energy efficiency of all their models (instead of regulating each product) sold in the market meet a predetermined level
- Mandate public institutions to preferentially procure products with low standby power consumption or with high energy efficiency labels
- Expand the list of products subject to energy efficiency labeling scheme
- Order the placing of warning labels on products that fail to meet a minimum standby power consumption standard
- Provide subsidies for promote investments on switching to energy efficient equipment

• **Energy Demand Management.** The need for eliminating energy inefficiencies across all sectors of the economy was at the heart of the Fourth Basic Plan for the Rationalization of Energy Use. To attain this end, identifying opportunities, assessing their potentials for energy savings, and evaluating the economic feasibility of the required investments were critical steps in delivering tangible results. In addition to strengthening the regulatory measures, the government proposed a diverse set of incentive measures to bring together participation from a wide variety of sectors and stakeholders with varying needs and capacities.

• **Establishment of Energy-Conserving Society.** Recognizing how the energy consumption pattern is strongly associated with the energy pricing structure, the government put forward reform measures to further rationalize energy pricing and incentivize energy conservation practices. In addition, the government promoted participatory schemes at the grassroots level to help energy-saving practices to take root in the public sphere (kindly refer to Chapter 5 for further details). The specific measures are enumerated below:

- The electricity prices are to phase out cross subsidization[3] and be gradually increased to better reflect the actual unit cost of power generation.
- As a means of reducing consumption for heating during the winter season, a differential tariff that charges prices according to seasons and end-use is to be introduced to natural gas pricing.
- The unit cost for district heating is to be capped by region in order to improve fairness and stimulate competition for enhancing productivity among energy suppliers.

Demand Management Measures to Cope with High Oil Prices (2009)

Alarmed by the threat of soaring oil prices, the government announced an additional plan to complement the Fourth Basic Plan for the Rationalization of Energy Use. This plan called Demand Management Measures to Cope with High Oil Prices was released in June 2009 in preparation for the possible skyrocketing of oil prices (note that the global oil prices actually exceeded US $100 per barrel in 2011 and through most of 2012, although the price escalations did not reach the levels of the 2005-2007 crisis). The plan was perceived as a tipping point where both the public and private sector decisively committed themselves to conserving energy and sharing the burden.

While the plan was deemed as a reinforced version of the Fourth Basic Plan, it laid out the additional items of interventions that succeeded in reassuring the private and public sector of the government's commitment to managing the country's energy demand. The core elements of the plan include the following:

• **Strengthening of the Government's Institutional Framework.** Recognizing how the past energy policies on the supply-side management have created institutional gaps in terms of regulating and monitoring energy consumption, the government required all relevant ministries to form an energy conservation division. The ministries are required to undertake full-scale measures to reduce energy consumption by setting targets and managing performance within

3 | Cross subsidization is a mechanism that subsidizes the loss of less profitable sectors with the gains incurred in high profitable sectors. In the ROK, different rates are charged depending on the types of end-use sectors: residential, general, educational, and industrial. The profit from the sales of residential and general electricity is used to cover the loss from industrial and agricultural electricity sales.

their authority. As a cross-ministerial body, the establishment of the Energy Efficiency Bureau was proposed under the Ministry of Knowledge Economy (with an ad hoc organization with a three-year term) to oversee the performance of the ministries. In addition, the annual energy supply and demand plan was to be reported to the state council, and the energy imports and consumption were to be reported on a quarterly basis.

- **Vehicle Emissions Control.** Realizing how the nation's emission standards and the technological competitiveness (in terms of emissions reduction and fuel efficiency) of domestic car manufacturers are lagging far behind those set by the global leaders, the government proposed the strengthening of the vehicle fuel standards to exceed the level of advanced countries by 2015. The government planned to provide 150 billion KRW for five years as seed investment for the R&D activities needed to meet the target, which will help attract an annual investment worth 550-720 billion KRW from the domestic car (and component) manufacturers.

- **Regulatory and Incentive Mechanisms.** The government further proposed a set of strengthened regulatory and incentive measures across all sectors of the economy. These measures included an escalated consumption tax on low energy efficient products, mandating energy-intensive businesses and buildings to appoint energy management officers, legislative amendment to encourage public institutions to procure products of highest energy efficiency, and providing corporate tax cuts of 50% for SMEs producing certified energy efficient goods.

2.3 Energy Supply Management – Promotion of Clean Energy Use

Recognizing New and Renewable Energy (NRE) as the most important alternative to fossil fuels and the need for its comprehensive development and exploitation in the future, the ROK enacted a law to promote the development of NRE technologies as early as 1987. Anticipating how the commercialization of technologies was supported by the market under the international climate treaty during the mid-1990s, the government laid the foundation for deploying NRE into the domestic energy market by formulating the Basic Plan for NRE Technology Development and Deployment, which served as a mid- to long-term action plan since the year 2001. Specifically, the plan includes setting targets for the level of domestic technology and for the share of energy generated from NRE, as well as strategies to achieve these targets, assessing the outlook and projections of their impacts, and making proposals on state subsidy programs.

Despite the government's aggressive focus on boosting the NRE sector, the ROK's share of NRE in the total energy generation continued to remain low at 2.37% as of 2007. In addition to the challenges of high front-end cost and low financial viability, the ROK's geographical and climate conditions are unsuitable for exploiting renewable energy. Most of the nation's land is covered by hills and mountains cut by steep river valleys that experience high seasonal climate variations. For example, the capacity factor for wind power generation in the ROK is approximately 25%, which is significantly lower than the average for most of Western Europe and the U.S. (the Northwest regions, in particular) given their capacity factor of about 50%. Under such conditions, the ROK has seen disproportionate deployment of renewable energy sources. Waste and hydropower made up for 77% and 14% of the total NRE supply respectively as of 2007, while natural renewables such as solar PV and wind accounted for less than 3%.

Low levels of technological sophistication and industrial infrastructure have been identified as critical barriers for deploying renewable energy. Although the government has prioritized investments in R&D activities based on the principles of selection and concentration – promoting development in three key areas namely solar PV, wind energy, and fuel cells – the level of technology has not caught up with the global leaders due to weak commitment and shortages of human resources with expertise in NRE. Specifically, public R&D investment in renewables only reached 63% of what was projected for the 2004-2006 period by the Second Basic Plan for NRE Technology Development and Deployment. Having failed to keep pace with the speed of product commercialization and industrialization in the global market, the ROK's deployment of renewable energy has relied heavily on imported facilities and technologies.

The Third Basic Plan for NRE Technology Development and Deployment (2009-2030)

In response to the nation's vision on low-carbon green growth, the government promptly revised the Second Basic Plan for NRE Technology Development and Deployment, which was set in 2002 with a time horizon of 2003-2012. An early amendment was deemed appropriate given how the nation was found to be off-track regarding meeting the target set by the Second Basic Plan (NRE share of 3.0% by 2006 and 5% by 2011) and the need for ensuring consistency of the plan with the First National Energy Basic Plan (2008-2030) released in 2008. In this light, the government directed public research institutions (Korea Energy Economics Institute and Korea Institute of Energy Research) to undertake a policy research over a period of 18 months, before the draft Third Basic Plan was ready to be disclosed in a series of public consultations. The Third Basic Plan was released in December 2008 and sought to shift the strategic policy focus of the NRE sector from "immediate boost in the volume deployment" to "promoting technology development," from "the use of public subsidies" to "promoting market-driven investments," and from NRE deployment through "large-scale systems" to "community-based or household-based, small-scale systems better customized to the local conditions."

Aligning its planning horizon to that of the First National Energy Basic Plan, the Third Basic Plan set an NRE deployment target of 11% by 2030, which was based on a comprehensive assessment of the ROK's potential NRE sources, supply capacity, technological levels, economic feasibility, and investment volume. Note that this target represents the share of NRE in the nation's total primary energy supply, and is substantially higher than the BAU estimates indicating a 5.7% share of NRE by 2030. The third Basic Plan predicted that the achievement of such a target would result in NRE generation of 39,517 GWh in 2030, accounting for 7.7% of the nation's total electricity generation. It is important to recognize that the Basic Plan also emphasized the need for breaking away from over-reliance on waste and hydropower sources and focusing on expanding the use of natural renewables including wind, ocean, and geothermal energy. Although solar thermal and PV are also expected to grow annually at 15-20%, their share of the total energy supply will be restricted as the deployment is based on the off-grid needs of households and small communities.

Based on the targets shown in Table 4, a total of 111.4 trillion KRW was estimated to be required from the public or private sources of finance until 2030, comprising 100 trillion KRW for NRE deployment, and 11.4 trillion KRW for R&D activities. The required annual budget envelope is likely to peak in 2020, which is the projected time when NRE technologies in the market can reach the stage of financial feasibility for deployment. Regarding the government's expenditures, the Third Basic Plan proposed that the government should bear approximately 35% of the total budget, equivalent to 39.2 trillion KRW (32 trillion KRW for NRE deployment and 7.2 trillion KRW for R&D activities). The government costs for extending subsidies for installation, low interest loans, and operating feed-in tariff schemes are 69%, 15%, and 16%, respectively, of the total budget needed for NRE deployment (32 trillion KRW).

Table 4: Target outlook for the deployment of NRE

Unit: thousand TOE

	2008	2010	2015	2020	2030	Annual Growth
Solar Thermal	33 (0.5%)	40 (0.5%)	63 (0.5%)	342 (2.0%)	1,882 (5.7%)	20.2%
Solar PV	59 (0.9%)	138 (1.8%)	313 (2.7%)	552 (3.2%)	1,364 (4.1%)	15.3%
Wind	106 (1.7%)	220 (2.9%)	1,084 (9.2%)	2,035 (11.6%)	4,155(12.6%)	18.1%
Bio	518 (8.1%)	987 (13.0%)	2,210 (18.8%)	4,211 (24.0%)	10,357 (31.4%)	14.6%
Hydro	946 (14.9%)	972 (12.8%)	1,071 (9.1%)	1,165 (6.6%)	1,447 (4.4%)	1.9%
Geothermal	9 (0.1%)	43 (0.6%)	280 (2.4%)	544 (3.1%)	1,261 (3.8%)	25.5%
Ocean	0 (0.0%)	70 (0.9%)	393 (3.3%)	907 (5.2%)	1,540 (4.7%)	49.6%
Waste	4,688 (73.7%)	5,097 (67.4%)	6,316 (53.8%)	7,764 (44.3%)	11,021 (33.4%)	4.0%
TOTAL	6,360	7,566	11,731	17,520	33,027	7.8%
Share of nation's total primary energy supply	**2.58%**	**2.98%**	**4.33%**	**6.08%**	**11.0%**	

Source: MKE, 2008d

As a means of achieving the deployment targets, the Third Basic Plan proposed to undertake three priority strategies, which are:

(1) facilitating NRE technology innovation and industrialization;

(2) boosting NRE deployment through a diverse set of promotional programs and introducing market-based mechanisms; and

(3) strengthening the basic infrastructure for NRE deployment.

- **NRE Technology Innovation and Industrialization.** As mentioned previously, the Third Basic Plan sought a paradigm shift from "boosting deployment" to "promoting technological development," based on the lessons learned from past experience (specifically the Second Basic Plan), which proved that without specific targets for achieving technological breakthrough, NRE deployment targets become unrealistic and unattainable. Accordingly, technical roadmaps and product roadmaps for each of the NRE sources were formulated, indicating specific plans for meeting the short-term (until 2010), mid-term (until 2020), and long-term (until 2030) targets for technology innovation and industrialization.[4]

  The government was to support R&D activities not only by providing the necessary budget, but building the demonstration sites or test-bed complexes that open opportunities for industries to pilot test their technologies. In addition, the government placed an emphasis on establishing a Korean technology certification standard for the NRE products – which is compatible to the leading global standards – in order to ensure its competitiveness in the global market.

- **Introduction of Market-based Mechanisms.** The Third Basic Plan stressed the need for NRE deployment to be led by the private sector based

4 | Note that these road maps served as a basis for policy actions and programs under the "Green Technology Agenda" described in Chapter 3 of this report.

on market principles, thus proposing to completely phase out the government's Feed-in-Tariff (FIT) scheme and the introduce the Renewable Portfolio Standard (RPS). In addition, the government aimed to strengthen the regulatory mandate of public sector organizations to invest in NRE systems, and make available NRE certification schemes (e.g., green building certification) that provide credits on voluntary initiatives for NRE deployment.

However, government subsidies targeting NRE deployment at the household and community level such as the One Million Green Homes Project continued to be available. Some critical aspects in the process of delivering these action plans include:

- Ensuring that NRE deployment better meets end-user requirements and secures financial feasibility for investment by upholding competition among different NRE sources;
- Enhancing the role of local governments by supporting the launch of local initiatives for NRE deployment, which are periodically monitored and evaluated by the central government;
- Strengthening the monitoring of NRE systems in operation (those that have been installed through government subsidies); and
- Intensifying the mutual support between the NRE technology development and NRE deployment agenda; for example, government support for NRE deployment programs is to be scaled up and made timely and responsive to the evolving levels of technology commercialization.

- **Strengthening of Basic Infrastructure.** Several administrative, legislative, and institutional arrangements were proposed by the Third Basic Plan as a means of strengthening the basic infrastructure needed for the deployment of NRE. Most importantly, the Renewable Energy Fund was to be launched with the support of government seed money to attract private finance for investments in NRE deployment. In addition, the government proposed to hold periodic consultations with the leaders of NRE industry to better respond to market needs, identify and improve regulatory barriers, and create an enabling condition for NRE investment. As solutions to help NRE industries build their scale and become more competitive, the government was to engage in public campaigns promoting NRE as affordable sources of energy and support academic curriculums of universities that are relevant to fostering of NRE experts.

2.4 Target Setting

As addressed above, the ROK government unveiled a robust set of strategies and policy measures for improving the nation's energy efficiency and utilization of clean energy, ensuring that this process provides opportunities for fostering new growth engines. As addressed above, the ROK government

Table 5: Example of technical roadmap (for solar PV) under the Third Basic Plan for NRE Technology Development and Deployment

	Short-term (until 2010)	Mid-term (until 2020)	Long-term (until 2030)
Target A - Unit cost of generation	300 KRW/kWh	150 KRW/kWh	90 KRW/kWh
Target B - Unit cost of system purchase	6,000 KRW/Watt	3,000 KRW/Watt	1,500 KRW/Watt
Scope of Activities	R&D on improving the efficiency of crystalline silicon PV module manufacturing process, and developing the technology for manufacturing a-Si PV modules	RD&D to support technology integration, commercialization, establishment of supply chains, and systematizing PV module manufacturing lines	Commercialization led by the private sector, through low-cost production arrangements and productization of systems with varying capacities and features

Source: MKE, 2008d

unveiled a robust set of strategies and policy measures for improving the nation's energy efficiency and utilization of clean energy, ensuring that this process provides opportunities for fostering new growth engines.

The Energy Efficiency Bureau, established under the MKE in July 2009, played a leading role in providing directions and monitoring progress for government interventions on the energy demand-side management. When the MKE was reorganized into MOTIE in 2013, this bureau was renamed as the Bureau of Energy Demand Management Policy and its operation (initially three years) was extended to July 16, 2015. On the other hand, the Korea Energy Management Corporation (KEMCO) was at the forefront of executing policy measures, including programs for energy management diagnosis, the Energy Service Company (ESCO), and energy saving campaigns. Meanwhile, its affiliate, the New and Renewable Energy Center (NREC), carried out measures to promote NRE deployment, such as a certification scheme for NRE systems, an FIT scheme, NRE mandatory use for public buildings, and NRE deployment support program.

Following the First National Energy Basic Plan (2008-2030), the primary targets of the energy sector given by the Five-Year National Plan for Green Growth were focused on enhancing the energy intensity levels and share of NRE. Achieving these targets was of paramount importance not only for transitioning to a leaner economy powered by new growth engines, but also for the setting and implementing the nation's GHG emissions targets. It is fair to point out that the energy sector targets and strategies released in 2008 set the tone and pace of the ROK's succeeding policies and actions formulated under the low-carbon green growth initiative.

3. Policy Actions and Programs

3.1 Policies and Programs on Renewable Energy

Driven by increasing environmental awareness and soaring oil prices, the ROK has shown great interest in policies and investments related to new and renewable energy (NRE). Against this backdrop, various programs are being carried out to utilize NRE to achieve energy self-sufficiency, reduce GHG emissions, and adapt to climate change.

The ROK initially implemented the feed-in tariff (FIT) scheme, an incentive program to promote voluntary participation in NRE distribution in early 2000, a time marked by the rapid commercialization of NRE. However, after ten years of implementation, the government transitioned from FIT to the Renewable Portfolio Standard (RPS) policy, which regulates the proportion of NRE within the total power supply. Moreover, the ROK also proposed to implement the Renewable Fuel Standard (RFS) policy, effective in 2015, which requires oil refineries to blend biofuel in their products. Various policies to incentivize voluntary distribution of NRE in the non-industrial sectors are also being carried out at the local level (refer to Chapter 7 on Green Homeland and Transportation). Such diverse policy measures represent the ROK's efforts to address the financial gaps in the NRE industry to help create an enabling environment for energy self-sufficiency. While NRE is still deemed to be less economically viable with huge gaps in technology development, its future growth prospects are immense. Thus, boosting investment, R&D, and other enabling policies is critical to tap this potential.

Table 6: Energy targets under the Five-Year Plan

	Annual Targets				
	2009	2010	2011	2012	2013
Energy intensity (TOE/million KRW)	0.317	0.313	0.307	0.297	0.290
NRE share (% of nation's total primary energy supply)	2.7	3.0	3.2	3.54	3.78
ROK's share of global renewable energy market (%)	2.8	3.6	4.3	5.0	5.4

Source: PCGG, 2009b

3.1.1 Feed-in Tariff Policy

The FIT scheme is a policy mechanism in which the government compensates power producers (PPs) for the price difference between the market price and production cost when the transaction price is lower than the standard price (the price set by the government).

Under this policy, the government mandates system operators (SOs) to purchase all locally generated renewable electricity from local PPs at specific rates (fixed prices) and sell it to users. In the process, the government will subsidize PPs with FIT for 15 to 20 years. The standard purchase price for renewable electricity is strategically lowered in phases, taking into consideration the enhanced economic feasibility or profitability of investments from the advancement of NRE technology. The ROK introduced the FIT scheme in 2002 to expand the NRE deployment and foster related domestic industries (manufacturing) and service sectors (engineering).

The main challenge for effective operation is to ensure that the sum of the market price of electricity and the FIT subsidy is maintained close to the actual cost of renewable energy generation. The level of FIT subsidy is automatically determined by the standard tariff set by the government, to which proper pricing is critical for the market to function. This means that excessively low standard prices may discourage investors and extremely high prices may fuel a sudden surge in NRE development, which might distort resource allocation and entail social costs. While the scheme is thus effective in mitigating investment uncertainties, its system of standard pricing is complicated due to the highly volatile market.

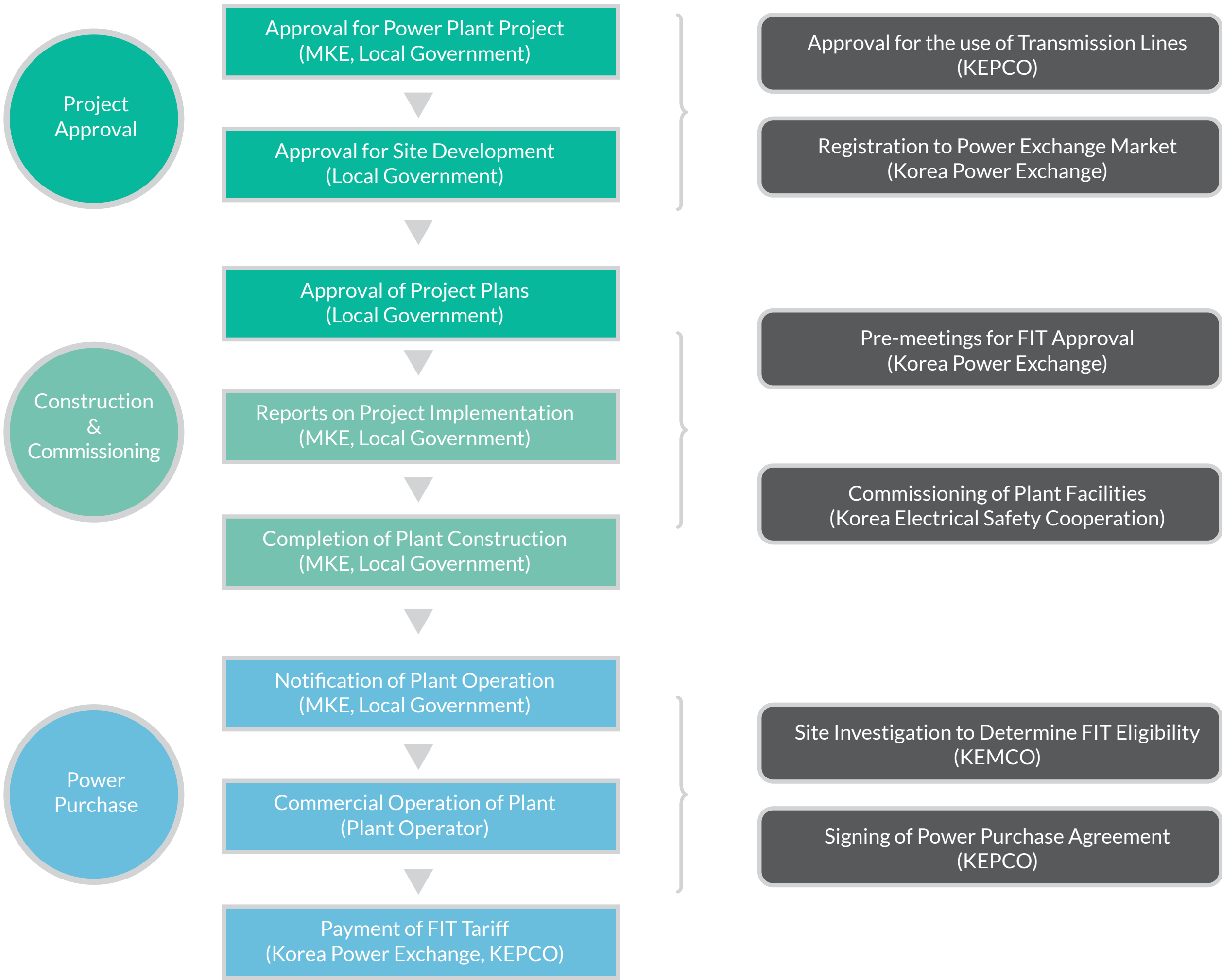
The FIT scheme has gained support in many developed countries such as Germany, Britain, the U.S. and Japan to strategically support domestic NRE industries in line with fulfilling mandatory GHG emissions reduction. Success stories have shown that the FIT can stimulate NRE deployment by easing investment uncertainties, engaging small and medium-sized PPs to generate local jobs, and promoting a diverse set of NRE sources by administering standard prices reflecting the technological and feasibility gaps of various energy sources. However, the scheme has also been criticized due to the difficulty in setting the proper standard prices, projection uncertainties on the necessary operational budget and its impacts, sensitivity of PPs to standard price fluctuations, and the long-term budgetary burden of FIT with significant risk for the government.

Implementation

Figure 6 shows the procedure for subsidizing the electricity generation of NRE power plants under the FIT scheme. An important step prior to the commercial operation of the power plants is that PPs must obtain approval through site investigation and document review for determining the FIT eligibility from the Korea Energy Management Corporation (KEMCO). KEMCO's evaluation provides the basis for setting the applicable standard price, which is reflected into the Power Purchase Agreement (PPA) between the PPs and the Korea Electric Power Corporation (KEPCO) or the Korea Power Exchange (KPX).

The PPA stipulates the legal requirements of preferential purchase of electricity generated from NRE. The traded amount of electricity based on the PPA is the basis for PPs to receive FIT subsidies. To maintain the explicitness and transparency of subsidy payments, PPs must put in place certified metering systems that monitor the amount of electricity generated by different energy sources or facilities as applicable. PPs must also provide detailed data regarding the production, consumption, and supply of electricity on a daily basis in a register (or using an automatic recorder) for record-keeping purposes.

Figure 6: Operational procedure for the FIT scheme



Source: KEMCO, 2014

The FIT payment to PPs is set by multiplying the price difference between the standard price of NREs and the system marginal price (SMP)[5] to the volume of electricity traded. The trade volume pertains to the power supplied to the market by PPs, but excludes consumption from the operation of the power plant. In general, the standard price agreed on the PPA is applied for 15 years from the first commissioning but the period can be extended to 20 years for photovoltaic power plant (effective since October 2008). The standard price and application period can be adjusted considering changes in oil prices, technological progress, commercialization, and power transaction results. This means that PPs that received the FIT subsidy before the price adjustment would fall under the standard price applicable when they first joined the scheme, and that the original price is effective for 15 years. Operators of NRE power plants can continue to sell their electricity to the government at the SMP even after the guaranteed period under the PPA has expired.

The standard price by NRE sources applicable to all PPAs is calculated based on the following criteria, and is revised as needed by the Ministry of Trade, Industry, and Energy (MOTIE):

- General costs related to NRE power plant construction, operations and maintenance (O&M), return on invested capital, and the level of taxes and public utility charges

5 | The System Marginal Price (SMP) is the transaction price of electricity set by KEPCO, ROK's single largest electricity power utility.

- Capacity factor of power generation, lifespan of the plant, accident modification factor (AMF), and energy consumption rate of the plants
- Levels of NRE technology commercialization and conditions for market deployment
- Costs paid by PPs in using transmission and distribution systems
- Degree of commercialization and deployment of NRE technologies
- Actual supply prices for electricity generated by NRE in the power market

One of the most important elements of operating the FIT scheme is the “quota” on electricity purchases imposed on each energy source. The government sets a cap on the preferential purchases of electricity generated by different NRE sources to maximize the limited budget allocated for the scheme. For example, FIT subsidies in the ROK only apply to the installations of solar PV, windfarms, and fuel cell facilities that are approved before reaching the cumulative capacity ceilings of 500 MW, 1,000 MW, and 50 MW, respectively. The government has sought to gradually increase the quota while lowering the standard price, considering how boosting the volume of the domestic market helps reduce the front-end costs for installation.

The standard prices levied by NRE sources is presented in Table 6 and 7.

As a means of ensuring fairness and addressing disparities between different sources of energy and the circumstances for their development, standard prices are made dependent on several factors including installed capacity, location of installation, and conditions of power generation. Note how PPs that generate electricity from hydro, waste, and bioenergy are given the option to set fixed or varying prices. They also have one chance to switch options over the entire duration of PPA. In addition, annual depreciation of the notified standard price applies to electricity generated from solar (4%), wind (2%), and fuel cell (3%) to ensure that standard prices continuously reflect the enhanced profitability of investments from technological advancement; however, annual depreciation does not apply to prices agreed in existing PPAs.

The MOTIE is the supervisory body for the FIT scheme while KEMCO (and its affiliate, the New and Renewable Energy Center, or NREC) is in charge of implementation on the ground. It should be noted that MOTIE administers the Electrical Industry Foundation Fund, which is the government’s source of FIT subsidies. The fund is raised by levying and collecting charges from public electricity bills as a means of securing the financial resources to support and sustain the nation’s energy industry.

Table 7: Standard price for solar PV generation (as of 2010)

Unit=KRW/kWh

Location	Guarantee Period (years)	Installed Capacity				
		Less than 30 kW	30 kW - 200 kW	200 kW - 1 MW	1 MW - 3 MW	More than 3 MW
General	15	566.95	541.42	510.77	485.23	408.62
	20	514.34	491.17	463.37	440.20	370.70
Building	15	606.64	579.32	546.52	-	-
	20	550.34	525.55	495.81	-	-

Source: KEMCO, 2014

The Proceeds of the fund also target various public needs, such as investments for rural electrification and R&D for improving energy technologies and services. The Korea Electrical Safety Corporation (KESCO), which is the designated public agency for conducting pre-service inspection on NRE facility installations, is an important enabler of the scheme's success since it upholds compliance to safety standards and technical requirements in NRE plants. The local government offices – having the authority over project approval and NRE plant construction and commissioning – play key roles, particularly by attending to the concerns of local communities on developing proposals.

Outcomes and Takeaways

Since the initiation of FIT in 2002, there have been 2,128 power plants with a total accumulated installed capacity of 1,054 MW that benefited from the subsidy. Without doubt, the scheme was successful in boosting NRE deployment despite public skepticism. FIT subsidies enabled the exploitation of natural renewable energy sources such as wind and solar, which continue to grapple with relatively low profitability. The completion and operation of large-scale windfarms of Gangwon (98 MW capacity) and Yeongdeok (39.6 MW capacity) from 2005 to 2006 marked the new era of clean energy in the ROK. In 2008, solar PV installation achieved an outstanding growth of 257 MW in installed capacity. In 2011, the total accumulated subsidy offered to PPs amounted to 1.1 trillion KRW and the total cumulative volume of electricity subsidized under the FIT scheme was 10,112 GWh. Although there was no new participation in the scheme when it was repealed in 2012, the annual subsidy payment is expected to remain above 300 billion KRW in the coming years as existing PPAs are effective for 15-20 years.

Table 8: Standard price for non-PV generation (as of 2011)

Unit=KRW/kWh

Source		Capacity	Additional Requirements		Standard Price		Note
					Fixed	Variable	
Wind		10 kW or more	-		107.29	-	Depreciation rate: 2%
Small Hydro		5 MW or less	Hydro	Over 1 MW	86.04	SMP+15	
				Below 1 MW	94.64	SMP+20	
			Multipurpose	Over 1 MW	66.18	SMP+5	
				Below 1 MW	72.80	SMP+10	
Waste Incineration		20 MW or less			-	SMP+5	Share of fossil fuels for power generation must be maintained under 30%
Waste (Refuse-derived fuel)		50 MW or less			-	SMP+15	
Bio Energy	LFG	50 MW or less	Over 20 MW		68.07	SMP+ 5	
			Below 20 MW		74.99	SMP+10	
	Biogas	50 MW or less	Over 150 kW		72.73	SMP+20	
			Below 150 kW		85.71	SMP+25	
	Biomass	50 MW or less	Ligneous biomass		68.99	SMP+15	
Ocean Energy	Tidal	50 MW or more	Maximum tidal range is over 8.5m	Installation on embankment	62.81	-	
				No embankment	76.63	-	
			Maximum tidal range is below 8.5m	Installation on embankment	75.59	-	
				No embankment	90.50	-	
Fuel Cells		200 kW or more	Based on biogas		227.49	-	Depreciation rate: 3%
			Based on other fuels		274.06	-	

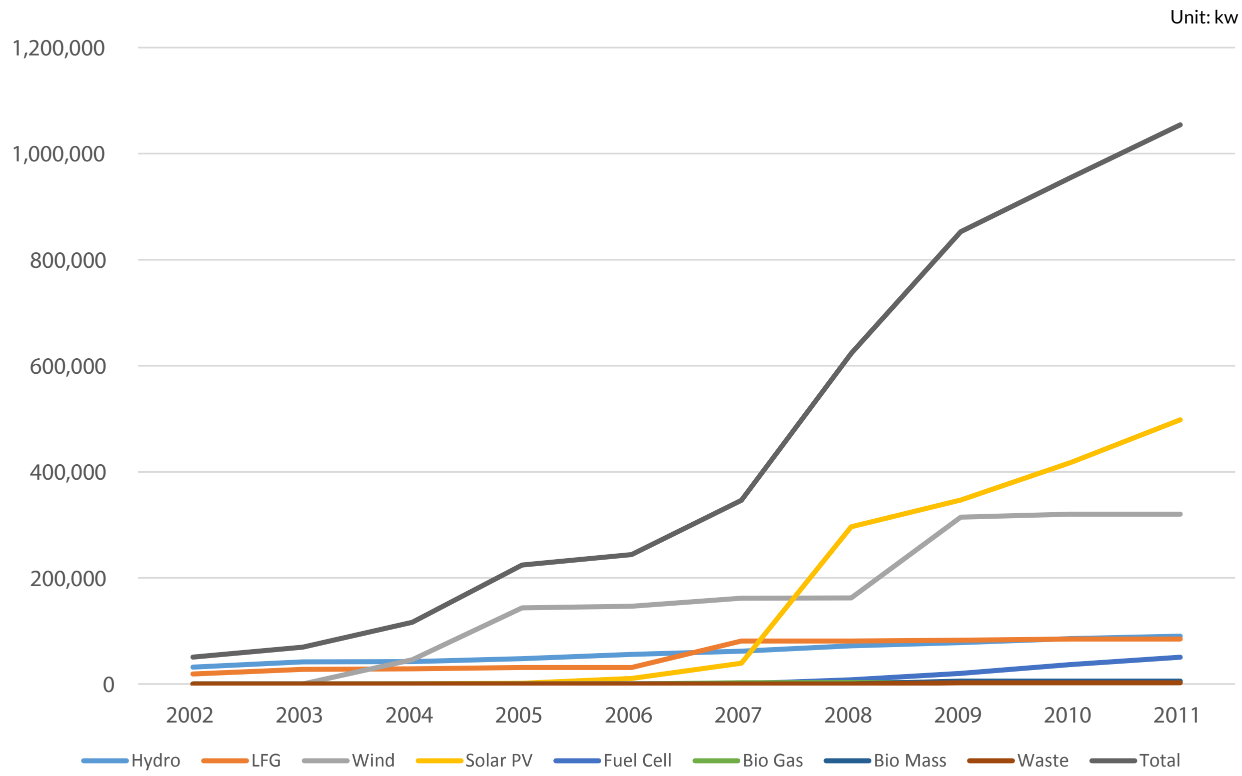
Source: KEMCO, 2014

Table 9: Annual outcomes of the FIT scheme

Category	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total
Amount of Electricity Generation (GWh)	159.9	269.8	309.9	390.2	489.9	854.8	1,185.4	1.503.0	2,427.9	2,520.7	10,111.5
Subsidy Payment (billion KRW)	3.4	5.6	5.0	7.6	10.0	26.6	119.5	262.7	331.8	368.9	1,141.0
Number of Power Plants	28	8	5	23	57	142	753	291	386	435	2,128
Installed Capacity (MW)	50.7	18.6	47.1	107.6	20.0	102.2	276.9	229.6	102.0	99.6	1,054.4

Source: KEMCO, 2012

Figure 7: Accumulated capacities of power generation under FIT scheme



Source: KEMCO, 2012

From a value-for-money perspective, the ROK's experience has provided solid evidence that subsidizing operational costs can be as effective as subsidizing front-end investment costs. In 2010, the National Assembly Budget Office released a report comparing the cost effectiveness of government subsidy programs for NRE deployment (refer to Table 9), many of which are aimed at subsidizing facility installations through grants or low interest loans, comprising approximately 60% of budgetary expenditure.

The volume of energy generation per unit capacity of facility in operation was found to be substantially high for those subsidized by the FIT scheme. Such results imply how the FIT scheme enables PPs to exert consistent efforts regarding the maintenance and management of facilities to maximize their profits, as the volume of electricity generation is linked to the revenue flow. In contrast, the PPs that benefit from the subsidies on NRE installations are more likely to overlook the operational efficiency of its facilities since it is already up and running. Recognizing how the underlying core purpose of boosting NRE deployment in the ROK through the FIT scheme was to promote domestic industries and services – especially the manufacturing sector – it is important to understand how the scheme has helped achieved this objective.

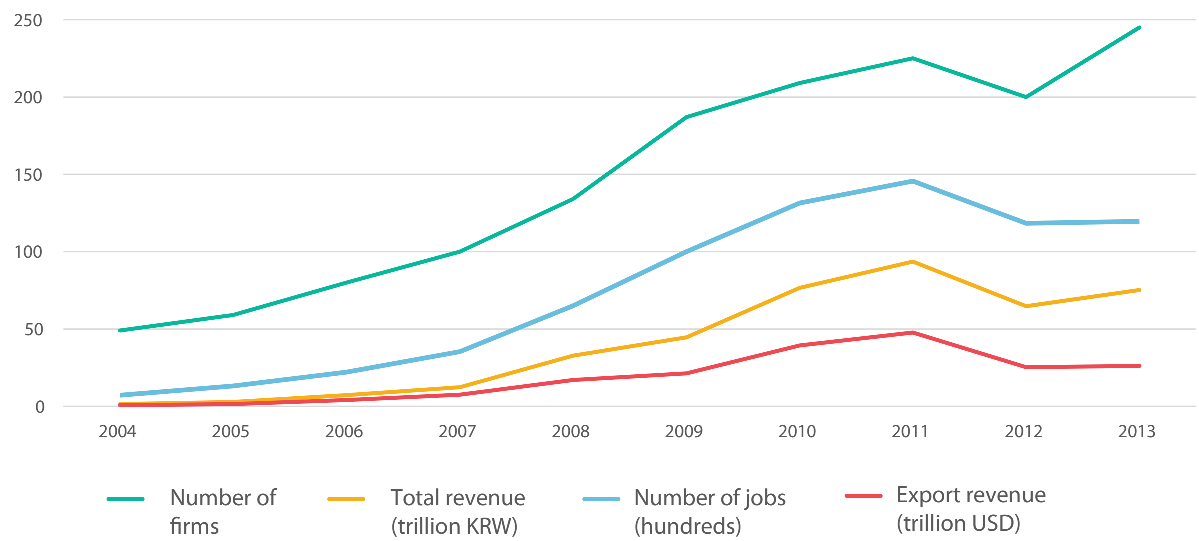
During the early stages of the ROK's NRE industry, the FIT scheme has played a critical role in realizing exponential growth in revenues and jobs. The government saw great potential for NRE goods to become the nation's next competitive export item. However, the total export revenue has fallen recently due to the lack of significant progress in combating climate change on a global scale. Wind turbines of different capacities (750kW, 1.5MW, 2MW) reached the commercialization stage and mass production by domestic firms, while vertical integration in manufacturing solar PV systems is achieved domestically.

Table 10: Operational efficiency of solar PV facilities: FIT scheme vs. installation subsidies

Type	Government program	Average installation capacity per facility (kW)	Efficiency (kWh/kW)	Efficiency compared with designed capacity
Installation subsidy	Green Homes Program	2.85	875	64%
	General Deployment Program	25	1,037	76%
	Regional deployment Program	72	1,161	85%
Operational cost subsidy	FIT Scheme	322	1,372	101%

Source: National Assembly Budget Office, 2010

Figure 8: Growth of domestic NRE sector during 2004-2013



Source: KNREC, 2014b

However, the application of the FIT scheme in the ROK has its own limitations. The NRE products have failed to overcome the cost competitiveness of leading exporters, especially China. In comparison to providing direct forms of incentives to NRE industries – such as provisioning tax levies and subsidizing utility costs as done by the Chinese government – the FIT scheme's benefits toward NRE industries arise indirectly from stimulating market demand. It should be noted that a large portion of the beneficiaries under the FIT scheme are facility constructors and PPs and it is natural that their preference for utilizing cheap and reliable items in the market has led to reliance on imported goods. According to the Korea Small Business Institute, 46.6% of solar PV facility components in domestic installations are imports as of 2010. In many aspects, the ROK's NRE industries (especially the small ones) have limited capacity for keeping pace with technological innovation and the mass production required to meet the domestic demand (Kim, 2010).

In 2008, the government decided to lower the standard price and maintain the FIT scheme until the end of 2011. The following year, the Renewable Portfolio Standard (RPS), which requires PPs to allocate a certain percentage of their energy mix for renewable sources, replaced the FIT scheme. However, the government's commitment to abandon FIT stirred controversy as the scheme had played a vital role in the promotion of NRE, thus substantially enhancing public awareness. The public also viewed this transition as contrary to the global trend since FIT was rapidly gaining momentum in several countries.

The growing financial burden of providing FIT subsidies was the major reason for its termination. In 2008, for example, the total amount of subsidy payment rose 4.5 times from the previous year. In addition, the design of the FIT scheme led to a surging number of solar PV installations, which had comparably low returns in terms of power generation. The average amount of electricity generated per one million KRW of subsidy (over the entire period of FIT implementation) was 1.92 MWh for solar PV, which is substantially lower than the average of 8.86 MWh for all subsidized NRE sources (refer to Table 10). In response, the government undertook measures in 2009 (the year after the subsidized number of solar PV installations marked an explosive growth) by capping the annual capacities of solar PV installation and excluding solar PV projects from being subsidized by eight state-owned energy companies. This government intervention demonstrates the difficulty in sustaining the efficiency of the scheme, which is largely affected by the evolving rates of return driven by technological progress. Note that many of the regulatory requirements related to the application of standard prices described in Table 8 and 9 (e.g., depreciation rate, location of installation, and conditions of power generation) are countermeasures to the original standard price guideline. Furthermore, another factor for discontinuing the FIT policy was to promote competition among PPs. As the RPS scheme is associated with trading of Renewable Energy Certificates (RECs), it was expected to drive competition among the PPs to enhance the cost effectiveness of NRE investments. In addition, RPS would better induce competition among NRE sources as it places no quota restriction on development.

3.1.2 Renewable Portfolio Standard (RPS)

The RPS is a market-oriented policy that stipulates the amount of renewable energy to be supplied in the market, along with the timeframe for meeting these standards. RPS has been adopted by several developed countries, including the U.S., Britain, Sweden, and Canada. Under the ROK's RPS, the PPs are obligated to generate NRE and given the option of fulfilling this by either directly engaging in NRE installations or purchasing RECs. Energy retailers have no obligations under the RPS as this market is monopolized by the public sector in the ROK.

In phasing out the FIT scheme that has been the centerpiece of the nation's drive toward generating green energy, the ROK government highlighted three objectives for adopting the RPS:

(1) expand the nation's supply of NRE;
(2) ease the government's financial burden arising from implementation of NRE; and
(3) support the development of domestic NRE industries.

While the FIT scheme and RPS share the same objectives, there is a clear difference in their operating mechanisms and pricing methods. The FIT serves as a price adjustment mechanism on how the amount of NRE generated in the market is largely dependent on the standard prices set by the government. In contrast, the RPS serves as a demand adjustment mechanism where market price for NRE becomes largely dependent on the government's mandate for the required amount of NRE generation. In comparison with the FIT scheme, which is an incentive program, RPS is a regulatory policy that offers the advantage of inducing price competition among NRE producers, reducing the government's financial burden, and easing the difficulties in making NRE supply forecasts, which is critical to achieving the long-term target (11% by 2030). However, the policy runs the risk of supporting the deployment of a limited number of NRE sources that offer the highest returns.

To facilitate a smooth transition, the ROK government pilot-tested the RPS by signing Renewable Portfolio Agreements (PRA) with six state-owned PPs, effective from 2009 to 2011. However, preparations for adopting the policy started as early as 2007 when the government commissioned the Korea Electrotechnology Research Institute (KERI) to draft the enforcement regulations and review the required legislative provisions. A series of workshops with industrial leaders, expert meetings, and public hearings was held during 2007-2009, before the RPS Taskforce Team was created under MKE with the mission to carry out a full-scale launch by 2012. After submission to the National Assembly in late 2008, the revised version of the Act on the Promotion of the Development, Use, and Diffusion of NRE – which phased out the FIT scheme and launched the RPS – was approved in March 2010.

Implementation

Covering both public and private PPs with a capacity of greater than 500 MW (targeted PPs), there are a total of 17 PPs subject to RPS as of 2015, with a portfolio that includes all types of NRE under the government classification. The target of 10% of the total power generation by 2022 will be achieved through annual increase of targets, starting from 2%

Table 11: Weighted value of REC for various NRE sources

Source	Weighted Value	Types of Energy and Criteria	
		Types of Installation	Criteria
Solar PV	1.2	Installations on general plot of land	Below 100 kW
	1.0		Above 100 kW
	0.7		Above 3,000 kW
	1.5	Installations on existing facilities (e.g., buildings)	Below 3,000 kW
	1.0		Above 3,000 kW
	1.5	Floating installations	
Other NRE	0.25	Integrated gasification combined cycle (IGCC), using by-product gas	
	0.5	Waste or landfill gas incineration	
	1.0	Hydro power, on-shore wind, bio energy, RDF, waste gasification, and tidal power (installation on an embankment)	
	1.5	Ligneous biomass and offshore wind power (less than 5 km of distance relay)	
	2.0	Fuel cell, tidal power	
	2.0	Offshore wind (greater than 5 km of distance relay), geothermal energy, tidal power (without embankment)	Fixed weighted value
	1.0-2.5		Variable weighted value
	5.5	Energy storage system (ESS) facility (integrated with wind power facility)	Effective year 2015
	5.0		Effective year 2016
	4.5		Effective year 2017

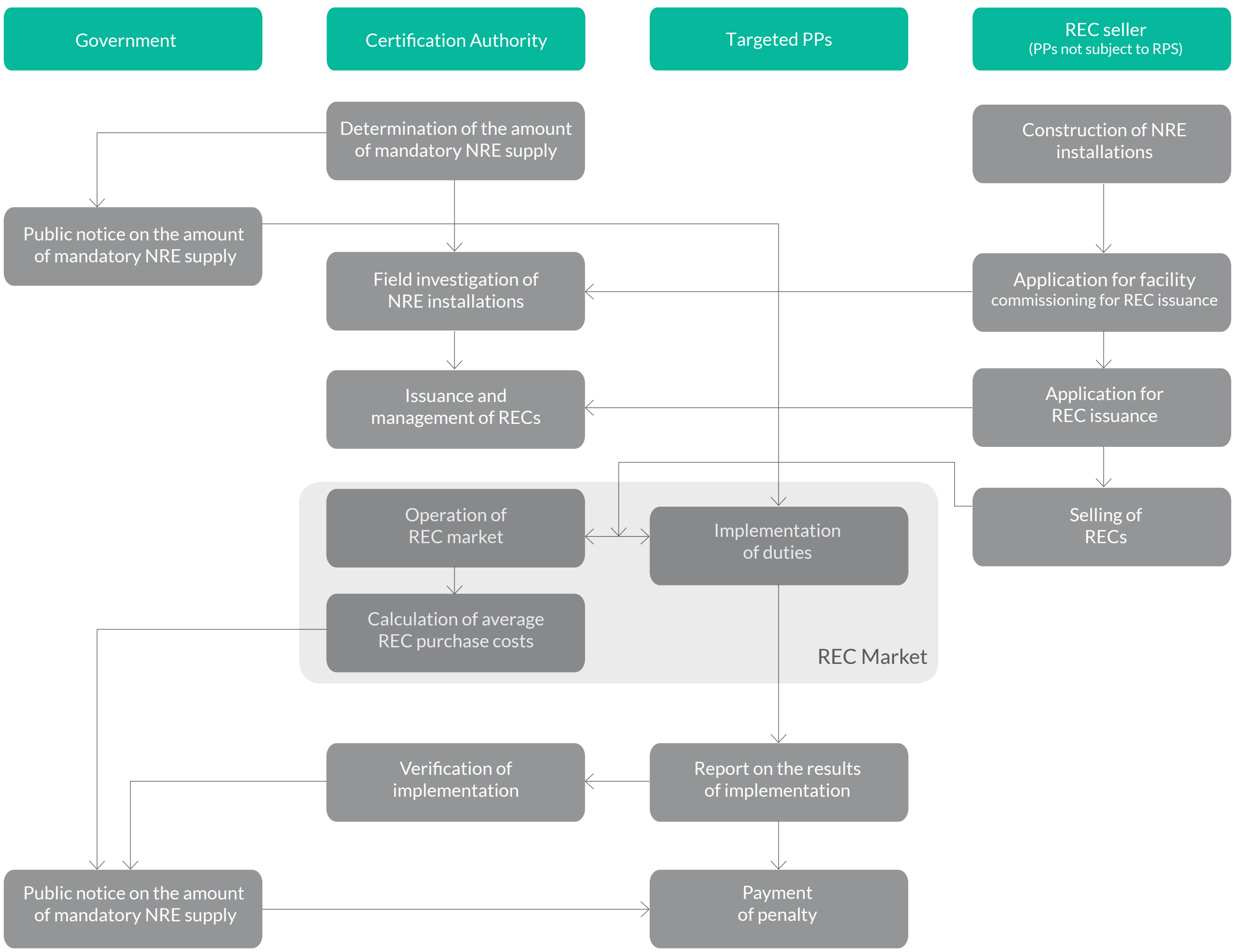
Source: MOTIE, 2015b

in 2012 and increasing by 0.5% each year up to 2016, followed by a one % annual increase thereafter to meet the total target. It should be noted that this figure is actually more ambitious than the nation's overall target of reaching 11% by 2030. Under the overall annual targets, the amount of mandatory NRE supply for each targeted PP is calculated based on their reference amount of past power generation (also net of power from NRE).

Anticipating that solar PV will disproportionally suffer under RPS as it comparably lacks the financial feasibility, the RPS includes carve-out provisions specifically for solar PV systems to be effective until 2015. This requires targeted PPs to supply a certain amount of energy generated from solar PV, which is to increase from 276 GWh in 2012 to 1,971 GWh in 2015. In meeting these requirements, targeted PPs are required to purchase at least 50% of energy (generated from solar PVs) by PPs that are not subject to the RPS (third party PPs). This rule had to be introduced considering how a complete phase-out of the FIT scheme would undermine small-scale investments in solar PV installations.

The unique feature that separates RPS from the FIT scheme is in terms of trading RECs, which are transaction units of certified power generation and supply from NRE. The RECs are granted to energy supplied by NRE facilities that have started commercial operation after January 2012. Targeted PPs are allowed to purchase RECs in the market to meet their requirements. In other words, third-party PPs are given the opportunity to sell their RECs to the targeted PPs, which will lead to profits aside from the selling of electricity to KEPCO or KPX.

Figure 9: Overview of RPS implementation



Source: MOTIE, 2015b

Note that a weighted value is multiplied to the actual amount of NRE supplied (MWh) in the calculation and granting of RECs.

Such measure aims to promote a balanced technological development and deployment of all NRE sources by controlling the number of RECs made available in the market. In principle, the weighted value is reviewed every three years and is calculated by taking multiple factors into account, including environmental impacts, levels of technological development, projected effects on promoting the NRE industry, unit cost of production, and the impacts on GHG reduction. As shown in Table 11, the weighted value may vary according to each renewable source and condition of facility installation.

The RPS implementation starts from determining the required amount of NRE-generation for targeted PPs, a procedure that is carried out by the certification authority (NREC). The calculated figures are reported to and approved by the responsible government ministry (MOTIE), before notifying PPs by January of the implementation year. RECs are issued monthly and PPs must apply for issuance at least 90 days before the end of the month in which the corresponding supply of NRE took place (RECs are effective for trading for three years from the date of issuance). Upon meeting its annual obligations by either directly issuing RECs (from making direct investments in NRE facility installation) and/or purchasing RECs from the market, targeted PPs are to report their annual performances to the government. Targeted PPs “retire” after submitting their RECs for compliance purposes and KNRE removes them from accounts of targeted PPs in the online RPS management system.

Failure to meet annual targets will entail a penalty, which is principally set based on the unmet amount of NRE and average market price of RECs for the implementation year. However, targeted PPs are permitted to borrow up to 20% (exceptionally 30% until 2014) of the required total amount of NRE to be generated for a given year from their renewable portfolios of the following years (three years maximum). As mentioned above, PPs not subject to mandatory NRE supply under the RPS can pursue NRE installations and receive RECs for trading. However, only the targeted PPs are eligible for REC purchases. Figure 9 provides an overview of the procedures for RPS.

The government (MOTIE), certification authority (KNRE), and PPs are all involved in the implementation of the RPS policy. MOTIE designated KNRE as the certification authority tasked to:

(1) calculate and report the annual amount of mandatory supply for each of the targeted PPs;

(2) manage certification issuance;

(3) operate the REC trade market;

(4) report the average transaction price; and

(5) verify the performances of targeted PPs.

Note how KNRE is also in charge of certifying the eligible facility to be used for demonstrating compliance with the RPS requirement (both for targeted and non-targeted PPs as shown in Figure 9); the institution conducts on-site inspection to see whether the facility conforms to technical and safety standards. Certified facilities are automatically registered through the online RPS management system, which is the platform for issuance, trading, and tracking all RECs.

The price of the RECs for trading is not pre-determined, but rather derived by the interaction of supply and demand in the market, which is divided into the over-the-counter market and the spot market. The over-the-counter market, which is open year round, is where a single seller and a single buyer bilaterally agree to make long-term REC transactions based on signing of contracts. The contract is reported to KNRE for actual transfer of RECs. However, transactions are made through auction or tendering in the spot market that opens once a month (both for RECs for solar PV and non-solar PV). While the choice of over-the-counter or spot market depends on the discretion of the PPs, the parties involved in the contract market must ensure that they comply with the contract period agreed with the counterpart. Breaching the terms may inflict loss or disadvantage on the counterpart.

Outcomes and Takeaways

Since the inception of the RPS policy in 2012 through the first half of 2014 (January-September 2014), there have been a total of 6,873 new NRE plant installations. In terms of the generation capacity, this is equivalent to 842 MW for 2012, 901 MW for 2013 and 1,423 MW for the first half of 2014 (total of 3,166 MW). Approximately 38% of the total generation capacity came from 6,730 solar PV installations. It is important to recognize how such outcomes far exceed those for the FIT scheme, which amounted to approximately 1,000 MW in generation capacity over the 11-year implementation period.

Despite the positive growth, the volume of new NRE facility installations was found to be insufficient as the targeted PPs continued to underperform in meeting their annual targets. In 2012, of the NRE supply obligations distributed among the targeted PPs, 35.3% were not met; 26.3% were granted extension while the remaining 9% were subject to non-compliance. In other words, out of approximately 6.4 million RECs imposed on 13 controlled PPs, only 4.2 million RECs retired in 2012. Accordingly, the penalty levied for non-compliance amounted to 25.4 billion KRW. Although the percentage of unmet NRE supply obligations decreased slightly to 32.8% in the following year, the volume of unmet RECs increased significantly as the annual target was raised from 2.0% to 2.5% of the total power generation.

Consequently, the penalty levied on seven targeted PPs with non-complied REC allocations reached 49.8 billion KRW in 2013; a significant portion of this increase is attributed to the increase in the average market price of RECs compared to 2012. It should be noted that penalties imposed have been largely targeted at state-owned PPs that are responsible for a large proportion of the total NRE obligation under the RPS.

The worsening financial stability of state-owned PPs participating in RPS is being recognized as a public concern; they have chronically suffered from the government's long-standing commitment to maintaining low energy prices. Details on the performance of targeted PPs indicate extremely high levels of compliance (nearly 100%) with solar PV requirements (carve-out provision). This outcome relates to how the solar PV offers the advantage of high flexibility in application (e.g., design and size), requires a shorter amount of time for site development and construction, and involves a less complicated process of acquiring permits. In contrast, obstacles in exploiting non-solar PV sources (which often have greater single site generation capacities) are seen as a major barrier causing sluggish performance. Many critics noticed the difficulty of initiating investments in non-solar PV energy facilities as they are more likely to trigger regulatory requirements dispersed among multiple ministries (e.g., Korea Forest Service on forest land-use, Ministry of National Defense on developing

Table 12: Outcomes of FIT scheme, RPA, and the RPS by NRE source (as of June 2014)

NRE Source	FIT (2001-2011)		RPA (2010-2012)		RPS (2012-)	
	Number of installations	Generation capacity (MW)	Number of installations	Generation capacity (MW)	Number of installations	Generation capacity (MW)
Solar	2,009	498.2	559	62.2	5,232	947.7
Wind	15	320.3	3	33.0	18	196.0
Hydro	64	90.2	9	22.9	40	639.2
Fuel Cell	20	50.5	2	5.2	17	113.4
Bio	19	93.0	-	-	49	1,022.7
Waste	1	2.2	2	418.5	14	316.5
Total	2,128	1054.4	575	541.8	5,370	3,235.4

Source: KNREC, 2014b

areas nearby military facilities). For example, dozens of windfarm projects in the ROK have been stuck in the early phase of licensing. The targeted PPs have emphasized that there are not enough RECs on the market for them to meet their obligations.

The energy generated from bioenergy and fuel cells has seen the most profound increase under the RPS. A staggering 1022 MW and 113 MW increase in generation capacity for bioenergy and fuel cells respectively was achieved over the 2.5 years of RPS implementation, which is higher than the 93 MW and 50.5 MW increase during 11 years of FIT scheme implementation. The RPS has indeed helped increase the nation's competitiveness in fuel cell technology. For example, POSCO Energy has invested huge sums in R&D and secured manufacturing capabilities for molten carbonate fuel cells. Taking advantage of the high-weighted value for fuel cells under the RPS (see Table 11), the firm recently completed building the world's largest fuel cell plant (59 MW system). However, increases in bioenergy generation capacity – which was primarily derived from biomass co-firing power plant installations – created unanticipated side effects of increasing biomass imports. Most notably, wood pellets that can be purchased at relatively low prices opened a convenient and cost-effective way of issuing RECs. In response, the government sought to impose a quota on the amount of RECs that can be secured through the use of wood pellets.

The integrity of the REC market is another area of concern. The market price of RECs has been volatile over the three years of implementation due to the government's market interventions. When the spot market opened in 2012, the prices of solar PV and non-solar PV RECs were approximately 229,000 KRW and 42,000 KRW, respectively. However, the price has been halved for solar PV RECs, while it doubled for non-solar PV RECs as of January 2015. Prices have fluctuated severely between this period, peaking at the end of 2013 (when targeted PPs were approaching annual compliance evaluations) but hitting near record lows toward the end of 2014. This trend has been largely affected by the government's supply of cheap RECs (government-owned RECs[6]) that sought to mitigate the financial burden of targeted PPs in the short term. The provision of RECs below market prices has hindered the signaling function of the market and raised uncertainties over the government's commitment to the RPS.

The RPS is thus progressing sluggishly given the multiple issues that are yet to be resolved. Due to opposition from the targeted PPs, the government took a step back in 2014, announcing that the initial target of meeting 10% of power generation from NRE sources by 2022 is to be moved to 2024. Despite the concession, the launch of the ETS in 2015 has cast doubts on the responsiveness of the ROK's energy industry to the mounting challenges. The RPS is an example of how the nation's ambition of greening its energy supply has continuously neglected to induce burden sharing across the value chain, especially among the end- users who enjoy the benefit of low energy prices. If the government is to adhere to such strategic direction, demonstrating strong commitments to minimizing uncertainties and boosting investor confidence are critical for the successful deployment of NRE.

3.1.3 Renewable Fuel Standard (RFS)

High dependence on foreign energy sources of the transportation sector and the desire to promote domestic industries have raised interest in renewable biofuels as an alternative to petroleum. In this regard, RFS represents the most significant government intervention to guarantee a market for biofuels in the ROK. The policy requires transportation fuel to contain a minimum volume of biodiesel. Transport fuel providers (domestic refiners and importers) are mandated to ensure that the minimum blending standards are fully met in market sales and consumption.

Developed countries such as the U.S., Britain, and Germany have implemented the RFS policy to actively respond to climate change, address energy security issues, and foster green industries. In the ROK where biofuels were first introduced to the domestic markets in 2002, the RFS was adopted specifically for diesel fuels (based on official public notice) in 2012 after going through a phase of voluntary agreements for blending with fuel providers for the 2007-2012 period.

6 | RECs secured by the government through issuance of RECs from NRE supply that arise from the government's FIT subsidies.

While the blending ratios of biodiesel experienced 0.5% annual increases during the first four years of the voluntary period (starting from 0.5% in 2007), it has been fixed at 2% since 2010. The legislation for the formal operation of RFS was passed in 2013 to strengthen the regulatory functions and administrative authority while ordinance and regulations are expected to be enforced starting July 2015 after a two-year grace period.

Implementation

Two key issues were highly contested in preparation for the RFS enforcement:

(1) selection of transportation fuels subject to mandatory blending; and

(2) determination of the blending ratios.

The government looked into the possibility of adopting the RFS for gasoline (to be blended with bio-ethanol) and LNG fuels (with bio-methane). Plans to increase the existing blending ratio set for biodiesel – which had been fixed at 2% until the launch of the RFS in 2015 – was also a critical issue, as the government was under extreme pressure from two opposing sectors – the fuel providers and biodiesel manufacturers. Consequently, the government held multiple closed-door consultations with relevant stakeholders including automobile manufacturers, refinery companies, and bioenergy providers.

After careful consideration, the government decided that the mandated ratio for blending biodiesel is to start at 2.5% in 2015, and be maintained for the first two years of RFS implementation. The blending ratio is to increase to 3% and be maintained for the four consecutive years (2017-2020). However, covering the transportation fuels other than diesel was postponed, without specific timeframes on enforcement.

The MOTIE is in charge of RFS operation. Specifically, it supervises the detailed procedural guidelines for implementing the RFS. The process involves the government notifying fuel providers of their obligations, carrying out of obligations by fuel providers, conducting annual verification of performances by the RFS implementing agency (to be determined), and imposing penalties upon non-compliance. Fuel providers that fail to meet the mandatory blend ratio face penalties, which are determined based on the average transaction prices of diesel fuel during the implementation year. Sanctions on business operations can also be imposed if procedures or targets are period breached.

Takeaways and Recommendations

The entities under RFS in the ROK are the four domestic refineries, along with fuel importers with relatively low market shares. According to the Korea Petroleum Association, 93% of the total annual volume of diesel fuel produced by four domestic refineries (19.5 trillion liters) is sold to the transportation sector, and approximately 0.4 trillion liters of biofuel has been purchased to meet the 2% blending standard as of 2013. The escalated blending ratio of 2.5% starting July 2015 is thus expected to increase the nation's annual biodiesel consumption by approximately 0.1 trillion liters.

As mentioned previously, there have been severe conflicts throughout the preparation for RFS launch. Oil refinery industries subject to RFS have insisted on maintaining the blending ratio at 2%, while the biodiesel production industries requested a 3% increase. Ultimately, the government enforced a more lenient regulation than originally planned due to concerns that putting excessive pressure on oil refineries may lead to imposing an excessive burden on the general public. Gaining public support for the policy is especially important in countries like the ROK, since an immediate expansion of biofuel use entails an increase of imports. Such imports may be a cheap alternative, but it has significant cost implications with regard to investments needed for securing facilities for proper storage, shipment, and logistics that are likely to be reflected in the consumer prices of diesel.

The proponents of RFS emphasize that expanding the use of biofuels provide benefits in terms of reduced dependence on foreign sources of energy, reduced GHG emissions, and increased profits from agricultural and industrial activities. In addition, RFS has the potential for enhancing the nation's energy security, increasing investments in related industries, and improving the environmental quality. [7] However, the critics of RFS in the ROK have raised concerns over the issue of biofuel production. For example, mandating the use of bioethanol – in which the ROK has a weak production base – is most likely to increase cheap imports from countries like Brazil. Such measure defeats the benefits of the RFS, specifically in achieving energy security, and protecting local agriculture and related industries. It should be noted that approximately 60% of biomass used for production of biodiesel in 2013 was imported. Regulating fuel providers to meet their targets with biodiesels made from domestically sourced biomass is an option being advocated by many critics.

The unintended consequences of biofuel use are also jeopardizing the integrity of the RFS. A worldwide expansion of biofuel consumption has indicated likely adverse impacts on other areas of policy importance, such as agricultural commodity markets and land-use patterns. Consequently, countries such as the U.S. and Germany that are currently enforcing the RFS have introduced sustainability standards to address these issues. Biofuels produced using biomass collected from key biodiversity areas are not accounted for in blend ratios. In contrast, the ROK government has yet to pass legislation on sustainability standards to counter the unintended consequences of RFS operation.

Although not without its challenges, RFS has potentials for contributing to the ROK's emission reduction and environmental sustainability. A good example is how the government's promotion of biodiesel use that started in 2007 has helped increase the collection and recycling rates of used cooling oil nationwide.

However, strengthening the government's fundamental rationale toward expansion of biofuel use is necessary for RFS to gain the required support of stakeholders with differing interests. The government's policy-measures for fostering domestic industries across the biofuel value chain are also a decisive success factor.

3.2 Policies and Programs on Energy Efficiency

In tackling the energy crisis, the ROK's past strategies have focused on exploring alternative energy sources and reviving nuclear energy. However, efficient use of the available finite energy is equally important. Since energy saved is as good as new energy generated, conserved energy is increasingly being viewed as the fifth fuel. Harnessing technologies to manage, store, and conserve energy can address the spate of energy challenges such as the supply-demand imbalances and mounting GHG emissions. To promote energy efficiency, the government has been implementing various policy incentives for the industrial sector, being the major energy consumer. In particular, incentives are targeted at small and medium-sized enterprises (SMEs) – having weaker energy management infrastructure than large conglomerates – to instill their voluntary participation in energy-saving activities. On the other hand, the government has set more stringent energy efficiency standards for large enterprises and the public sector to set optimal examples for the private sector and individual households.

3.2.1 Tax Credits for Investments in Energy-Saving Facilities

The policy offers tax deductions to local individuals and companies that invest in energy-saving facilities to encourage the private sector to pursue energy efficiency. Facilities subject to tax deduction are legally acknowledged and provided in the year when the investment is concluded. If the investment period covers two years or more, the tax deductions are based on the amount of investment made during each taxable year. The policy was first implemented in 2000 and has been offering tax benefits for investments made since 2001.

7 | Biofuels emit substantially lower volumes of direct GHG than fossil fuels when produced, harvested, and processed under the right circumstances (Renewable Fuel Standard: Overview and Issues, Congressional Research Service, October 2010).

Implementation

Tax deductions are applicable only for investments pertaining to newly purchased assets or items with proven energy conservation benefits. The deduction amount is calculated based on fixed rates of the total sum of investment. The fixed amount is deducted from either the income tax (limited to income tax of business income) or corporate tax during the taxable year. However, the deduction amount is capped at 30% of the corporate tax for the given year (with a waiver for SMEs).

The Ministry of Strategy and Finance (MOSF) provides the official classification of energy-saving facilities. Water-saving facilities such as faucets or toilets, as well as facilities categorized as for manufacturing of NRE (acknowledged by relevant laws) are also included. Investments on energy-saving facilities that have not been classified by the MOSF may also receive benefits upon submission of application (with proof of at least 10% energy consumption) and approval by KEMCO. Tax deductions undergo a simple process of reporting and approval and recipients submit the details of their investments to the relevant tax offices annually.

Since the implementation of the policy, the rate used to calculate the deductible amount has been readjusted several times. The policy started with a rate of 10% in 2001, and this figure was maintained between 7-10% during the early years of implementation. As one of the key measures to deal with the soaring oil prices in 2008, the ROK government attempted to strengthen the tax incentives for energy-saving activities by increasing the rate from 10 to 20% of the total sum of investment. However, as concerns were raised regarding how the provision of incentives have concentrated on a limited number of companies, the rate was readjusted to 10% in 2011; as a compensation scheme, the government abolished the capping of annual deduction amounts. In 2014, the government made further revisions by diversifying the rates by the size of firms. Differential rates of 3%, 5%, and 10%, now apply for large, medium, and small-sized enterprises, respectively. The policy is planned to be effective only until the end of 2016.

Outcomes and Takeaways

The majority of tax deductions were part of corporate taxes. As shown in Table 14, the average total amount deducted has reached 200 billion KRW per annum since 2009. Obviously, benefits have largely been directed to large enterprises with significantly higher and sustained volumes of investment. For example, 95.5-97.7% of the total tax deductions were awarded to large firms that comprised 58.2-72.9% of the total number of beneficiary firms during 2008-2011. In 2011, SMEs with a 41.8% share of the total number of beneficiary firms accounted for only 2.9% of the total tax deduction provided. Moreover, the top 1% of the beneficiary firms (based on annual revenues) were subject to 97.4% of the total amount of tax deduced. After the differential rates have been introduced (large, medium, and small-sized companies), the government expects a sharp reduction in total tax deductions. The MOSF reported that the annual total deduction from investments in energy-saving facilities for 2015 is expected to drop to 34.5 billion KRW.

Table 13: Scope of energy-saving facilities

Classification	Example facilities and systems
Energy-saving facilities	• Energy-saving systems of industrial facilities and buildings, power demand control systems, energy efficient equipment and materials, and electronic goods that reduce standby power • NRE generation facilities
Water-saving facilities, water-saving equipment, wastewater reuse system[8]	• Water-saving faucets and toilets
Facilities that manufacture intermediary or finishedcomponents of NRE installations (limited to solar PV, wind, and small-scale hydro)	• Solar PV component (e.g.,PV modules and inverters) manufacturing facilities

8 | Wastewater re-use systems refer to facilities that prevent the disposal of wastewater into public sewage. Instead, it enables the re-use of wastewater for other purposes.

Table 14: Annual tax deductions for investments in energy-saving facilities

Unit: billion KRW

Amount	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Rates (%)	10	7	7	10	10	10	20	20	20	10	10	10
Total Deduction	15.9	46.5	23.0	23.2	28.3	67.6	130.0	257.7	257.6	382.7	281.4	226.1
From Income Tax	0.0	0.05	0.1	0.2	0.1	0.1	0.2	0.2	0.3	0.2	0.1	0.3
From Corporate Tax	15.9	46.5	22.9	23.1	28.2	67.5	129.8	257.5	257.3	382.5	281.3	225.8

The ROK has been offering tax breaks to encourage private sector spending to align with government strategies through a multiple number of tax credit schemes. For example, tax credits (similar to those for energy-saving facilities) also apply for investments in environmental protection, targeting a wide range of facilities that fall under the categories of environmental sustainability, clean manufacturing, and GHG reduction. Although the private sector has identified such incentive schemes as a decisive factor to scaling of investments, government efforts in building and maintaining a clear rationale to provide tax credits is especially important. Setting the effective period and deduction rates must be aligned to meet these needs. The ROK's schemes tend to have relatively low deduction rates targeting a wide range of investments to be effective over a long timeframe (over 10 years). In countries such as the U. S., tax deduction rates often reach 10-50% but with capped ceilings (it should be noted however that the U. S. has significantly higher rates of corporate tax and imposes an alternative minimum tax).

3.2.2 Government Loans on Energy Use Rationalization Projects

The ROK government began to initiate energy conservation policies using financial instruments after the second global oil crisis in the late 1970s. It created the Energy Use Rationalization Fund in 1980 to provide low-interest loans for both energy producers and consumers to boost investments on energy efficiency and conservation. The proceeds of the loan have been diversified over the years of operation to support the nation's evolving investment needs. Today, the loans cover three primary projects: ESCO, TMS, and installation of energy equipment. TMS projects refer to relevant investments carried out by entities subject to TMS to meet their GHG emissions reduction and/or energy-saving targets. Projects for installation of energy equipment include investments in energy-saving facilities, high energy-efficiency product manufacturing systems, and energy demand management systems.[9]

Implementation

The details on the types of loan recipient and lending conditions are summarized in Table 15. The loan is limited to the costs of purchasing and installing (includes engineering and pilot testing) new energy equipment with proven energy-saving benefits (and/or GHG emission reduction benefits). It does not cover the purchase of land, construction of buildings, and value added tax (VAT). The detailed description of eligible items (e.g., boilers, waste heat recovery systems, lighting equipment, and energy storage systems) are provided in the policy guidance document.

It should be noted that loans are provided only to SMEs, non-profit organizations, and public institutions. However, large companies may also receive support in the form of interest subsidies, in which the government compensates only for the difference between the market interest rate and low interest loans offered by the program.

In other words, the energy users shall receive loans from commercial banks that offer interest rates higher than those of the low-interest loan program, and subsequently receive the government subsidy for the amount of incremental cost incurred from the difference between the two interest rates. Through such measures, the government can take advantage of lessening the financial burden while making good use of commercial loan programs. A total of 18 commercial banks have opted to provide loans on

9 | Energy-demand management systems refer to hardware solutions such as thermal storage cooling systems for improving the energy supply-demand balance.

projects recommended by the government to receive interest subsidies.

The low-interest loan program offers funds at fixed interest rates and/or variable interest rates, which follow the average yield on three-year treasury (e.g., 2% as of 2012 3Q), and has a repayment period of 5-7 years (after a three-year grace period). Up to 100% of the project's total costs are to be covered by the loan, while the minimum amount of the loan is set at 20 million KRW.

However, the loan implementing agency (KEMCO) is authorized to exercise control over the maximum loan amounts per project to ensure that the limited annual budget for the program provides benefits to an appropriate number of energy users. Energy users who wish to avail themselves of the loan should submit the application form to KEMCO for evaluation. External experts are invited to evaluate the applications in the form of quantitative scores, where a grade of 70 points or higher leads to the issuance of loan agreements (KEMCO), or recommendation letters for initiating loan contracts with a commercial bank. However, loan applications of less than 50 million KRW are exempted from quantitative evaluation and instead undergo a simple qualification assessment. Upon signing of loan contracts, KEMCO verifies whether investments have actually taken place as planned. It performs site inspection and performance evaluation annually for completed projects.

Table 15: Proceeds of low interest loans for energy use rationalization projects (as of 2014)

Loan Purpose	Recipient Type	Maximum Loan Amount per Recipient	Loan Conditions
1. ESCO Projects	ESCO implementation entities having contracts with energy users (investments on facility retrofit)	30 trillion KRW	Grace Period : 3 years Repayment Period: 7 years
2. TMS Projects	Entities subject to TMS (investments to meet energy consumption and GHG emission targets under TMS)	15 trillion KRW	Grace Period : 3 years Repayment Period: 5 years
3. Installation of Energy Equipment - Energy saving facilities - High energy-efficiency product manufacturing systems - Energy demand management systems	All entities with plans to make relevant investments	 15 trillion KRW 1 trillion KRW 5 trillion KRW	

Outcomes and Takeaways

As the administrative authority for the Energy Use Rationalization Fund, MOTIE allocates the annual budget for government's low interest loans. In 2012, the total annual budget for the low interest loans and interest subsidies amounted to 530 billion KRW and 70 billion KRW, respectively. As shown in Table 16, the size and the number of beneficiaries of the Energy Use Rationalization Fund have increased significantly compared to the fund's initial operation. It should be noted how projects relevant to the Voluntary Agreement (VA) scheme and mass energy generation have also received loans prior to 2010. The details of loan proceeds in 2011 indicate that:

- Lighting fixtures, heat recovery systems, equipment for optimizing manufacturing processes, power generators, boilers, and air heating/cooling systems were the most commonly invested items under ESCO projects.

- Equipment for optimizing manufacturing processes and recovering waste heat, furnaces, and power generators were the most commonly invested items under TMS projects.

- Waste heat recovery systems, energy demand monitoring and control systems, compressors, boilers, infrared radiation dryers, high-frequency induction heating devices, heat recovery exchangers, and energy-saving heating devices are the most commonly invested items under the projects for installation of energy equipment.

There were 830 loans provided to SMEs in 2011, which was about six times the number of loans granted to large companies, amounting to 352.3 billion KRW or 60% of the total budget. Large-scale loans greater than 4 billion KRW (35 projects totaling 259.2 billion KRW) and 1 billion KRW (96 projects totaling 189.8 billion KRW) comprised only 13% of the total number of loans, but accounted for 76% of the total amount of loans granted. Small-scale loans worth less than 100 million KRW constitute 48% of the total number of projects and comprise only about 4% of the total amount of loans granted.

Table 16: Amount of loans granted for energy use rationalization projects

Years	Budget (billion KRW)	Amount of Loan Granted (billion KRW)	Rate of withdrawal (%)	Amount of Loan Granted (billion KRW)				
				ESCO	TMS (and VA)	Energy Equipment	Energy Demand Management Systems	Mass Energy Generation
'80-'99	-	2,951	-	113	-	1,431	-	1,407
2000	446	399	89.4	86	39	113	-	161
2001	396	387	97.6	75	29	109	-	173
2002	526	503	95.5	140	68	139	7	150
2003	478	477	99.9	100	77	127	11	162
2004	480	474	98.7	83	66	130	8	187
2005	670	690	102.9	183	131	178	15	183
2006	655	645	98.4	133	114	183	20	196
2007	640	617	96.4	136	95	224	33	130
2008	683	679	99.5	112	117	312	39	100
2009	583	581	99.7	132	141	246	12	50
2010	512	512	100.0	131	139	243	-	-
2011	602	590	98.1	285	169	136	-	-
Total	-	9,504	-	1,708	1,182	3,571	145	2,898

Source: KEMCO, 2013

ESCO Projects in the ROK

Under the Energy Service Company (ESCO) project, ESCOs pursue investments to enhance the energy efficiency of users and recoup the investments from savings accrued in energy bills. The financing scheme, which originated in the U. S. in the late 1970s, was introduced in the ROK in 1992. In order to stimulate the ESCO market, the government has been providing tax credits and low interest loans for ESCO projects.

Investment agreements between the energy user and ESCO are based on assessments of energy saving potentials and projections on related costs and benefits. In the ROK, these agreements take the form of three different types of legal contracts: shared savings; guaranteed savings; and new shared savings. Once the contract is signed, ESCO carries out the necessary installation work and provides post-installation services including staff training on energy conservation. The savings in energy costs upon facility installation are shared in accordance with the terms of the contract. The contract between the energy user and ESCO is terminated once the investment costs are recouped observing the terms of the contract. The energy user is rightfully entitled to any benefits that arise from energy savings after the termination of the contract.

Table 17: Types of ESCO project contracts (between energy user and ESCO)

Category	Shared Savings	Guaranteed Savings	New Shared Savings
Principles	• ESCO raises the project fund with its own capital or through a loan from a third party (financial institution) • Energy cost savings realized by the energy user is shared with ESCO to redeem the investment costs	• Energy user raises the project fund and ESCO guarantees the minimum energy cost savings • ESCO compensates for the loss to the energy user, if the actual amount of energy cost savings fails to reach the agreed minimum amount	• ESCO raises the project fund with its own capital or through a loan from a third party (financial institution) • ESCO guarantees the minimum energy cost savings • Energy cost savings realized by the energy user are shared with ESCO to redeem the investment costs
Characteristics	• Energy user has no financial implication arising from front-end costs • The most prevalent type of contract in the ROK	• ESCOs with greater scope to sharpen their technical services to energy users, as they shoulder no burden of fund raising • Implemented in the ROK since 2004	• Seeks to exploit the advantages of "Shared Savings" and "Guaranteed Savings" contract

The ROK's experience revealed that ESCO projects provide a win-win solution among stakeholders with different interests. ESCOs gain investment profits and avail themselves of incentives from the government, and energy users avoid shouldering the burden of huge upfront investment costs and technical risks in generating energy savings through the support of ESCOs. Meanwhile, the government benefits by increasing opportunities for energy-saving industries, creating new jobs, and helping achieve the national GHG emissions target. Over the years, the scope of ESCO projects in the ROK has been extended from simple component replacements to complex system retrofits that exploit technological advances (e.g., waste heat recovery). The size of a single investment has also increased – from an average cost of 500 million KRW during the initial phase to the present value worth 0.9-1.3 billion KRW. Accordingly, the government has strived to meet the growing demand for low interest loans by increasing the annual budget allocated from 5 billion KRW in 1998 to 130 billion KRW in 2010.

The Energy Use Rationalization Fund is the government's flagship mechanism to encourage the private sector to invest in energy-saving facilities. By mobilizing low-interest loans worth 500-600 billion KRW annually, to support a wide range of activities, the fund has helped ease the financial burden of the private sector in driving energy conservation and achieving substantial savings in energy costs. Particularly, the proceeds of the fund have continuously evolved to meet the changing market demand and the government's regulatory standards. For example, in response to the launch of the TMS in 2012, the fund allocated a separate budget for supporting investment projects of entities subject to TMS; the annual budget was later escalated from 10 billion KRW to 15 billion KRW to meet the increasing demand. Furthermore, the fund's guidelines have been revised in 2012 to enhance industrial responses to the increasing risks in energy supply. It now allows large companies and non-profit organizations to receive the support for installing energy demand management systems that was previously confined to SMEs. Also, the list of items eligible for purchase from the loan proceeds has been updated to keep up with the market trends and technological advancement.

Nonetheless, the policy has yet to address several challenges. Relative to the substantial budget spent for this initiative, the outcomes of energy efficiency improvement have been criticized from a value-for-money perspective. Since 2009, KEMCO has been carrying out post-evaluations, but only on a limited number of completed projects. In addition, some of these post-evaluations were confined to merely checking whether or not the facilities have been properly installed. The root cause of the problem lies in the shortage of human resources to manage over 1,000 projects per year. With the absence of a long-term follow-up mechanism, the outcome is limited to the number of new installations and its genuine intention to achieve progress on energy efficiency through the replacement of industrial facilities may be overlooked. In addition, stringent management of the fund proceeds across all stages of operation (approval to post-evaluation) is critical in ensuring the effectiveness of the program. KEMCO's past experiences have revealed that some beneficiaries have disguised themselves to receive loans on projects with no energy-saving benefits.

3.2.3 Government Support for Energy Diagnosis of SMEs

Energy diagnosis is a process carried out by expert groups (energy consultant) to assess the industrial facilities' energy consumption patterns, identify measures for enhancing energy efficiency, and recommend investments to optimize energy use. In the ROK, facilities of private sector entities with annual energy consumption of over 2,000 TOE should undergo energy diagnosis every five years.

Acknowledging how SMEs generally have limited capacity in dedicating adequate resources to engage in energy efficiency investments, the government has been providing financial support to better achieve the desired outcomes of energy diagnosis. SMEs owning facilities with total annual energy consumption of less than 10,000 TOE (sum of all facilities owned) are eligible to receive partial support from the government in meeting their obligations. In addition, the government also supports SMEs with no obligations (annual energy consumption of less than 2,000 TOE) to voluntarily carry out the energy diagnosis. Underscoring the need for interventions in small-scale facilities with frequent high energy losses due to unnecessary energy consumption, the government launched support for 10,000 businesses to carry out voluntary energy diagnoses over a five-year period (2010-2014). The scheme also helped improve the competitiveness of SMEs and their level of preparedness for policies on GHG emissions.

Implementation (Voluntary Diagnoses of SMEs)

The SMEs that wish to avail themselves of the energy diagnoses can directly apply via the website of KEMCO – the agency in charge of overall management, supervision, and provision of funding support under MOTIE – or directly through the energy consultant. The contract signed between the SME and the energy consultant is reported to KEMCO prior to the delivery of services. Upon completion of energy diagnosis and KEMCO's verification of the actual amount of labor input spent, the diagnosis report is submitted and reviewed by KEMCO.

In addition to the site visit, KEMCO conducts a satisfaction survey on the recipient SME to evaluate the performance of the energy consultant. Finally, KEMCO disburses the fees claimed by the SME.

The MOTIE announces the standard cost for energy diagnosis of SMEs annually based on projections of the direct costs and labor costs (two persons engaged in two days of site investigation and two days of report writing). Of the total fee per business facility worth approximately 4 million KRW as of 2012, the government carries 70-90% of the standard cost, while the remaining amount subject to VAT is covered by the participating SME. Funding is available on a first-come, first-served basis according to the submission dates of diagnosis reports.

KEMCO notifies SMEs of the total budget allocated each year, in addition to sharing a contact list of certified energy consultants and standard form of contract to be used between SMEs and the energy consultants. It should be noted that the government's support for SMEs with annual energy consumption between 2,000-10,000 TOE also follows similar procedures and requirements.

Outcomes and Takeaways

Although the detailed outcomes of policy implementation have not been made available, the amount of energy saving and emissions reduction potentials derived from both mandatory and voluntary energy diagnosis serve as a good reference.

Table 18: Outcomes of energy diagnosis in the ROK (2007-2012)

Category	Items	2007	2008	2009	2010	2011	2012	Total
Facilities with annual energy consumption greater than 2,000 TOE (mandatory diagnosis)	Number of Facilities	383	420	559	545	469	546	2,922
	Potentials for Energy Saving (TOE/year)	429,013	549,333	710,412	479,840	438,800	440,622	3,048,020
	Potentials for Energy Saving Identified as Percentage of Total Energy Consumption (%)	4.6	8.0	6.4	5.9	4.7	3.5	5.3
	Potentials for Emissions Reduction (tCO_2/year)	1,086,377	1,463,397	1,754,496	1,184,438	1,080,153	1,004,434	7,573,295
Facilities of SMEs with annual energy consumption between 2,000-1,000 TOE (Mandatory diagnosis)	Government Support (% of diagnosis cost)	70	70	90	90	90	70	-
	Total Government Budget Spent (million KRW)	2,093	1,489	2,660	2,277	2,299	2,259	13,077
	Number of Facilities	145	111	152	128	144	166	846
	Potentials for Energy Saving (TOE/year)	44,579	30,953	39,256	33,504	37,513	40,426	226,231
	Potentials for Emissions Reduction (tCO_2/year)	99,672	78,714	88,164	81,841	79,384	89,597	517,372
Facilities of SMEs with annual energy consumption less than 2,000 TOE (voluntary diagnosis)	Government Support (% of diagnosis cost)	-	-	-	90	90	-	-
	Total Government Budget Spent (million KRW)	-	-	-	6,660	1,496	-	8,156
	Number of Facilities	-	-	-	2,000	430	-	2,430
	Potentials for Energy Saving (TOE/year)	-	-	-	57,265	32,484	-	89,749
	Potentials for Emissions Reduction (tCO_2/year)	-	-	-	124,770	73,291	-	198,063

Source: KEMCO, 2013

The government's support for obligatory energy diagnosis of SMEs during 2007-2012 helped identify the average energy saving and GHG reduction potentials of approximately 267 TOE/year/facilities and 611 tCO_2/year/facilities, respectively. SMEs of smaller energy consumption that have been supported to conduct voluntary energy diagnosis (2010-2011) have identified relatively smaller potentials of approximately 37 TOE/year/facilities and 82 tCO_2/year/facilities. Such potentials are derived from various hardware or operational interventions (e.g., facility retrofit, optimization of facility operations, and establishment of energy consumption monitoring system and database compilation), as well as management interventions (e.g., participatory employee programs that help instill the mindset to conserve energy).

Moreover, some success stories showcasing local governments' active participation has been noteworthy. For instance, the province of Jeonraanam-do has signed an agreement with KEMCO in 2010 to support a portion of energy diagnosis costs to be borne by SMEs under the voluntary scheme. Based on the diagnosis reports supported by Jeonranam-do, the identified potentials of energy saving averaged 10.3% per annum and valued at 1.084 billion KRW per year or 21.7 million KRW per diagnosed facility. The example illustrates how the diagnoses provide a platform for SMEs and central or local governments to collaborate in addressing the energy crisis and reinforcing business competitiveness.

Despite the success, the government failed to meet the target of engaging 10,000 businesses to carry out voluntary energy diagnosis over a five-year period (2010-2014). The government support for voluntary energy diagnosis ended in 2013 due to the lack of participation of SMEs. In addition to the low level of awareness and appreciation of the importance of energy efficiency, SMEs consider the 10-30% levy on the diagnosis fee as burdensome. As for the energy consultants, engaging in facilities with high energy use was much more profitable as they generally have higher contract values.

Although the government's underlying intention in engaging SMEs in energy diagnosis is to reduce the blind spots in the energy efficiency movement, the lack of follow-up mechanisms on realizing energy-saving potentials was an obstacle in winning the buy-in of SMEs. Thus, voluntary energy diagnosis should seek to extend support toward actual implementation by diversifying and scaling up of incentives to respond to the unique needs of SMEs.

3.2.4 Mandatory Public Procurement of Energy Efficient Goods

Electronic appliances and equipment account for a large portion of the energy consumed by households, businesses, and industrial sectors. With growing public interest and government's tightening of regulatory standards, the introduction of energy efficiency grades and certifications have made it easier for consumers to make environmentally friendly choices. However, it is true that energy efficient goods in the market are generally more expensive, often prompting consumers to buy cheaper and less efficient products. Such behavior can lead to reduced demand for energy efficient goods, thereby increasing their prices.

To enable the public sector to lead the energy conservation efforts, the policy on "Mandatory Public Procurement of Energy Efficient Goods" requires all government institutions to prioritize the purchase of energy efficient goods. Specifically, the agencies should identify and select goods with "high energy efficiency certifications" or "highest energy efficiency grades" upon purchase of new electronic appliances.

- The high energy efficiency certification program is a voluntary certification scheme of the ROK for industrial and construction equipment with energy saving features, meeting the minimum energy efficiency performance standards. A total of 45 items are eligible for certification, which include electric pumps, inverters, ventilation systems, and gas boilers.

- A total of 22 electronic appliances are eligible to acquire energy efficiency grades in the ROK, such as home appliances (e.g., refrigerators, washing machines) and lighting systems (e.g.,incandescent light bulbs, fluorescent light bulbs, lamp stabilizers). These appliances must meet the minimum energy performance standard to be sold in the domestic market and are stamped with energy efficiency grades of 1 (most efficient) to 5 (least efficient). In addition to the grades, the labels also provide information on the product's average electricity consumption (in kWh/month and KRW/year) and CO_2 emissions (in g/hr).

Implementation and Takeaways

The policy applies to all public institutions, including not only central and local governments but also special local administrative agencies and government-funded institutes. The subject institutions must purchase products with high energy efficiency certifications or products rated as grade 1 under the labeling standards. However, if there are no such products available in the market, institutions are allowed to select the next best product. Exemption also applies to small-scale purchases, recognizing the importance of streamlining procurement processes. There were additional requirements for purchasing lighting fixtures, as at least 30% of all new street lamps and public building's lighting systems were required to use LED products by 2013 (60% by 2015 and 100% by 2017), while 40% of all lighting systems in public buildings were required to adopt LED products by 2014 (60% by 2015 and 100% by 2020). Such figures have been put in place after the government released the National Roadmap on LED Deployment (2011), aiming for LEDs to cover 60% of all of the nation's lighting systems by 2020.

It is important to understand that the mandate for procurement of energy efficient goods is only one of a long list of mandates given under the Regulations on Energy Use Rationalization of Public Institutions. The obligations are largely divided into two categories covering a wide range of activities:

- Rationalization of Energy Use in Public Buildings
  - Procuring energy efficient foods
  - Acquiring the highest building energy efficiency grade (limited to new buildings and expansion of existing buildings)
  - Carrying out energy diagnosis (every five years) and ESCO projects (upon identification of energy saving potential greater than 5%)
  - Establishing NRE facilities to meet energy demand (15% by 2015, limited to new buildings and expansion of existing buildings)
  - Restricting the heating and cooling systems (i.e., room temperature above 28°C and below 18°C in summer and winter seasons, respectively) and elevators (e.g.,not to stop on lower floors)
- Rationalization of Energy Use for Transportation
  - Purchasing sub-compact models or green cars (at least 50% of all new vehicles procured)
  - Reserving parking spots exclusively for sub-compact models and green cars, which are located closer to the front entrance of public buildings
  - Implementing the weekly car-free day program

KEMCO supports MOTIE in supervising the compliance of public institutions with the abovementioned policies. The representative offices of public institutions shall establish a "GHG emissions reduction and energy saving committee" and hold semiannual meetings to self-monitor and assess the outcomes of implementation. The central and local government authorities annually conduct evaluations on these outcomes and address the needs for carrying out complementary measures in case of underachievement.

Although the specific outcomes from implementing the public mandate have not yet been made available, it is without doubt that the public institutions of the ROK have played a critical role in instilling a culture of energy conservation. In addition to operating the public sector TMS (refer to Chapter 2), these mandates have strengthened the government's direct control over energy demand arising from public institutions.

In addition, leveraging the purchasing power of public authorities has helped expand the markets for energy efficient goods (for example, government purchase was accountable for approximately 35% of the domestic LED display market in 2013). However, as the proportion of energy consumed by the public sector only accounts for less than 2-3% of the nation's total consumption, substantial savings can only arise from the dissemination of energy efficient practices among the private sector and the general public.

3.3 Rationalization of Energy Prices

Energy pricing and taxation are important fiscal instruments that can promote energy conservation and NRE deployment. Fundamentally, energy prices provide the direction to efficiently allocate resources in the energy market. If the government sets energy prices too low without adequately reflecting its actual generation costs, energy users are not motivated to exploit energy-saving opportunities. Low fossil fuel prices also mean that the energy sector is more likely to neglect the development of clean energy, which often entails complex financing mechanisms and high technical risks.

Most energy industries, in one way or another, tend to operate in an imperfectly competitive market. The electric power and gas industries, in particular, are dominated by local monopolies. In addition, energy generation and consumption cause externalities in the market such as air pollution and traffic congestion, which are regular signs of market failure and could lead to inefficient resource allocation and inadequate social welfare. Accordingly, the government intervenes in the market using regulations or taxing mechanisms to prevent and deter such market imperfections. In light of reinforcing efficiency in resource allocation in the context of energy pricing, the government essentially adheres to the following principles:

- **Realistic Costs:** Applying objective criteria to price calculations to reflect the full cost (including a reasonable profit margin) of energy supply services

- **Fair Return:** Guaranteeing an optimal and fair return for energy companies

- **Equitable Pricing:** Avoiding price discrimination against a certain group of energy users and applying a fair energy cost-return ratio across all groups of end-users

Recognizing the importance of energy-pricing in achieving low-carbon green growth, the ROK government presented measures to revise the pricing system for electricity, gas, and heat energy under the existing policy framework. In preparation for a major policy revision, the government acknowledged the shortcomings of its past interventions. Prior attempts to improve energy efficiency have relied heavily on government-driven regulations and energy-saving support programs rather than utilizing economic incentives such as price signals in the marketplace. In light of the ROK's energy security challenges, the government laid out the following goals to boost energy efficiency:

First National Energy Basic Plan (2008)

- Reform the tax system to reflect the full cost of energy generation
- Facilitate a free market mechanism to encourage competition among and within energy sources
- Simplify the energy tax system and allow flexibility in operation to help balance the country's conflicting needs in terms of energy security, price stabilization, government tax revenues, environmental sustainability, and social inclusion.

Fourth Basic Plan for Rationalization of Energy Use (2008)

- Electricity Prices: Phase-out cross subsidization and streamline the differential tariff system
- Gas Prices: Introduce a pricing mechanism that reflects fluctuations in seasonal demand and global market prices
- Heat Energy Prices: Introduce a system whereby the government induces free competition among energy producers under the binding price ceilings set at a regional level (to reflect their given circumstances)

Nevertheless, the ROK government has yet to accomplish the transition to a market-based energy pricing system. Despite the ambitious plans and prevention of past mistakes, the government's commitment to ensuring domestic market price stability and industrial growth by utilizing economic stimulus policies has not led to concrete actions. This critical gap has overlooked the necessity of energy-price reforms in line with the low-carbon green growth vision. This section briefly touches upon the ROK's imminent challenges and progress in energy reforms under the Five-Year Plan for Green Growth.

Electricity Pricing

In the ROK, electricity rates are divided into wholesale price determined by the Korea Power Exchange (KPX) and retail price set by the Korea Electric Power Corporation (KEPCO). A cost-based pool (CBP) is operated by KPX to determine the System Marginal Price (SMP), while the retail prices of electricity are strongly regulated by the government. This means that electricity is supplied by a state monopolist KEMPO, at a price that is controlled by the government. Basically, the electricity rates are differently charged according to use: residential, general, educational, industrial, agricultural, and street lighting services.

The core problem of the current electricity pricing is that it does not reflect the actual costs of electricity supply. Most importantly, the government has failed to fully recognize the capital costs involved in energy supply, which must be recovered primarily through energy consumption costs incurred by end users.

Driven by the nation's economic growth policies that restrict increase in commodity prices, the consumer energy prices have been kept below average electricity generation costs since 2005. Even during the periods, after the mid-2000s, when the global oil prices continuously plummeted, the government kept electricity prices low, thus escalating price distortions. A good example is how the energy consumption for household heating has shifted from burning of natural gas and petroleum products to electricity-use during this period (Kim, 2014).

Varying tariffs among user groups, which fundamentally reflect the differences in supply costs for different electricity usage (with distinct load patterns), are also escalating the discrepancies in energy pricing in the ROK. A good example is how the rates for residential and general services are set comparatively high to encourage energy saving, while the rates for industrial and agricultural services are set significantly lower to help relevant sectors maintain their market competitiveness. Such interventions have been naturally viewed as cross-subsidization of energy costs among user groups and are being done as the government struggles to deal with the snowballing of debts from energy supply.

On the other hand, the differential tariffs system (for household energy use only), which charges higher rates on heavy consumers to control excessive electricity use, has been scrutinized for its weak impact on uplifting the principles of cost recovery. Under the ROK's differential tariff system, unit electricity rates are divided into six classes, with the maximum rate being set more than 11 times the minimum rate. Such diverse scales of unit costs have been identified as the cause of the growing household burden from energy costs and such costs have not been revised (since 2005) to reflect the growing levels of household consumption. A combination of time-of-use tariff and seasonal tariff applies for electricity consumed by the industrial, educational, and general services (Park and Kim, 2012).

Under the First National Energy Basic Plan (2008) and the Fourth Basic Plan for Rationalization of Energy Use (2008), the government achieved small but positive steps in rationalizing electricity prices. In particular, electricity rates were raised significantly for industrial services, helping the cost recovery rates to increase from 77.7% in 2008 to 88.4% in 2012 (refer to Figure 10).

In addition, the government also raised the electricity prices by an average of 5.4% in 2013 (6.4% for industrial services). Such action naturally helped partially resolve the issue of cross-subsidization among energy users; the cost-recovery rates of energy supplied to the industrial sector (87.5%, 2011) has now reached the level for household use (88.3%, 2011). However, the cost recovery rate of energy consumed by the agricultural sector still remains low at 34.6%. The overall cost recovery rate is also below 90%, indicating how government interventions were insufficient to bring about a transformative change in the energy market.
The problems in differential tariff scheme for

Table 19: Electricity supply costs and average sales price by year

Unit: KRW/kWh

	2005	2006	2007	2008	2009	2010	2011
Supply Cost	75.88	80.48	82.95	102.00	92.06	96.27	103.31
Average Sales Price	74.39	76.45	77.71	79.24	84.23	86.80	90.32
Rate of Cost Recovery (%)	98.00	95.00	93.70	77.70	91.50	90.20	87.40

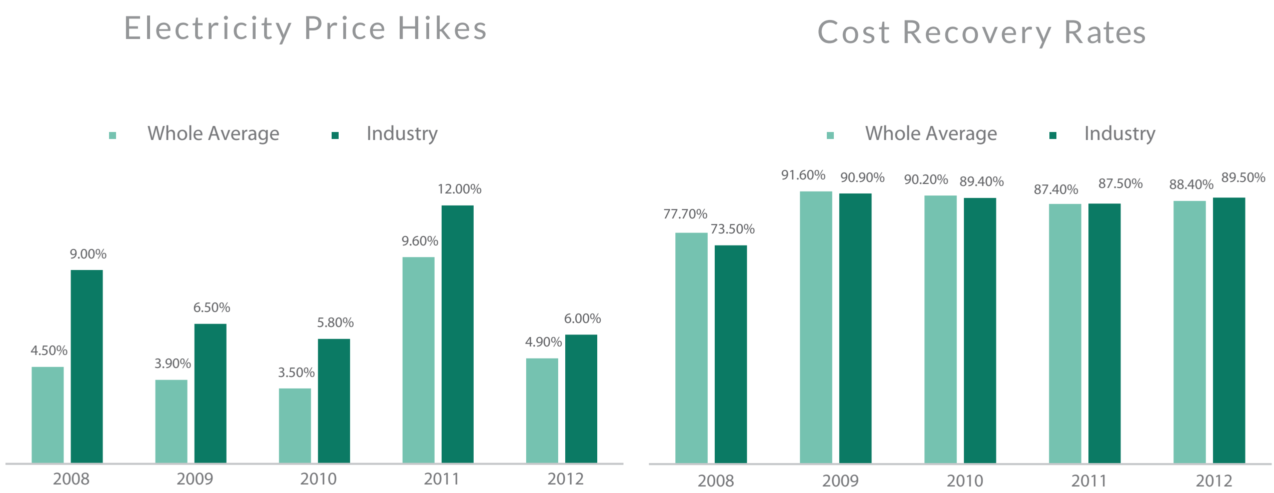
Source: KEEI, 2013a

Table 20: Changes in price and consumption levels by energy source (2012 compared to 2000)

	Kerosene	Heavy Oil	Natural Gas			Electricity		
			Household	Industry	General	Household	Industry	General
Nominal Price Fluctuation (%)	149.1	270.0	110.3	172.1	119.6	15.3	59.2	6.1
Real Price Fluctuation (%)	71.3	172.3	44.6	44.6	61.6	-20.7	17.2	-21.9
Changes in the amount of consumption (%)	-68.5	-58.8	38.8	38.8	188.5	71.2	88.4	116.4

Source: Kim, 2014

Figure 10: Electricity price hikes and the cost-recovery rates by year



Source: MOTIE, 2014

household electricity-use are yet to be resolved. The scheme has been heavily criticized for provoking social tension as many of the poor communities rely heavily on electricity for heating purposes during the winter season. It should be noted how this circumstance runs contrary to the scheme's objective of easing the financial burden on impoverished communities by reducing the unit electricity rates for light consumers. The scheme is also against equity as it is not applicable to industrial consumption of electricity. Despite the circumstances, the government has been reluctant to take actions on easing the tariff scheme, primarily due to the lack of commitment and failure to reach a consensus among stakeholder groups with varying interests (e.g., consumer groups, energy industry, and the National Assembly). In many ways, the issue has turned into a political debate as the country's changing livelihood patterns (e.g., increasing number of single or double households with high levels of income) has made it difficult for the scheme to remain as an effective demand-side management intervention. Consequently, the ROK government has been increasing the unit costs at an identical rate across the six-tier system.

In summary, the average electricity rates of the ROK are approximately 32% lower than the OECD average, as of 2013. Price distortions are made especially evident by the wide gap between prices of electricity and other sources of energy. While the average electricity rates of OECD countries are double the unit prices of kerosene and heavy oil, the ROK's electricity rates for households are only 62% of its kerosene prices. It is overwhelming to see how government commitment has controlled electricity price below the prices of primary energy sources. Without doubt, much of the nation's slow progress in deploying NRE facilities is attributed to the failure in implementing full-scale reform of electricity prices.

Table 21: Comparison of household and industrial energy prices

Unit: USD/TOE

	Average Energy Prices (Household Use)			Average Energy Prices (Industrial Use)		
	Kerosene	Natural Gas	Electricity	Kerosene	Natural Gas	Electricity
ROK	1,753	907	1,082	1,088	839	959
Japan	1,388	2,137	3,218	1,064	908	2,259
Germany	1,287	1,167	3,939	744	703	1,729
U.S.	1,165	455	1,382	-	165	779
OECD	1,370	734	1,991	-	321	1,422

Source: OECD, 2013

Natural Gas Pricing

There has been a dramatic increase in the use of liquefied natural gas (LNG) in the ROK since its introduction in 1986. As part of the government's active promotion of LNG deployment, LNG use for power generation has significantly increased and consequently, LNG demand for residential use such as cooking and heating has exceeded that of power generation. In the ROK, natural gas consumption is twice larger in winter than in summer due to the high demand for heating.

The Korea Gas Corporation (KOGAS) retains a monopoly over gas imports and wholesale, while approximately 30 private gas suppliers exclusively supply LNG in their respective districts. Though the sales of gas are dominated by the district suppliers, the consumer prices and revenue caps are regulated by local governments. Thus, the consumer pricing of LNG is fundamentally determined by both the central and local governments. Basically, the consumer LNG prices consist of fuel costs (LNG) and supply costs. The fuel cost is reviewed every odd month of the year to reflect price changes in the global market. Despite the fact that fuel costs account for more than 80% of consumer prices, the ROK government delayed the application of the pricing mechanism (reflecting price changes of raw LNG) from 2008 to ease the burden on the public of skyrocketing prices. Amid consumer concerns over high inflation, the government resumed the price linkage with the international market in September 2010, but this was called off again in July 2011, thereby damaging the credibility of the pricing mechanism.

Although the impacts of such government interventions have not been considered, it is true that the distortion of gas prices has contributed to the imbalances in the prices of petroleum products (e.g., LNG, LPG). With the natural gas price failing to send accurate market signals, demand management measures such as the Total Management Scheme (TMS) and ESCO projects have struggled to gain momentum.

But most importantly, discrepancies in natural gas prices have inflicted social costs on consumers, including potential hikes in future gas prices. The suspension of the price linkage with fuel costs may have benefited the energy users, but it has had critical implications for KOGAS and private gas suppliers that suffered from losses due to worsening cash flow. For example, accounts receivable of KOGAS rose to over 4.2 trillion KRW as of the end of 2010, from 100 billion KRW at the end of 2007, and this deficit is highly likely to be passed on to the taxpayers.

As a result of the excessive focus on public welfare and industrial competitiveness, the ROK government fell short of realizing the main goal of the Fourth Basic Plan for Rationalization of Energy Use – to establish a flexible pricing system that accurately reflects the fluctuations in seasonal demand and global market prices. The government has yet to achieve positive results from rationalizing gas prices in line with the low-carbon green growth vision. Given that the gas industry is fully controlled by KOGAS, the government needs to redesign its pricing system in a way that addresses monopoly-induced market inefficiencies.

3.4 Government Revenues for Financing Energy Sector Programs

The importance of securing sustainable revenue flow for the government to fund its policy measures cannot be overstated. In the ROK, the government has established and managed the Special Account for Energy and Natural Resource Projects and the Electric Power Industry Basis Fund by imposing a levy on supply and consumption of petroleum and electricity. The accumulated fund is strictly designated to finance the government's energy programs.

The Special Account for Energy and Natural Resource Projects aims to stabilize the nation's supply and demand for energy while fostering energy price stability. The fund is mobilized by collecting tariff on petroleum/LNG import and sales and consumer charges for gas safety. For example, 16 KRW was imposed per liter of crude oil and petroleum products imported as of 2012, leading to a fund collection worth 1.1 trillion KRW.

The accumulated fund is used for investments on government-led projects involving the activities below:

- Support toward state-owned energy R&D research centers
- Support for government-led programs related to the development and deployment of renewable energy technology
- Support for government-led programs on energy-saving facilities
- Investment in state-owned companies specializing in energy and natural resource development
- Support for private sector projects that pursue overseas energy and natural resource development
- Operation of government's policies and programs related to climate change response (e.g., TMS)

On the other hand, the government established the Electric Power Industry Basis Fund in 2000 to acquire resources to build the foundation for the electric power industry and sustain its development. The main source of the fund is the fee charged at electricity bills, which is capped at 6.5% of the electricity rates, and has been set at 3.7% in 2006 and has remained the same ever since. The volume of the fund has continued to increase over the years, from 0.3 billion KRW in 2001 to 2.3 trillion KRW in 2012. KEPCO is in charge of collecting the fees while MOTIE is responsible for managing the fund. Under the low-carbon green growth agenda, the fund has been channeling its resources for deploying smart-grid systems, R&D on NRE technologies, and operational costs of the feed-in tariff (FIT) scheme.

The proceeds of the fund will finance grants or loans that seek to stabilize the supply of electricity, including the activities below:

- Energy suppliers' efforts to expand the deployment of NRE sources
- Government-led programs on electricity demand management
- Government-led projects on rural electrification for remote islands and other isolated areas
- R&D projects relevant to electricity use
- Research and public relations on safe electricity use

Table 22: Annual revenue and expenditure of the Special Account for Energy and Natural Resource Projects (2012)

Unit=KRW/kWh

Category	Annual Revenue	Category	Annual Expenditure
Government contribution	81	Support towards state-owned energy research centers	201
Tariff on petroleum imports	1,941	Climate change and energy programs	673
Sales tax on petroleum products	282	Low-carbon green growth programs	582
Recollection of loan repayments and interests	1,180	Energy and natural resource development projects	1,178
Others	1,211	Others	1,552
Total	4,695	Total	4,186

Source: MOTIE, 2014

4. Assessment

A paradigm shift in energy supply and demand that promotes low-carbon green growth requires the improvement of fundamental industrial structure. However, demand patterns, once created, are hard to change in the short term. Energy users may respond to incentives in the short term but without significant structural reforms, they are likely to revert back to the old ways. On the other hand, it takes many years to replace existing energy systems requiring large front-end costs and with long lifespans (i.e., high inertia). Therefore, energy supply-side policies ideally involve long-term planning horizons.

To understand the context behind the implementation of the Five-Year Plan (2009-2013) in the ROK, it should be noted that the increasing calls for investment in renewable energy became less appealing after 2009 due to dramatic changes in the energy market, especially when the North American Shale Gas Revolution helped stabilize the international energy markets. Stabilizing oil prices and plummeting price of carbon credits have affected the popularity of NRE investments. In addition, the implementation of the post-2012 global climate regime was delayed to 2020. The 2011 Fukushima Daiichi nuclear disaster also prompted some countries to revert to using fossil fuels like coal, and the rising distrust of nuclear power led to a heightened public awareness of energy security issues.

Table 23: Changes in energy consumption and intensity in the ROK

Sector	2000	2008	2009	2010	2011	2012	2013	2009-2013 Growth (%)
Energy Consumption (million TOE)	149.9	182.6	182.1	195.6	205.9	208.1	210.2	15.5
- Industry	83.9	106.5	106.1	116.9	126.9	128.3	130.9	23.4
- Transportation	30.9	35.8	35.9	36.9	36.9	37.1	37.3	3.9
- Residential and Commercial	32.4	36.2	35.7	37.3	37.5	37.9	37.3	4.5
- Public and Others	2.6	4.1	4.3	4.5	4.6	4.8	4.7	8.7
Energy Consumption by Industry (million TOE)								
- Petroleum Products	48.2	54.7	56.4	57.4	59.6	59.7	60.1	6.6
- Anthracite Coal	1.3	3.9	4.2	4.9	5.8	4.8	5.0	18.0
- Bituminous Coal	17.8	21.2	18.7	23.4	26.9	26.4	26.8	43.2
- Electricity	11.4	16.7	17.0	19.2	20.8	21.4	22.1	29.9
- Liquefied Natural Gas (LNG	-	-		-	0.6	0.8	0.7	0.5
- City Gas	3.3	5.9	5.9	7.3	8.4	9.5	9.9	68.1
- Others	1.9	3.9	3.9	4.2	4.6	5.8	6.5	68.4
Targeted Energy Intensity (TOE/million KRW)	-	-	0.236	0.234	0.228	0.222	0.217	-
Actual Energy Intensity (TOE/million KRW)	0.278	0.249	0.248	0.253	0.256	0.252	0.247	-

Source: KEEI, 2014

These developments reveal how the legitimacy and effectiveness of low-carbon green growth has been continuously challenged in the ROK. It is clear that skyrocketing oil prices primarily drives public interest toward energy-saving initiatives and NRE deployment. However, oil price stabilization drives the national energy policy away from pursuing energy security through a stable energy mix. In 2011, the nation suffered from rolling blackouts because the unexpectedly hot summer temperatures triggered high power consumption during the maintenance period of a number of nuclear power plants. The government also halted the operation of several nuclear reactors for safety inspection due to growing concerns over the poor quality of its components. Following the Fukushima disaster, the public has become skeptical of nuclear energy as revealed by the local residents' opposition to the construction of new nuclear facilities.

4.1 Quantitative Assessment

The primary goals under the energy agenda presented by the Five-year Plan for Green Growth are the improvement of energy-use efficiency and expansion of NRE deployment. First, in terms of energy intensity which reflects energy efficiency performance, the ROK reached another peak in 2011, thus falling short of meeting the set targets under the First National Energy Basic Plan. This rebound in energy intensity, which exhibited a steady decline after 1997 (0.295 TOE/million KRW), was brought by the heightened industrial activities in the course of economic recovery.

The increase in the total energy consumption over the 2009-2013 period far exceeded the projections in 2008. This was driven strongly by the industrial sector, which registered a staggering growth of 23.4% for four years. Note that as of 2012, the energy consumption by the industrial and public sectors surpassed the government projections by 13.6% and 2.7%, respectively, while the consumption was below the projected levels for the transportation, residential, and commercial sectors. Consequently, the share of industrial consumption in the total energy use reached 61.4% in 2012, which did not meet the anticipated decline as what was achieved in the past (57.5% in 2007 to 56.1% in 2012).

The GDP growth of the manufacturing sector from 2009-2013 reached 28%, which surpassed the national GDP growth of 16.3% over the same period. Thus, the industrial growth propelled the overall economic recovery from the 2008 financial crisis but impeded the achievement of energy-efficiency targets. An in-depth examination of consumption patterns by energy source reveals that the increased demand for bituminous coal, city gas, and electricity by the industrial sector caused significant changes in the nation's energy portfolio:

- A rapid expansion of blast furnace capacities by the steel manufacturing sector contributed to a 43.2% growth (calorie basis) in bituminous coal consumption over 2009-2013.

- High global prices of naphtha – commonly used by the oil refinery and chemical industries – were the prime cause of the increased consumption of its substitute, city gas. Similarly, the increased global prices of kerosene (due to increased demand for electricity generation after the Fukushima disaster) and expanded use of buses powered by compressed natural gas (CNG) also triggered the increase in city gas consumption. From 2009-2013, the industry and transportation sectors exhibited a 68.1% and 35.3% increase in city gas consumption, respectively.

- Taking advantage of the relatively low electricity prices, the manufacturing sector specifically the steel, chemical, machinery, and electronics industries registered an increase in electricity consumption (29.9% increase) in 2009-2013. Likewise, the households and commercial sector's shift from petroleum (19.3% decrease) to electricity (10.2% increase) was evident in the same period.

At the heart of the problem is the fact that the energy intensity levels of the ROK's major industries are exceptionally high compared to other economic activities. For instance, the production of steel, chemicals, and transportation materials (i.e., car making and shipbuilding) constitute the largest components of the overall manufacturing sector with energy input ratios[10] of 7.6%, 18.9%, and 21.8%, respectively. Such figures far exceed the energy input ratio for electronics manufacturing, which

10 | Energy input ratio is equivalent to the amount of energy input divided by gross input in production; the statistics provided in this section are as of 2012.

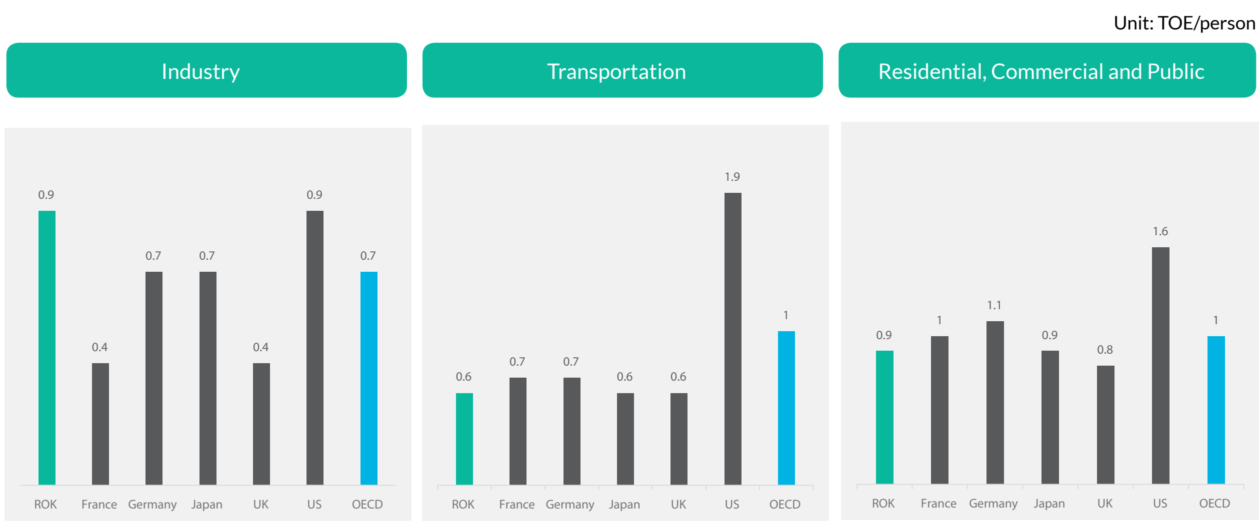
stands at 1.4%. Accordingly, the energy consumption per capita of the ROK's industrial sector is well above those of the world's leading manufacturing countries, including Germany and Japan. However, this does not imply that the ROK's manufacturing sector has high levels of absolute energy intensity compared to its global competitors.

In terms of NRE deployment rate, the ROK struggled to meet the target of getting NRE to comprise 3.78% of the total primary energy supply by 2013. Despite the continued annual growth, the NRE share as of 2013 fell short of the target by 0.26%. While it is encouraging that the growth of NRE generation was several times higher than the growth of the total primary energy supply, it should be noted that bio and waste energy make up for more than 80% of the total NRE generation in the ROK. While NRE constitutes 3.86% of the nation's total electricity generation, this figure drops to 1.67% if energy generated from non-renewable resources were to be excluded, in accordance with the IEA standards. Globally, this figure places ROK at the bottom of the list among OECD countries.

The government's decision to phase out the FIT scheme and adopt the RPS has had some positive outcomes in increasing the NRE installation capacity. As previously pointed out, the RPS was able to accelerate the deployment of NRE several times faster than the recorded increase in NRE generation capacity under the FIT scheme. However, RPS only achieved 64.7% and 67.2% of the set targets in 2012 and 2013, respectively, and most of the new installations are related to solar energy. Specifically, the targets for wind and ocean energy were by far underachieved, as many energy producers failed to overcome the obstacles created by the government's strengthened regulations on land use and environmental protection. In addition, NRE investment plans were heavily challenged by local opposition groups, which revealed how winning public support for NRE deployment remains farfetched. For instance, the approval of offshore wind farm projects heavily promoted by the central government has made slow progress at the local level due to the local governments' growing fears of public backlash.

Meanwhile, the ROK's domestic NRE industry produced tangible results due to the government's support. From 2008 to 2012, the industry achieved a 1.5 times increase in the number of NRE companies, 1.8 times increase in employment, a two-fold increase in sales, and 1.5 times increase in exports. However, the sustained viability of the NRE industry is questionable as its growth has been fundamentally supported by the government's proactive interventions to leverage low investments. The increasing volume of NRE component imports from China demonstrated how increasing NRE deployment does not necessarily result in the growth of the domestic NRE industry.

Figure 11: Energy consumption per capita by sector



Source: MOTIE, 2014

Table 24: Amount of NRE generation and its share of total primary energy supply

Sector	2009	2010	2011	2012	2013	2009-2013 Growth (%)
Targeted NRE Share (% of nation's total primary energy supply)	2.7	3.0	3.2	3.54	3.78	40.0
Actual NRE Share (% of nation's total primary energy supply)	2.50	2.60	2.74	3.18	3.52	40.8
Total Primary Energy Supply (thousand TOE)	243,311	263,805	276,636	278,698	280,290	15.2
Total NRE Generation (thousand TOE)	6,086	6,856	7,583	8,851	9,879 (100.0%)	62.3
- Solar	152	195	225	264	372 (3.8%)	144.3
- Wind	147	176	186	193	242 (2.5%)	64.5
- Hydro (includes large hydro)	607	792	965	815	892 (9.0%)	47.1
- Ocean	0	0	11	98	102 (1.0%)	-
- Geothermal	22	33	48	65	87 (0.9%)	293.0
- Bio	580	755	963	1,335	1,558 (15.8%)	168.5
- Waste	4,558	4,862	5,122	5,999	6,502 (65.8%)	42.7
- Fuel Cell	19	42	63	83	122 (1.2%)	537.8

Source: KEEI, 2014

Table 25: Growth of domestic NRE industry in the ROK

Sector	2007	2008	2009	2010	2011	2012
Number of Business Entities	100	134	187	209	225	200
Number of Jobs	3,532	6,496	10,000	13,149	14,563	11,836
Investment Volume (billion KRW)	623	1,901	2,955	3,537	9,357	6,467
Sales (billion KRW)	1,233	3,268	4,463	7,663	9,357	6,467
Export (100 million US$)	7.4	17.1	21.3	39.3	47.7	25.2

Source: MOTIE, 2014

4.2 Qualitative Assessment

The ROK's energy policies and plans under the low-carbon green growth strategy have been coherently formulated with specific targets and policies. Despite the evolving landscape of the global energy market, the government remained ambitious in terms of meeting the targets. For example, the Sixth Basic Plan for Power Supply and Demand (2013-2027) released in 2013 actually escalated the nation's NRE deployment target, from 7% to 12% of the total primary energy supply by 2027. Indeed, such goals have veered away from the tradition of setting energy security as a supplementary objective since past government strategies have perfunctorily included NRE deployment as a priority without providing a detailed action plan.

Despite the positive progress, the ROK's efforts in transitioning toward a cleaner and less energy-intensive economy still have a long way to go, as the economy's flagship industries remain highly energy-intensive. On a positive note, the 2009-2013 period was successful in highlighting the importance of influencing the demand-side management, which was embraced widely across the nation and challenged the long-held conviction that stable energy supply is the "silver bullet" to energy security. The mid- and long-term targets on energy intensity and NRE deployment provided a strong signal for boosting investment, while serving as a guidepost for the required levels of technological innovation. However, there are important shortfalls that should not be overlooked, particularly in terms of achieving the practicality and effectiveness of energy policy instruments and the state's commitment to implementing the much-promised reforms.

Failure in Robust Energy Price Signaling

The delayed reforms in energy pricing hamper the improvement of energy intensity in the ROK. Given its high energy imports, energy pricing is a matter of national importance as it has clear and direct economic impacts at the micro- and macro-levels. The bottlenecks in energy price reform are largely political, running counter to the public demand for protecting social welfare and fostering economic competitiveness. Despite the highly fluctuating global energy prices, the rationalization of energy prices was still prevalent. Low energy prices act as a critical barrier to energy efficiency, making relevant investments less attractive and encouraging energy users to sustain their existing energy use patterns.

The ROK's experience demonstrates the limitations of government's regulatory efforts due to the lack of robust energy-pricing signals. Although subsidizing energy-conservation investments with revenue levied on fossil fuel imports may have positive short-term outcomes, this strategy is contradictory in the long term as energy saving runs the risk of jeopardizing the security of budget required in sustaining the provision of incentives. Without doubt, an essential policy tool to optimize energy efficiency and expand deployment of NRE is to establish a pricing system that responds well to market forces. Therefore, the ROK's urgent task is to push for transforming its energy pricing system to reflect the real cost of energy use.

Deficiencies in Driving a Fundamental Transformation

The ROK's ambition for energy efficiency has painstaking implications for its economy. Underlying the nation's economic success story is a vicious cycle: government's excessive energy demand projections (reflecting aspirations for strong economic growth); high public investments in energy infrastructure; lowering of energy prices due to oversupply in the market; and increase in energy demand (KEI, 2013). The idealist dilemma of government policies that fail to make fundamental changes to the energy market (i.e., piecemeal adoption of regulations that have proven successful in developed countries), and the nation's lack of commitment to break away from the vicious cycle also contributed to the failure in meeting the energy intensity targets.

For instance, the ETS was on the brink of disapproval due to the fierce opposition from industries and businesses. The government decided to delay the proposed tax on vehicle carbon emissions to the end of 2020 due to the rising pressure from domestic car makers who fear that the levy could curb sales. Two important policy interventions (i.e., Energy Efficiency Resource Standards/EERS and Top-Runner Approach), which were deemed critical in transforming the energy marketplace as laid out by the First National Basic Energy Plan (2008) and Fourth Fourth Basic Plan for Rationalization of Energy Use (2008), were also postponed indefinitely.

- The EERS is a scheme that mandates energy utilities (and/or distributors) to achieve quantitative goals for reducing sales through energy efficiency programs for customers. By placing responsibility for energy efficiency requirements on the utility company, energy utilities support energy users to find the most cost-effective and readily available ways of energy conservation. While the scheme was reviewed as an effective market-driven approach for demand-side management by the government, the state-owned energy utilities subject to the scheme expressed strong opposition, raising questions on how the reduced sales could be compensated for. The government planned to launch the scheme in 2012 but it was postponed without further notice.

- The Top-Runner Approach is an innovative program that seeks to save energy consumed by the use of electronic appliances by identifying the most energy-efficient model (“top runner”) for a given product category and setting its performance as the minimum standard to be achieved by all models sold in the market within a specified number of years. Recognizing how the nationwide regulatory policies for energy efficiency (i.e., TMS, ETS, and EERS) have focused on transforming the energy and industrial sectors, the ROK government planned to adopt the Top-Runner Approach from 2010 to stimulate changes in the non-industrial sector. However, the plan was discarded due to strong opposition from appliance manufacturers, who claimed that the scheme would be an additional burden to the existing measures (e.g., energy efficiency certifications and low standby power warning labels). Most importantly, the Top-Runner Approach was perceived as an obstacle in enabling the domestic sales market to recover from the global financial crisis.

Limitations in NRE Strategies

The core of the ROK’s NRE policies during the period of the Five-Year Plan for Green Growth was to increase NRE deployment and foster relevant domestic industries. Given the nation’s geographical and climate-related constraints, aiming for the 11% (of nation’s primary energy supply) target by 2030 was by all means very ambitious. For example, the UK, with an annual volume of total energy consumption similar to the levels of the ROK, possesses wind energy development potential of approximately 10,600 TWh/year which is more than ten times that of the ROK (Lua, et al., 2009). In addition, the technological levels and price competitiveness of the ROK’s domestically produced NRE components have remained well below the global standards, thus revealing the still low financial viability of NRE development. To boost NRE deployment, the government provided huge subsidies, including long-term contracts with energy generators, paying for the wholesale market rates for electricity (especially under the FIT scheme).

The government’s low pricing policy for electricity and its shortcomings to create the enabling conditions for investment impede the progress in NRE deployment. As mentioned previously, under the low pricing structure whereby the high costs in electricity supply from NRE installations were pushed onto the public utilities, government subsidies was recognized as an unacceptable fiscal burden, which explains why the government decided to switch from the FIT scheme to RPS in 2012. On the other hand, the government failed to take adequate steps to secure potential sites for NRE development. Indeed, utility companies under the RPS, which were required to source a certain amount of their power generation from renewable sources, had difficulties in finding and securing sites for their facilities. In particular, many wind farm and tidal power projects have not pushed through due to strong opposition from environmental groups and local residents who are concerned about the noise and environmental damage of NRE projects. The limited feasible sites for NRE facilities intensified competition between power suppliers for securing financially viable locations for building new facilities. The local residents often demand compensation and oppose the construction if their demands are not met.

Deploying NRE has boosted the local economy but the government needs to address the problems related to the sites of NRE facilities when the demands of locals are likely to increase the front-end costs of investments, thereby discouraging investment by the power producers. Many of the favorable locations for wind energy in the ROK (i.e., sites with average wind speeds greater than 6m/s) are, for example, in ecologically protected areas. Moreover, tidal power installations could pose serious threats to wildlife and people’s livelihoods. The government thus has to maneuver through these obstacles by reaching an agreement with local authorities, environmental specialists, power producers, NGOs, and local stakeholders. Some of the vital tasks that could speed up NRE deployment include central government interventions to streamline the project approval process (e.g., sharpening legislation and implementation guidelines to ensure robust assessment of environmental impacts); stronger commitment of local authorities to resolve the conflicts over stakeholder relocation and compensation; and awareness-raising activities by investors and NGOs to gain public support for NRE development.

Despite some of the tangible outcomes achieved by the local NRE industry, it still accounts for less than 1% of the ROK’s export volume. Based on this figure, the government’s target to capture 5% of the global NRE market by 2012 proved to be unrealistic. In many aspects, the government’s efforts to foster

NRE industries need to be tested in a longer term, given the evolving nature of the global NRE market and the ROK's achievement in narrowing the technological gap. The Korea Energy Economics Institute (KEEI) reported in 2013 that the nation's average level of NRE technologies stands at 81.7% vis-á-vis global leaders – with solar, hydro, and bio-energy technologies having reached the world's highest levels (KEEI, 2013c). However, the domestic NRE industry still struggles in commercializing and pilot-testing its technology goods, primarily due to the lack of adequate financing (i.e., presence of financiers with an appetite for high risk and high returns), human capital (i.e., lack of experts in specialized technical fields), and market opportunities (i.e., small size of the domestic market as a test-bed for export market).

The global renewable energy market went through a volatile period as it recovered from the 2007 financial crisis, largely hampering opportunities for a second-mover market win. The volume of global investments in renewable energy development has continued to decline in 2012-2013 due to the reduced demand from the EU, which has been leading the world's renewable energy market. The declining unit prices of renewable energy installations have also contributed to the decreasing global market volume. The ROK's challenge lies in diversifying its export targets (i.e., China and Japan which are countries revealing big plans and numbers) while promoting R&D initiatives to help achieve higher price competitiveness of domestic NRE products. However, it is questionable whether the current government is keen on promoting the NRE industry as one of its export industries. The target has been revised downward from 10% to 8% by 2022 under the domestic RPS program in 2014 to ease the burden on energy producers. In addition, many of the large conglomerates have started to scale back their NRE businesses due to high global competition.

5. Takeaways and Recommendations

The ROK's remarkable economic growth over the past decades, despite its lack of domestic energy resources, can be credited to the government's energy-supply interventions such as reducing risks in energy imports, diversifying its energy portfolio, and introducing market mechanisms to improve supply efficiency. However, the quantitative expansion of the energy market – which was driven by sustained surplus in energy supply over demand – has long neglected to prioritize and resolve the fundamental challenge of high dependency on fossil fuel imports and increased environmental loads. Accordingly, the past efforts to emphasize demand-side management and a shift away from fossil-fuel use was seriously undermined by the strong prevalence of more input- for more output-oriented ideals.

Due to the economic slowdown and energy challenges, the ROK's adoption of the low-carbon green growth paradigm was not just an option, but a necessity. The nation's energy dilemma has clear implications for other countries in this respect as its experience highlights how developing economies need to tackle environmental challenges in the early stages of development by shaping demand patterns considering long-term supply constraints. In an era of climate change, overcoming poverty based on economic growth that is rooted resource-intensive activities and technologies has less chance of sustained success and entails greater costs.

Notwithstanding its limitations, the ROK's energy policies provide several invaluable lessons. First, the government's early efforts to institutionalize and mainstream energy efficiency into energy policies have had positive outcomes. Amidst the second global oil crisis (1979), the government passed the Energy Use Rationalization Act and created KEMCO to lead the nation's energy conservation efforts. This eventually laid a solid foundation for strengthening the energy demand-side management plans (i.e., Fourth Basic Plan for Rationalization of Energy Use, 2008-2012) and implementing energy conservation programs (i.e., ESCOs, tax-credits, and government loans for energy-saving facilities).

Timely efforts to secure public revenues enabled the ROK government to exploit various incentive schemes, which were important in balancing its use of top-down regulatory schemes. By imposing levies on petroleum supply, the government created special funds for energy-saving initiatives as early as 1980. The proceeds of these funds played a critical role at the peak of the country's energy intensity in 1997, followed by a steady decline until 2009. These funds also served as the financial basis for the government's energy saving and NRE deployment initiatives implemented under the Five-Year Plan for Green Growth.

Given the intensive capital and technology required in the energy industry, the central government in many developed countries is deeply involved in the energy market as it has better capacity than the private sector to mobilize the necessary resources. However, government control over energy pricing in the ROK has demonstrated how excessive intervention tends to distort investments and interfere with the spotting of market signals by energy users. In this context, even the most effective interventions for enhancing energy efficiency and increasing NRE deployment can become ineffective, largely due to "government failure" rather than "market failure."

The government needs to precisely understand and monitor the market value of its policy instruments as "too much" support will distort the entire energy market and "too little" intervention will be likewise ineffective. In addition to supporting the policymakers' commitment to sustaining their actions, such efforts can also help persuade the stakeholders in providing the necessary support. Much of the industrial and business opposition to government plans in the ROK have arisen from disagreements over the impacts of penalty and reward scenarios (e.g.,RPS, ETS). Hence, the government must properly identify the "winners" and "losers" of its policies, prove that the benefits outweigh the costs, and avoid triggering of rent-seeking behaviors.

The ROK government recognized technology innovation as the key to realizing its energy aspirations, as proven by its subsidies to R&D initiatives across a wide range of activities. Cooperative efforts by research institutions and private sector entities (including public utility companies) to commercialize energy saving and NRE generation technologies have received frontal government support. Such action should be well credited for as technologies have become an integral part of all energy business models, from production of primary energy resources to final use in industrial facilities.

References

Energy Use Rationalization Act. 2014. Republic of Korea Statutes Act No. 12298.

Enforcement Decree for the Framework Act on Low-Carbon Green Growth. 2010. Republic of Korea Statutes Presidential Decree No. 25456.

Framework Act on Low-Carbon Green Growth. 2010. Republic of Korea Statutes Act No. 11965.

Joint Work of Relevant Ministries. 2012. *The Second Five-Year Plan for Green Growth (2014-2018).* Accessed April 17, 2015. http://www.greengrowth.go.kr/?page_id=2452.

KEEI, Korea Energy Economics Institute. 2013a. "New Government's Directions on Energy Policy." KEEI Working Paper, Seoul.

KEEI (Korea Energy Economics Institute). 2013b. *Yearbook of Energy Statistics.* Seoul: Korea Energy Economics Institute. Accessed April 17, 2015. http://www.keei.re.kr/keei/download/YES2013.pdf.

KEEI (Korea Energy Economics Institute). 2014. *Yearbook of Energy Statistics.* Seoul: Korea Energy Economics Institute. Accessed April 17, 2015. http://www.keei.re.kr/keei/download/YES2014.pdf.

KEMCO (Korea Energy Management Corporation). 2012. *White Book on New and Renewable Energy, 2012.* Seoul: Korea Energy Management Corporation and Ministry of Knowledge Economy. Accessed April 16, 2015. http://www.knrec.or.kr/knrec/13/KNREC130110.asp?idx=1516.

KEMCO (Korea Energy Management Corporation). 2013. *Korea Energy Handbook 2013.* Seoul: Korea Energy Management Corporation. Accessed April 16, 2015. http://www.kemco.or.kr/web/kem_home_new/info/statistics/data/kem_view.asp?sch_key=&sch_value=&c=305&h_page=1&q=17788.

KEMCO (Korea Energy Management Corporation). 2014. "Website of Korea Energy Management Corporation." Accessed April 16, 2015. http://www.kemco.or.kr/web/kem_home_new/new_main.asp.

Kim, Sun-woo. 2010. *Supply Chain Analysis of NRE Sector and its Status in SMEs.* Seoul: Korea Small Business Institute.

Kim, Tae-heon. 2014. "Prospects and Implications on 2014 Energy Demand." In Energy Focus 2014 Spring, Korea Energy Economics Institute, Seoul.

KNREC (Korea Energy Management Corporation New and Renewable Energy Center). 2014a. "Data on New and Renewable Energy Trends." New and Renewable Energy Trends 2014-1, Energy Management Corporation New and Renewable Energy Center, Seoul.

KNREC (Korea Energy Management Corporation New and Renewable Energy Center). 2014b. "Website of Energy Management Corporation New and Renewable Energy Center." Accessed April 16, 2015. http://www.knrec.or.kr/knrec/index.asp.

Lua, Xi, Michael B. McElroy, and Juha Kiviluoma, 2009. "Global potential for wind-generated electricity." School of Engineering and Applied Science, Cruft Lab 211. Department of Earth and Planetary Sciences, Harvard University 106 (27):10933-10938.

MKE (Ministry of Knowledge Economy). 2008a. *Demand Management Measures to Cope with High Oil Prices.* Accessed April 17, 2015. http://eiec.kdi.re.kr/infor/ep_view.nt=&searchtopic=P&showListSize=20&pageNo=271

MKE (Ministry of Knowledge Economy). 2008b. *The Fourth Basic Plan for Electricity Supply (2008-2022).* Accessed April 17, 2015. http://energyjustice.kr/zbxe/44035.

MKE (Ministry of Knowledge Economy). 2008c. *The Fourth Basic Plan for the Rationalization of Energy Use (2008-2012).* Accessed April 17, 2015. http://www.archives.go.kr/next/search/listSubjectDescription.do?id=006554&pageFlag=.

MKE (Ministry of Knowledge Economy). 2008d. *The Third Basic Plan for the Deployment of Renewable Energy (2009-2030)*. Accessed April 17, 2015. http://www.archives.go.kr/next/search/listSubjectDescription.do?id=006553&pageFlag=.

MKE (Ministry of Knowledge Economy). 2008e. *The Second Basic Plan for the Deployment of Renewable Energy (2009-2030)*. Accessed April 17, 2015. http://www.archives.go.kr/next/search/listSubjectDescription.do?id=006553&pageFlag=.

MOTIE (Ministry of Trade, Industry, and Energy). 2014. *The Second National Energy Basic Plan*. Accessed April 17, 2015. http://www.motie.go.kr/motie/py/td/energeitem/bbs/bbsView.do?bbs_seq_n=104479&bbs_cd_n=37.

MOTIE (Ministry of Trade, Industry, and Energy). 2015a. *Regulations on Energy Use Rationalization of Public Institutions*. Accessed April 17, 2015. http://www.motie.go.kr/motie/in/ay/policynotify/notify/bbs/bbsView.do?bbs_seq_n=62216&bbs_cd_n=5.

MOTIE (Ministry of Trade, Industry, and Energy). 2015b. *Guideline for Managing and Operating Policy for Mandatory Supply of Renewable Energy*. Accessed April 17, 2015. http://www.motie.go.kr/motie/ne/rt/press/bbs/bbsView.do?bbs_cd_n=16&bbs_seq_n=79290

National Assembly Budget Office. 2010. "Performance Evaluation on NRE Deployment Program." Performance Evaluation 10-02. Seoul. Accessed April 27, 2015. http://knsi.org/knsi/admin/work/works/nabo_100225_wonmun.pdf.

OECD. 2013. *IEA Energy Prices and Taxes Statistics*. OECD iLibrary. Accessed April 27, 2015. http://www.oecd-ilibrary.org/energy/data/iea-energy-prices-and-taxes-statistics_eneprice-data-en.

Park, Kwang-soo, and Tae-heon Kim. 2012. "A Comprehensive Study on an Establishment of Market-Friendly Energy Pricing System." KEEI Basic Research Report 12-24, Korea Energy Economics Institute, Seoul.

PCGG (Presidential Committee on Green Growth). 2009a. *National Strategy for Green Growth (2009-2050)*. Accessed April 17, 2015. http://www.greengrowth.go.kr/?page_id=2450.

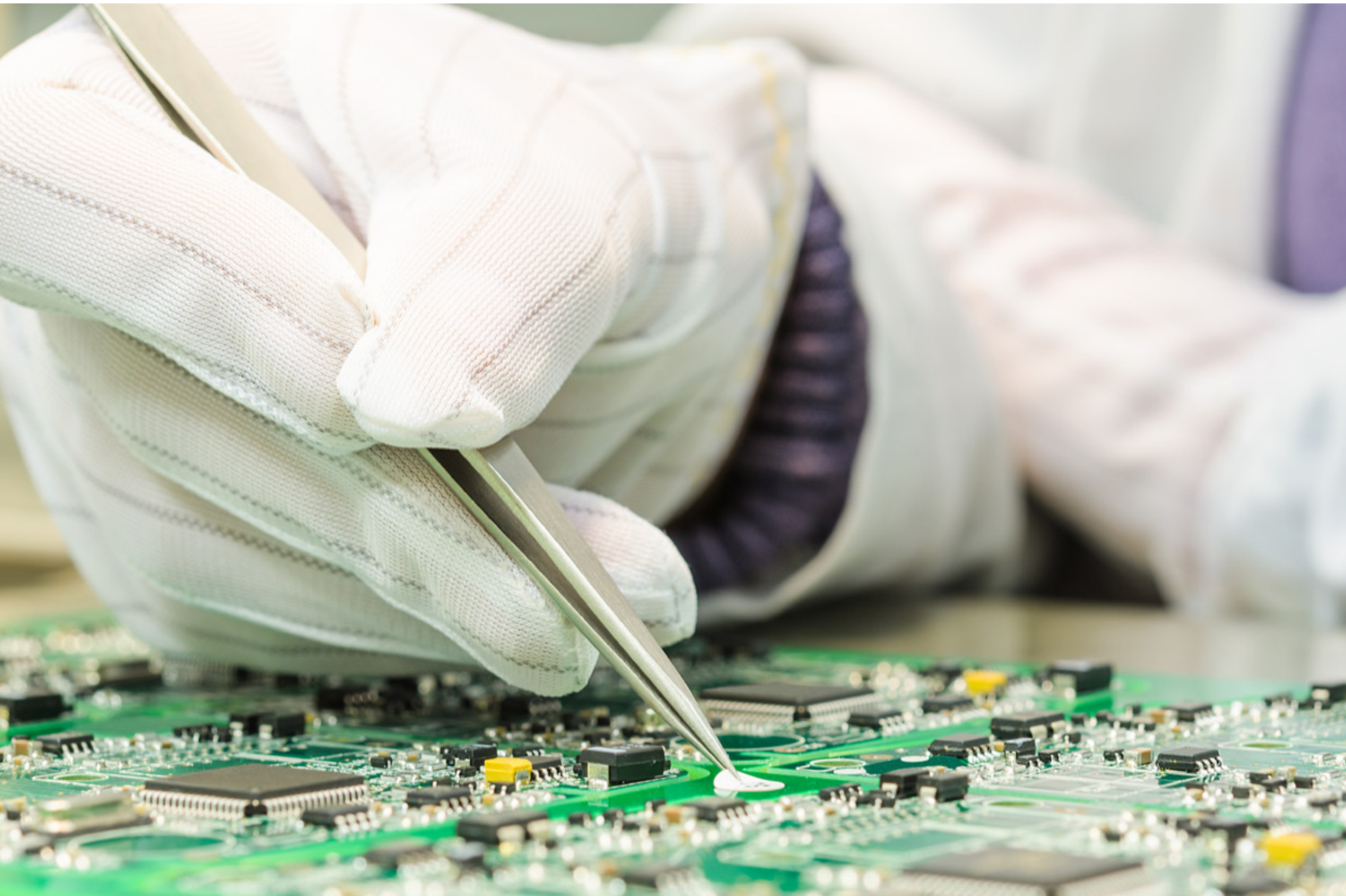
PCGG (Presidential Committee on Green Growth). 2009b. *The Five-Year Action Plan for Green Growth (2009-2013)*. Accessed April 17, 2015. http://www.greengrowth.go.kr/?page_id=2452.

Prime Minister's Office, Ministry of Strategy and Finance, Ministry of Education, Science and Technology, Ministry of Foreign Affairs, Ministry of Knowledge Economy, Ministry of Environment, Ministry of Land, Infrastructure, and Transport. 2008. *The First National Energy Basic Plan (2008-2030)*. Accessed April 17, 2015. http://energyjustice.kr/zbxe/48310.

Special Account for Energy and Natural Resource Projects. 2014. Republic of Korea Statutes Act No. 12930.

Korea's Green Growth Experience: Process, Outcomes and Lessons Learned

Chapter 4: Green Technology and Innovation



CHAPTER 4

GREEN TECHNOLOGY AND INNOVATION

Summary

Technological innovation has been a key enabler of the ROK's growth especially in its earliest stages of economic ascent. Today, it remains paramount in the context of the nation's low-carbon green growth strategy as it regards green technology as a new growth engine – a strategic pivot that creates a virtuous cycle of environmental, economic, and social benefits. The ROK has a long way to go in this field given how other developed countries have made advances in the past but by adopting the principle of selection and concentration and significantly boosting R&D investments, it has succeeded in narrowing the technological gap with the global leaders. Among the 27 key green technologies selected as priority areas for investment and commercialization, positive outcomes are most evident in secondary cells and LED while the progress in other technologies will require more time and resources to be globally competitive. The government has played multiple roles in this endeavor as a provider of direction, target setter, and financier. Key policies include expanding basic research and generic technology development through green technological convergence, fostering specific technologies for greening energy-intensive industries, investing in eco-friendly technologies with the highest potential impact, and strengthening green R&D infrastructure.

1. Introduction

1.1 Overview

Technological advantage serves as the source of industrial competitiveness in an ever-changing world. Innovation in technology is often considered a prerequisite for economic growth, and the main challenge for innovation policies stems from the need to fast-track technological development in an efficient manner. Generally, the term "technological innovation" refers to the development of innovative products or realizing groundbreaking improvements in manufacturing processes, which are crucial elements that determine the competitive edge of industries. Experiences of many advanced and newly industrialized countries have illustrated how this process determines the success or failure of businesses; accelerating the technology development-commercialization-marketing process is key to improving the productivity and competitiveness of economies.

The OECD's conference proceedings report on "Patents, Innovation and Economic Performance (2004)" provides concrete examples based on empirical analysis of the impact of technological innovation on economic growth in OECD countries. Investment in technology R&D and protection of intellectual assets were listed as decisive factors driving economic growth.

The Republic of Korea (ROK) transformed itself into a newly industrialized country thanks to the efforts of domestic companies that have successfully introduced and internalized advanced technologies under supportive government interventions. How could the ROK achieve such accomplishments despite its inherent constraints of having a small territory, large population, and limited amount of natural resources? Technological innovation has a key role to play in overcoming these challenges.

Generally, developing countries implement various strategies that aim to transfer technologies from advanced countries. Such strategies can typically be divided into two types:

(1) attracting multinational corporations to build production bases and thus seeking to maximize technological spillovers; and

(2) strengthening the country's own R&D capacities in an effort to learn and internalize imported technologies (Cho, 2000).

The ROK's strategy falls within the latter type; the government sought to maximize opportunities of technology transfer primarily by fostering the nation's own R&D capacity. If the 1960s-1970s marked a period when the government's technology policies focused on prioritizing technology items for import and promoting their domestic internalization, the 1980s-1990s was a period when independent technological innovation was strongly supported by the government through the provision of grants, tax credits, and enacting appropriate legislation (e.g., Basic Science Research Promotion Act, 1989; Invention Promotion Act, 1994). Accordingly, industries that started off from simply importing and imitating foreign products aspired to learn and internalize relevant technologies that eventually engaged them in developing their own. Government's investments that helped create effective platforms for technology R&D, and interventions to protect domestic industries played an important role in this process.

The ROK's current plans in promoting "green technology innovation" also follow this systematic approach toward technology development that the nation has been pursuing until now. In other words, the government once again invested heavily in fostering the R&D capacities of industries engaged in the manufacturing of energy-efficient and eco-friendly products, the sector which has been targeted to become a new engine for the nation's economic growth. It is important to note that the government strategically focused on key areas that were relevant to the country's existing technological capabilities and considered to have the highest potential for advancing into or creating new markets. One example is solar cell technology. The increasing global demand for solar cell components was identified as an opportunity, especially as relevant technologies and manufacturing processes are already being used in the semiconductor industry, which is a sector where the ROK already stands as a global leader.

What is technological innovation?

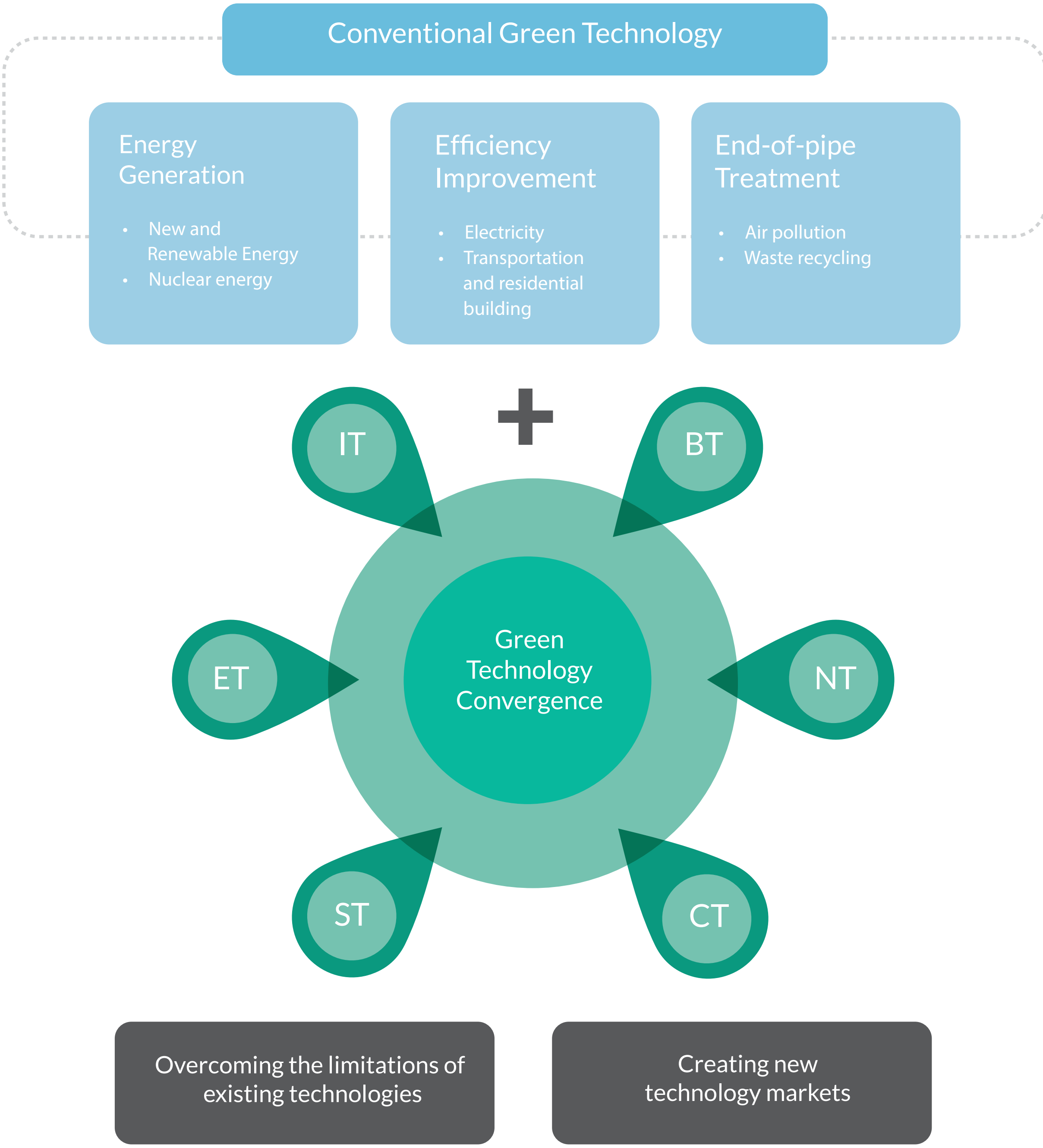
Technological innovation refers to a transformation of economic structure brought about by the commercialization of breakthrough technologies. Given that the process of technology development can be divided into the three stages of invention, innovation, and diffusion, the meaning of "technological innovation" was perceived (from the perspective of academia) to be the second stage in which new products or manufacturing processes are realized.

Today, however, it is more broadly acknowledged as the entire process of technological development and is often referred to as introduction of new technologies and practices to a given society or economy (GGGI, 2015).

The government viewed green technology as the strategic pivot that creates a virtuous cycle of environmental protection and economic growth. Against this backdrop, the government developed a clear concept of how it envisioned green technology and presented directions for investment. Generally, green technology refers to technologies that enable the sustainable utilization of resources, such as renewable energy technologies. However, the ROK government expanded this concept by linking it to the mechanisms of technological convergence.

The ROK's concept of "Green Technology Convergence" promotes the convergence of existing and/or emerging technologies such as IT (Information Technology), BT (Biotechnology), and NT (Nanotechnology) in an effort to maximize the opportunities of improving environmental performance. Indeed, this concept incorporates the government's intention to fully utilize the nation's know-how and competitiveness in emerging IT, BT, and NT.

Figure 1: Concept of green technology convergence



Note: CT stands for cultural technology, ST for space technology, and ET for environmental technology

Source: NSTC, 2009

1.2 Baseline Assessment

Root Causes of Challenges

Advanced countries have long realized that "environmental issues" provide opportunities to create new engines of economic growth. Having witnessed a dramatic increase in demand for renewable energy facilities following the implementation of the EU Emissions Trading System (EU-ETS), governments anticipated that the creation of such new markets would inevitably expand at the global scale if the world was to make a transition into a low-carbon pathway. Understanding technological innovation as a key success factor for entering and competing in newborn markets, advanced countries including Japan and the U.S. have made early commitments to R&D initiatives. It is important to understand that such actions have also been followed by several developing countries as well. One good example is China, a country that has become the largest solar panel manufacturer in the world. Such accomplishment is an outcome of increasing R&D activities, engaging in M&A transactions to accelerate product innovations, and strong government commitment to nurturing domestic industries.

Amid rapid industrialization, the ROK has failed to take enough actions to address the nation's environmental problems and technologies for their abatement. More recently, the nation's economy has been experiencing jobless growth and weakening of its major growth engines. With climate change and resource crisis emerging as immediate risks, energy and environmental issues became decisive factors determining the future of the national economy. Under the circumstances, developed countries that were already several steps ahead in commercializing green technologies posed a significant threat to the ROK's economy. Technology-driven regulations of developed countries started to act as trade barriers for the ROK's export items. Hence, if the ROK's industries were failed to keep pace with the technological innovations, the nation's export performance was most likely to be severely hampered. The trend toward an increasing number of TBTs (Technical Barriers to Trade) notifications being issued by the World Trade Organization (WTO) is a good reflection of the changing context of the global market. Under the growing interest in climate change and environmental protection, the number of TBT notifications related to energy and environment has soared from 99 in 2004 to 269 in 2009.

Examples of changes in EU markets due to tightening environmental regulations

Eco-design requirement for Energy-using Products (EuPs, 2015)

EuP stipulates environmentally friendly design standards for household electronics, including set-top boxes, lighting facilities, dishwashers, laundry machines, and refrigerators. Strengthened regulations in key areas such as energy efficiency have led to prohibiting imports and selling goods with low-energy performance goods in the EU market. For example:

- Washing machines must comply with standards set on energy efficiency and water consumption;
- Dishwashers must be accompanied by information on their energy efficiency.

Mandatory participation of aviation industry in EU-ETS

From 2012, both EU and non-EU airlines operating flights from, to, and within the European Economic Area (EEA) receive emission allowances and are required to comply with EU-ETS.

Regulations on vehicle emissions

EU legislation set mandatory emission reduction targets for new cars since year 2012. Basically, the fleet average to be achieved is 130 g/km, but different emission limits apply according to the mass of vehicles.

Relevant Problems

While the ROK boasts the highest level of industrial productivity (3rd out of 24 countries; OECD, 2006), the country remains at the bottom of the OECD's list of countries (22nd out of 24 countries; OECD, 2006) in terms of green productivity, an index which takes into consideration environmental performance in addition to industrial productivity. As reported by the "National Green Technology R&D Master Plan (2009)," the ROK's levels of "green" technology remains at 50-70%[1] of that of advanced countries, and its share of the global green energy market – e.g., renewable energy, energy efficient buildings – is minuscule at 1.4%. The ROK's number of technical publications and patents, which reflects a nation's technological competitiveness and efficiency of R&D investments, falls far behind the average of the world's leading countries. In addition, technical publications and patents issued by the ROK were also found to lack quality, as indicated by their low levels of citations.

The ROK's commitment to green technology in terms of its volume of R&D investments has been restricted by the continued needs for fueling innovation of its primary manufacturing industries. For example, green technology R&D received approximately 900 billion KRW as of 2008, which accounts for only 9.3% of its total R&D investment. While the ROK's R&D expenditure relative to GDP has continued to remain well above the OECD average since the early 2000s, green technologies were never a part of the priority list of investment. Despite restricted budgetary support, R&D investments in the green technology sector were being centered on activities that specifically aim for product development, by-passing the costly and time-intensive efforts needed in developing core technologies. Such efforts geared toward product commercialization through the bundling of imported technologies are unlike the nation's past experiences in building technological self-reliance.

Policy Options

When the ROK announced its Five-Year National Plan for Green Growth in 2008, there was a rapid growth of the global "green" market, based upon expectations that it would reach the scale of the

Table 1: The ROK's levels of technical publications and patents in the green technology sector

Unit: Percentage of 10 global leaders

Sector	Sub-category	Number of Publications	Cites per Publication	Number of Patents	Cites per Patent
Prediction Technology	Climate change prediction and impact assessment	3.7	37.0	25.3	2.0
Energy Generation Technology	Renewable energy (Solar, wind, bio, etc.)	23.0	49.9	11.2	4.8
	Nuclear and nuclear fusion	22.9	33.1	6.4	6.5
	Hydrogen and fuel cell	31.8	63.1	12.9	3.0
Efficiency Improvement Technology	Efficiency improvement of transportation	9.5	36.6	9.1	3.7
	Green land	5.1	47.4	23.1	4.1
	Efficiency improvement of green process ad materials	14.5	45.1	15.6	4.2
	Efficiency improvement of electricity	22.8	41.3	7.5	2.9
End-of-Pipe Technology	Monitoring and control of air pollution	5.2	72.5	8.0	2.9
	Water quality	4.3	47.7	34.5	2.1
	Environmental restoration	6.2	29.4	43.5	1.8
	Waste recycling	12.1	31.1	16.8	2.5
	Environmental health	4.0	38.6	8.5	7.4

Source: Lee, 2009

1 | Technological levels and industrial competitiveness are often evaluated against the levels of the global leaders in the ROK. Evaluations are primarily based on qualitative analysis such as the Delphi method, expert surveys, and interviews, but are commonly supported by quantitative analysis such as analytic hierarchy process (AHP) and use of relevant indicators (e.g., cites per patents, technology impact index).

global IT market in the near future. For example, the value of renewable energy markets projected for 2018 was US$ 325.10 billion, which is three times that of the US$ 115 billion in 2008 (Makower, Pernick, and Wilder, 2009). Although estimates of the size of the global green market vary according to sources, Innovas – a consulting firm commissioned by the British government to conduct market studies – estimated that the renewable energy market size as of year 2007-2008 was approximately US$ 4.3 trillion. The report by Innovas breaks down the green goods and services (termed low-carbon and environmental goods and services, LCEGS) sector into three areas: traditional environmental services, such as recycling, and water and waste management; renewables, such as wind, hydropower and biomass; and emerging low carbon, including nuclear power, carbon finance and building technologies. Of the green market, the low-carbon business is expected to account for nearly half of the market, while renewable energy and traditional environmental activities comprise the remaining half.

Such explosive growth of the global green market prompted the ROK government to envision green technology as the new driver for sustaining economic growth. The government set an ambitious goal of improving the nation's technological level up to 80% of that of the world's leaders by 2012, and up to 90% by 2020. To this end, the National Science and Technology Council (NSTC) formulated the "National Green Technology R&D Master Plan," which is a comprehensive outline of the government's strategy and investment plans, overriding all existing plans implemented by different line ministries. Subsequently, the government formulated the "Strategic Roadmap for Commercialization of Green Technologies" to help the industrial sector build capabilities to compete in the global market.

Table 2: Action Plans for Green Technology Innovation under the Five-Year National Plan for Green Growth

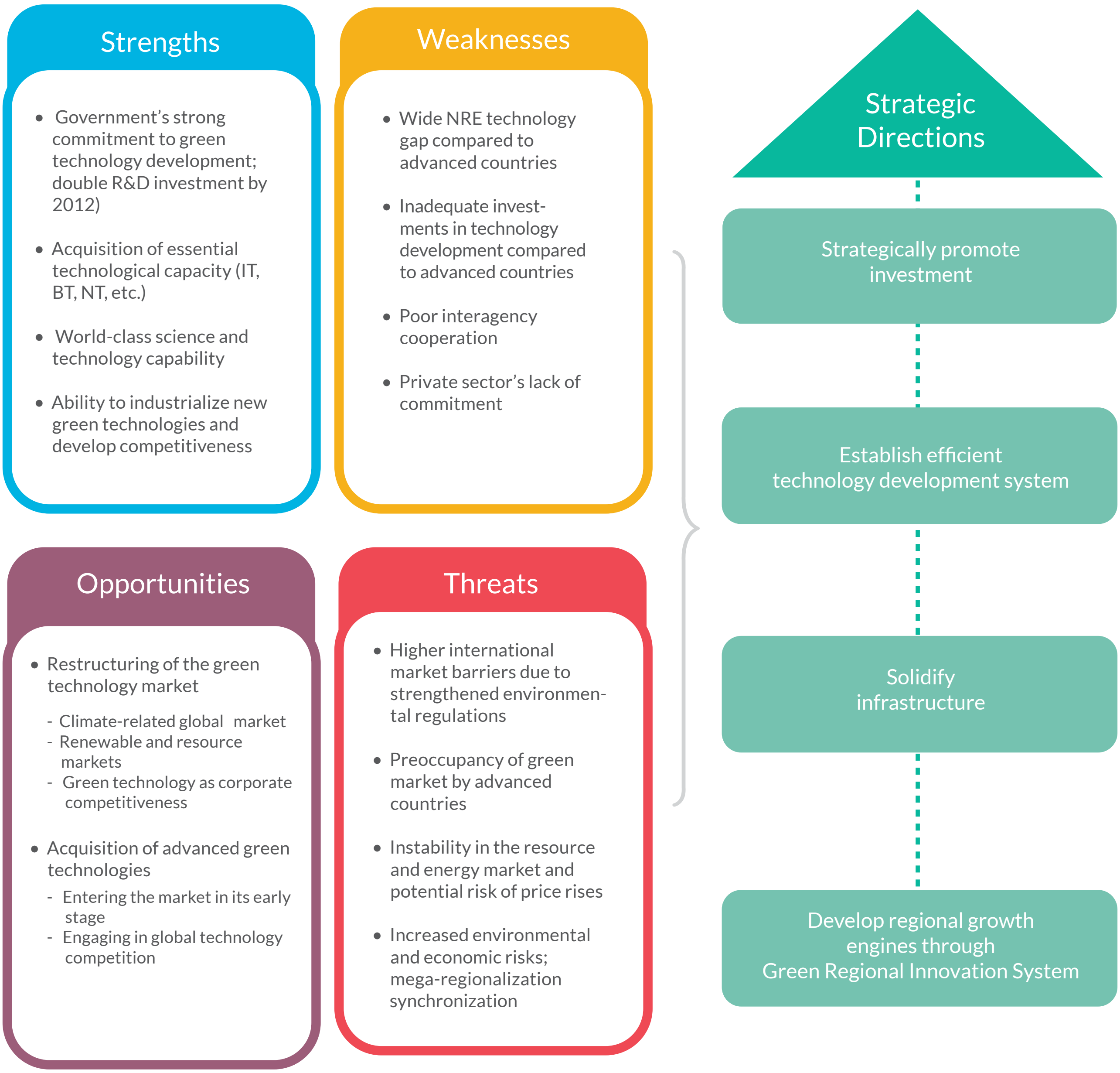
Tasks	Actions
1. Strategic expansion of the investment in green technology development	a. Expand government-led green technology development b. Strengthen balanced green technology R&D on basic and applied researches and application development c. Green the existing national R&D projects and technology development support system
2. Establishment of an efficient green technology development system	a. Strengthen the integration and coordination system for green technology development b. Establish an industry-university-institute cooperation system considering the value chain of green technology R&D c. Create a green technology R&D hub and establish local green technology development governance
3. Facilitation of the transfer and industrialization of green technology	a. Strengthen the platform to industrialize the outcome of government-led green technology development projects b. Carry out projects for a practical use of green technology to promote the transfer and industrialization of green technologies c. Build a platform to facilitate green technology startups
4. Expansion of infrastructure for the development of green technology and industry	a. Train competent manpower in the green technology to ensure the development of green technology into a growth engine b. Build advanced testing, certification, standardization infrastructures for green growth c. Set up a world class green technology information system
5. Promotion of international cooperation for green technology development	a. Promote strategic partnership with world's powerhouse of green technology through international organizations b. Enhance green innovation capability through the globalization of green technology development and diffusion c. Build up the substructure of international cooperation in green technology development
6. Development of green technology and industry into a new growth engine	a. Enhance the core competency of a company by securing green growth related core technology and commercialization technology in advance b. Create early markets by adopting the international standards, product certification standards, and mandatory scheme of eco-products procurement c. Ensure rational improvement of regulations, policies, and laws that interfere with technology development, private investment, and market creation d. Promote green technology as an export drive by opening new overseas markets

Source: Lee, 2009

"Green Technology Innovation" is one of the ten policy agenda items presented in the Five-Year National Plan for Green Growth and comprises six action plans. As shown in Table 2, these action plans cover different phases of technology development, from the early stage of basic research on scientific findings and practice, to diffusion and commercialization of technologies.

Of significant importance is gaining an understanding of how this serves as another good example of the ROK model of technology innovation, which follows the principles of "selection and concentration" – to be discussed in the following sections of this chapter.

Figure 2: SWOT analysis for engagement in green technology



Source: PCGG, 2009b

1.3 Challenges and Opportunities for Green Growth

Technology innovation is the essential element to understanding how economic growth and environmental sustainability can be made mutually compatible. This is especially true, given how the tightening of environmental regulations has already reshaped the industrial landscape and placed green technologies at the center of business strategies. Although there are differing opinions on whether green industries will create more jobs than conventional "brown" industries, there is no doubt that the greening of the industrial sector will create additional job opportunities. It was within this context that former President Lee Myung-bak mentioned that "green growth's success is dependent on technology innovation" and encouraged "businesses of all sectors and sizes to actively participate in technology innovation" (PCGG, 2010b). For the ROK's economy, the emerging green market was a threat as much as it was an opportunity. As a latecomer to the market, the ROK was not expected to outstrip the leading competitors in the short term, but the government was optimistic and committed, as many green technologies were still at an early stage of development.

2. Targets and Strategies

2.1 Principles of Selection and Concentration

Over the course of 50 years, the ROK has achieved phenomenal economic development that is still to this day considered a rare miracle. While the key drivers for economic development can be multi-faceted, many experts attribute the ROK's economic success to the government's strategy or principle of "selection and concentration." Under the principle, government's financial assets were directed into a selected number of industries or technologies that were deemed to have the highest future potential. Amid the challenges of confined land space, limited natural resources, and poverty (a consequence of the Korean War), this principle proved to be successful in turning one of the poorest countries in the world around to become a bona fide economic success within just half of a century. Korea's related experiences provide meaningful implications for developing countries.

The principle of selection and concentration was generally applied through the following process; first, the government selected primary sectors and industries of focus based on analysis of the global trends and future prospects. In the following stage, governance, law, and political infrastructure needed to foster the selected industries and technologies were established. In addition, relevant ministries came together to formulate mid- to long-term plans based on which rigorous R&D investments were initiated. Finally, innovators that participated in the strategic industry and technology development received full frontal support. During this process, the government sought to constantly monitor their progress as a means of magnifying the success.

This process has been utilized by the ROK government over the past 50 years of economic growth. In the 1960s, the textile, cement, and fertilizer industries were the focal points. From the 1970s to 1980s, the shipbuilding, steel, petrochemicals, and electronics industries were selected as new areas of focus. At the end of the 20th century, the IT industry was selected as a new strategic industry and received the government's full support. "Green Industries" in the late 2000s under the Lee Myung-bak administration and "Creative Industry" under the most recent Park Geun-hye administration also received strong attention.

It is important to recognize that the government has continued to employ the "sticks and carrots" approach, with "sticks" in the form of administrative guidance (a euphemism for the government's top-down authority) and "carrots" in the form of incentives to the innovators that lead the building of strategic industries. For example, in order to push forward the policies that promote export production during the initial stages of industrialization, the ROK government borrowed heavily from abroad and provided the export industries with capital at low interest rates, often below the market levels. Also, additional incentives such as a variety of tariff exemptions, accelerated depreciation, exemptions from value-added taxes, and duty-free imports of raw materials were provided to motivate and encourage exporters to improve their performance. However, the government also made sure that the corporations that did not respond to the government-set goals and targets were pressured. For example, corporate tax returns were subjected to careful examination, applications for bank credit were studiously ignored, and outstanding bank loans were not renewed (Kim, 1997).

In order to lay a solid foundation to support technological innovation, the ROK government established government-funded research institutes and initiated the "National R&D Program," which helped compensate for the low R&D capabilities of the private sector during the early stages of industrialization. The Korea Institute of Science and Technology (KIST) was built as the first national research institute in 1966. The institution branched out its work into multiple government-selected strategic sectors in the 1970s, to help fill-in the technological gaps and capacities of the private sector.

In 1982, the government initiated the "National R&D Program" to increase its support for technological development in key strategic industries. A notable example is the full-fledged support of the government for the development of the semi-conductor industry. In 1986, the ROK government started a monumental project for the development of the ULSI (Ultra-Large-Scale Integration) semiconductor (DRAM) with joint participation of the Electronics and Telecommunications Research Institute (ETRI), Samsung Semiconductor Telecommunication (SST), Lucky Gold Star Electronics (Currently renamed as LG Semicon), and a research center under the umbrella of Seoul National University. Within just over three years, the team succeeded in developing the 4M DRAM. Government success was duplicated in the development of 16M DRAM, 64M DRAM, and ultimately led to the development of the world's first 256M DRAM, which helped the nation to gain its status as the leader of the global semiconductor market.

Case Studies on the Principles of Selection and Concentration

A. Shipbuilding industry in the 1970s

EuP stipulates environmentally friendly design standards for household electronics, including set-top boxes, lighting facilities, dishwashers, laundry machines, and refrigerators. Strengthened regulations in key areas such as energy efficiency have led to prohibiting imports and selling goods with low-energy performance goods in the EU market. For example:

- The shipbuilding industry, steel industry, machinery industry, and petrochemicals industry were selected as the four key industries eligible for government support.
- Government anticipated that success in the shipbuilding industry is likely to have spillover effects into other industries, such as industrial machinery, steel, electricity, and electronics.
- Hyundai Heavy Industries was selected as a firm entitled to government support, and was provided with financial resources in the building of the shipyard at Ulsan. Out of the 20 billion KRW needed for construction of the shipyard, the government shouldered 14.7 billion KRW using public capital and provided the remaining 5.3 billion KRW through the soft-loan program from Japan.
- The government also provided additional funding for the construction of seawalls around the shipyard equivalent to 2 billion KRW.
- Thanks to sustained government support, the ROK overtook Japan's shipbuilding orders and dry dock supplies in 1985.

B. Automobile industry in the 1980s

- The government recognized the automobile industry as having the biggest forward/backward linkage effect
- In 1973, the government established a "long-term plan for promotion of the automobile industry" and selected "seven principles for support," including:
  - Protection of the domestic market against foreign imports
  - Tax deductions for domestic automobile makers
  - Administrative actions and financial loans to expand the domestic market share of Korean-made automobiles
- Under such government support and subsidies, Hyundai Motors Group developed the nation's first domestic automobile called "Pony" in 1975. Approximately 10 years later, the next generation of the Pony – named "Excel" – was selected by the government as one of the nation's top 10 export items for the U.S.. Excel was the first Korean-made automobile to be exported to the U.S.

C. Semiconductor industry in the 1990s

- Along with Japan, the ROK government recognized semiconductors as "the rice of industry" because the knowledge embedded in the chips became the driving force in many other industries considered key to economic competitiveness.
- The Ministry of Information and Communication took the lead in supporting the domestic industries with the enactment of the "Information Technology R&D Act" in 1992.
- The government created two specialized public funds, the "Telecommunications Service Provider Endowment Fund" in 1994 and the "Informatization Promotion Fund" in 1996, to provide direct support to the semiconductor industry.
- National R&D programs were directed to help teams of private firms and national institutions to advance semiconductor technologies.
- Samsung Electronics succeeded in developing the world's first 64M DRAM in 1992.

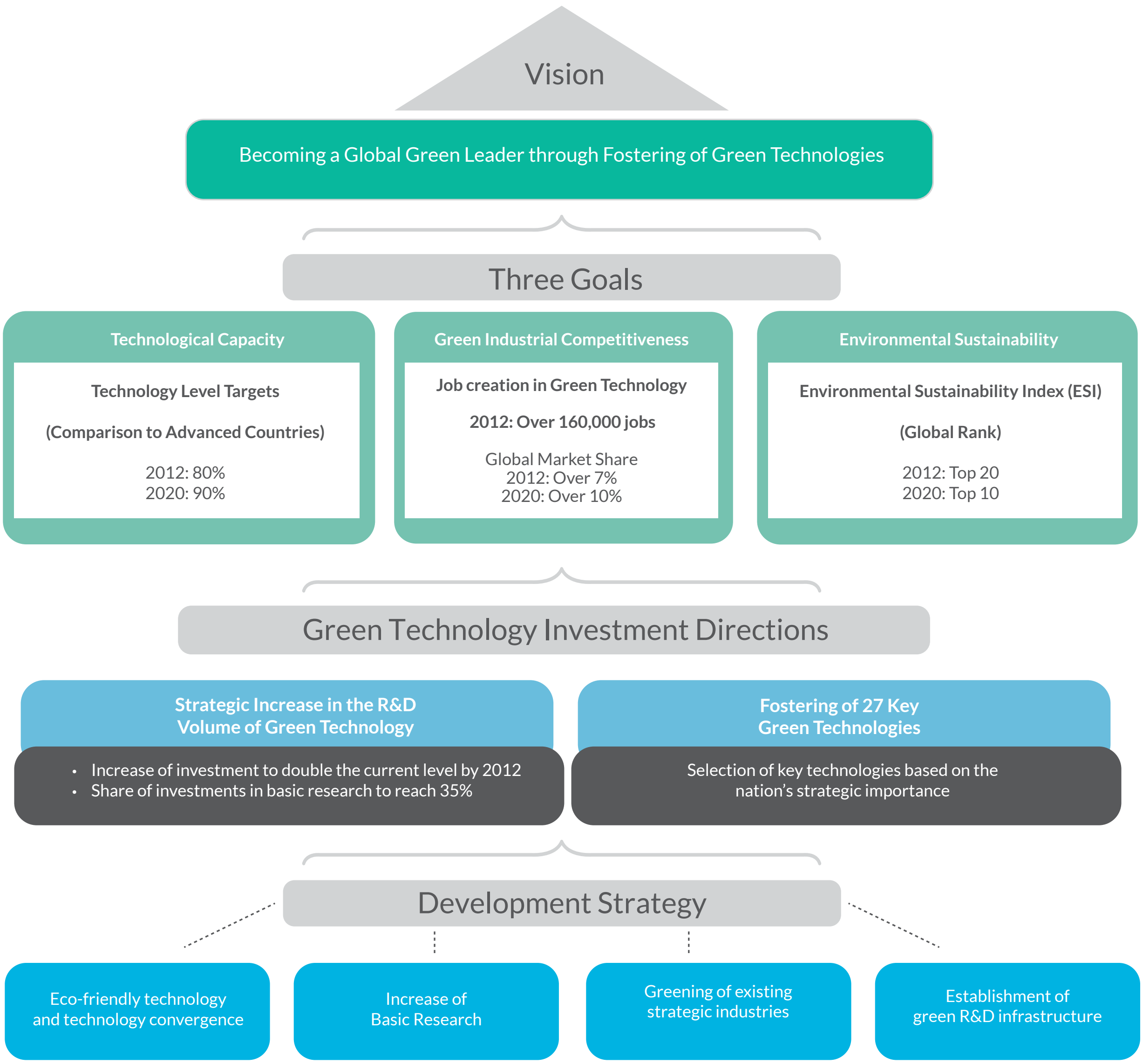
2.2 National Strategy and Target Setting

The devising of national strategies for fostering green technologies was no exception to the principles of selection and concentration; the concept of green technologies which started to gain attention after President Lee took office in 2008 were to be supported by massive government subvention. Once again, the government started to analyze the global trends in the technical market and identified industries that were projected to grow rapidly amid technological breakthroughs. Innovators that participated in the R&D of green technologies were to be provided with a diverse range of incentives. However, having built a democratic governance and competitive market economy, the government engagements were not as reciprocal to a selected number of corporations (that eventually developed into chaebols – the ROK's form of business conglomerate) as they perhaps would have been in the 1960s-1990s.

Establishment of Green Technology R&D Master Plan (2009)

The blueprint for the government's vision on green technologies took the form of the "Green Technology R&D Master Plan" released in January 2009. As illustrated in Figure 3, the plan envisioned to make the ROK a global green leader through fostering of green technologies, and declared the nation's three priority goals. In the setting of these goals, the government looked carefully into the trends and future prospects of green technologies, the status of early movers in the global green technology market, domestic capacities and levels of human resources, the nation's performance in terms of environmental sustainability, and the existing strategies and policies of different ministries relevant to green technologies. Note how the Environmental Sustainability Index (ESI) was incorporated as a means of linking technological advancement to the nation's progress toward environmental sustainability.

Figure 3: Vision and goals of national R&D in green technologies



Source: NSTC, 2009

A notable significance of the master plan is in how it set out the concept of "Green Technologies" as sought by the government. Aligning with the nation's concept of low-carbon green growth, green technologies are defined as those that have a direct influence on both economic growth and environmental sustainability; basically, they can be categorized into technologies that are either relevant to:

(1) environmental prediction;
(2) factors of production; or
(3) environmentally sound economic activities.

As mentioned in the previous section, this concept upholds the idea of technological convergence as it helps in rethinking opportunities, in creating creative solutions to drive economic growth, as well as in conferring the benefits across different dimensions of environmental sustainability. Some examples of technological convergence are the use of radioactive-rays for treatment of pathogenic microbes in waste water; utilizing IT networks to minimize losses in energy systems; use of LED lights to improve agricultural yields and shorter growth cycles; and biological fixation of CO_2 from the atmosphere by using marine organisms.

- Green technologies relevant to environmental prediction (termed prediction technology) are those relevant to monitoring and assessment of environmental pollution and changes in ecosystems, as well as making projections on future climate impacts.

- Technologies relevant to the factors of production can be divided into three − following the input-process-output model of production. Green technologies in the "input" domain refer to those that seek to minimize utilization of depletable resources, while those for the "process" domain focus on improving industrial efficiency and minimizing pollution loads. End-of-pipe technologies that focus on removal of existing contaminants in the environment (by-products of industrial processes) are viewed as green technologies in the "output" domain.

- Technology used by knowledge-based industries that have direct contributions to climate change mitigation form a special category of green technology. Augmented reality (or virtual reality) technologies that help select the optimal wind locations for development of windfarms through data visualizations are a good example of technologies that fall within this category.

As a document that supersedes all existing R&D plans and policies, the master plan entailed government's mid- to long-term investment directions and support. A two-fold increase in R&D spending by the government was envisaged for green technologies during the period 2008-2012. In addition, the share of basic research[2] in budgetary spending was to reach 35% as a means of promoting emergence of "core technologies."[3] Following the principles of selection and concentration, the master plan articulated 27 key green technologies which were to enjoy the highest government preference for investment; the selection process was divided into three phases:

(1) identification of candidate technologies (joint ministerial effort);
(2) evaluation of a portfolio of 75 green technologies (expert reviews and ministerial validation); and
(3) selection and approval of 27 key technologies (review by the Green Technology Council, GTC).

- In the first stage, a comprehensive review was carried out on existing ministerial strategies, R&D master plans and thematic reports, which led to the compilation of 75 priority green technologies. Among many technology needs assessment reports and surveys reviewed, the report entitled "Green Ocean Agenda" prepared by the Ministry of Trade, Industry and Energy (MOTIE) served an important function. The document presented a total of 100 priority technological solutions needed to fight climate change and resource depletion, based on discussions by a group of local academic, research and industrial leaders (approximately 150 individuals) and public surveys.

- In the following stage, the portfolio of 75 priority technologies was categorized into three groups based on evaluations on their level of contributions to economic growth and environmental sustainability, and strategic importance in regard to the nation's development. The level of contributions to the nation's economic growth and environmental sustainability was determined based on analysis of existing data such as global market outlook, thematic reports including IEA's "Energy Technology Perspectives" and research outputs from the Ministry of Environment (MoE), which promoted a better understanding of recent trends in technological innovation. The strategic importance of different green technologies was assessed through the collection of surveys and focus group discussions. As illustrated in Figure 4, the evaluation eventually provided a basis for the setting of investment priorities; three groups of technologies were proposed to receive different levels of investment according to their varying levels of importance.

- The final selection of 27 key green technologies was eventually based on assessments of the strategic importance, technological capability, investment priority (as identified from the portfolio evaluation), and needs as asserted by relevant line ministries.

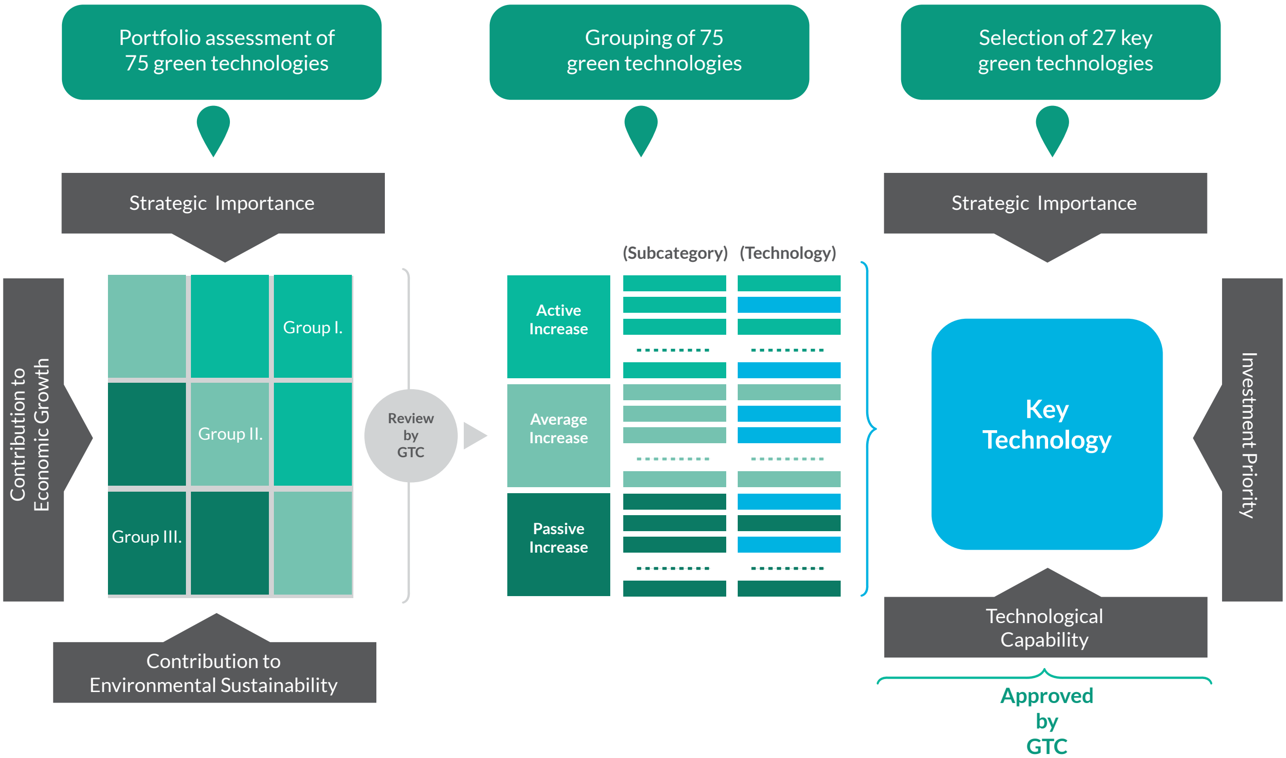
2 | Basic research refers to research for the advancement of fundamental knowledge, without specific application toward processes or products.
3 | Core technologies refer to those that are fully unique (not relying on any existing technologies), and thus have the potential to be applied in various forms as essential in product development.

Table 3: Technologies identified by the "Green Ocean Agenda"

	Sub-category	Number of Publications
Depreciation of the quality of life	• Well-being life conditions • Clean water • Zero waste	• Well-being architectural design • Well-being water • Material re-use from waste recycling
Global warming	• CO_2 reuse • Low-emissions processes • IT-based solutions to respond to changing climate	• CO_2 to plastics • Low-weight high-insulation aerogel materials • Electricity saving e-Homes
Depletion of fossil fuels and fossil fuel price fluctuations	• Clean coal technology • Biomass fuels • Sustainable goods and services	• Ultra-clean coal • High concentration biofuels • Energy recovery technology

Source: NSTC, 2009

Figure 4: Process for the selection of 27 key green technologies



Source: NSTC, 2009

Table 4: 27 key green technologies

Technology Areas			27 Key Green Technologies
Main	Mid Category	Sub Category	
Prediction Technology	Climate change prediction and impact assessment	Climate change prediction	Climate change prediction and modeling
		Climate change adaptation	Climate change impact assessment and adaptation
Energy Generation Technology	Renewable energy	Solar energy	Silicon thin-film cells (enhancement of efficiency and cost-competitiveness)
			Non-silicon solar cells (for mass production)
		Bio energy	Bio-energy generation systems and facilities
	Nuclear/ Nuclear fusion	Nuclear energy	Light water reactor design and construction
			Environmentally friendly nuclear nonproliferation and fast reactor core
		Nuclear fusion	Fusion reactor design and construction
	Hydrogen and Fuel cell	Hydrogen production and storage	High efficiency hydrogen production and storage
		Fuel cell	Next generation fuel cell systems
	Environmentally friendly manufacturing technology/ Increase in materials efficiency	Environmentally friendly manufacturing technology and environmentally friendly products	Accelerated plant growth technology
Efficiency Improvement Technology	Efficiency improvement and high efficiency in fossil fuel	CTL and gasification technology	CTL (Coal to Liquid) technology for Integrated Gasification Combined Cycle (IGCC)
	Efficiency improvement in transportation	Automobile, railroad, marine vessels, space flight, transportation vessels	Highly efficient low pollution vehicles (green cars)
			Intelligent transportation and logistics
	Green land	Green city	Eco-space and urban regeneration
		Green home/ Green building	Environmentally friendly low energy buildings
	Environmentally friendly manufacturing technology/ Increase in materials efficiency	Manufacturing technology/ Increase in materials efficiency	Green process technologies (to optimize energy consumption and environmental load)
	Efficiency improvement in electricity	LED, IT equipment	LED display and green IT
		Usage of superconductivity, Power Information Technology	IT system for energy industries, and energy efficiency technologies for electric appliances appliances
		Energy Storage Systems	High-efficiency secondary battery
End-of-Pipe Technology	Monitoring and Control of air pollution	CO_2 capture, process and storage	Carbon capture and storage (CCS)
		Monitoring and control of Non-CO_2	Non-CO_2 treatment technology
	Water quality	Water treatment	Water quality assessment and management
		Water supply	Technologies for securing alternative water resources
	Waste	Waste recycle and waste energy	Waste reduction, recycling, and re-use
	Waste and environment preservation	Ecology risk assessment	Monitoring of toxic pollutants and environmental remediation
Clean Industrial and Economic Activities	CT, soft technology base IT and knowledge service	Virtual reality	Virtual reality technology

Source: NSTC, 2009

Green Technology Commercialization Strategy (2009)

In recognition of technology development and commercialization as evolving processes that are highly interactive, the ROK government presented another strategy document in May 2009. This document titled the "Green Technology Commercialization Strategy", aimed to provide a blueprint to technology R&D and market penetration. First, the strategic document clarified the links between technologies under development and their related goods or services which were to emerge in future markets. For example, the next-generation membrane filtration technologies and intelligent process control systems were to significantly improve the performances of future desalination and water re-use facilities.

Subsequently, the timeframe for commercialization of each technology was drafted (technological roadmap), which provided a clear picture to when government support needs to be concentrated under different purposes. For example, smart grid technologies was to require additional efforts for applied research (until 2012), before entering a stage of pilot testing and commercialization (2013-2020) and full market penetration (2021-2030). The seven technologies (from the 27 key technologies) that were assessed as ready for commercialization or would even create substantial markets by 2012 were:

(1) LED lighting
(2) high-performance silicon solar cells
(3) hybrid cars
(4) smart grid systems
(5) advanced light water reactors
(for nuclear energy)
(6) fuel cells
(7) carbon capture and storage systems

Finally, the document identified policy reform measures as stimulants for fast-tracking technology commercialization for the domestic market and these include the following:

- Introducing real-time power trading systems and enforcing the nation's critical energy facilities to be equipped with energy storage systems
- Strengthening building codes for improving energy consumption and reducing GHG emissions from the building sector
- Revising legislations to allow electric vehicles to enter general motorways and strengthening of vehicle emissions standards
- Introducing the Renewable Portfolio Standard (RPS) program and strengthening of technical certification standards for renewable energy systems
- Strengthening environmental regulatory standards for industrial manufacturing processes and introducing of incentive schemes for pollution reducing investments

Selection of Ten Core Green Technologies (2010)

In February 2010, relevant line ministries jointly presented a proposal to PCGG on further prioritizing the 27 technologies of focus into ten core green technologies. The selection sought to accelerate the commercialization of technologies as derived by existing plans, in response to the government's legislative preparations for setting up a national emissions trading scheme (ETS). However, this process also provided an opportunity to tighten the reins of innovation actors, by ensuring that their R&D efforts are aligned to the proximate demand from the emerging market. The ten core green technologies include:

(1) next generation secondary batteries
(2) LED display
(3) green PCs
(4) high-efficiency solar cells
(5) green cars
(6) smart grids
(7) advanced light water reactors
(8) fuel cells
(9) CSS (carbon capture and storage) systems
(10) advanced water treatment systems

2.3 Green Technology Target Setting (Five-Year National Plan for Green Growth)

By exercising the principles of selection and concentration and investing approximately 6.3 trillion KRW over the period of 2009-2012, the National Science and Technology Council targeted to close ROK's technological gap with the world's leaders to 20% by 2012.

In the longer-term, the ROK was to close this gap to 10% by 2020, which would make the nation one of the world's top-five countries in green technology. In this process, the government estimated a significant increase in the nation's share of the global green market, along with the creation of more than 170,000 new jobs.

Table 5: Green Technology R&D Goals

Field	Target					
	2008	2009	2010	2011	2012	2020
Green Technology level as compared to the global leaders	-	-	-	77.7%	80%	90%
Job creation in the fields of green technology	7,000	13,200	24,100	54,000	74,500	-
Global share of green technology market	-	-	-	-	7%	10%
Environmental Sustainability Index (Among OECD countries)	Rank within top 20					Rank within top 10
Share of basic research in government's green technology R&D budget	35% (In 2007: 17%)					

Source: NSTC, 2009

3. Policy Actions and Programs

3.1 R&D Investment Plans

Appropriate and effective allocation of budgets to promote technology innovation initiatives is a challenge for governments across the world; fundamentally, budgetary policies and priority setting in this field are not guided by a widely accepted theory, thus are often carried out based on government appetite without rational decision making. In the ROK, the government established the National Science and Technology Council (NSTC) in 1999 as the platform of coordinating the nation's setting of science and technology agenda and budgetary priorities. Supported by all relevant ministries, the Green Technology Committee (GTC) under the NSTC started formulating annual green technology investment plan from 2009, which provides the details on how the government is to utilize the assigned R&D budget. Basically, a large portion of this investment was to be channeled into R&D activities for 27 key green technologies; for example, more than 70% of the R&D budget allocated to green technologies for 2009 was to be used for activities relevant to 27 key green technologies. However, additional efforts sought to prioritize investments based on assessments on several factors, including potentials for future demand, market growth, and the nation's current/ future technological gaps.

Potentials for Future Demand and Market Creation

In order to align R&D investments to the potential for technology market creation and future demand, GTC divided 27 key technologies into three strategic investment groups (Lee, 2009):

- **Group-1** brings together areas where investments are to be concentrated in the coming 5-10 years. Technologies that have proven cost-benefits and increasing market volume fall into this group; such characteristics highlight the need for the private sector to take the lead in R&D efforts. However, the government is to support the private sector by filling the gaps in impending human resource needs and infrastructure for technology commercialization. The ROK's list of technologies in this group includes water quality control, high-performance solar cell, and waste re-use technologies (7 out of 27 key green technologies).

- **Group-2** compiles technologies in need of taking a mid- to long-term perspective of 10-20 years, under the prospects of seeing new market creations. A substantial amount of basic research is needed for the technologies of this group, many of which have high potential to provide public benefits such as resolving the food and water crisis. The ROK's list includes bio-energy production systems, high efficiency vehicles, and accelerated plant growth technologies (16 out of 27 key green technologies).

- **Group-3** represents technologies that are uncertain to lead to market creation, but have massive potentials to make an impact in the future. Many of these technologies are still at their conceptual stage that are likely to occur in the future. Sustained investments in R&D activities are required for these technology areas, which include climate change prediction, urban regeneration, and hydrogen production (4 out of 27 key green technologies).

Technological Gaps and Investment Timeframe

As different technologies require different periods of time and amount of investments to lead to commercialization, the government sought to understand the projected timeframe of necessary financing. Building upon the identification of technology related goods and services, and the technological roadmap as laid out by the "Green Technology Commercialization Strategy (2009)," a group of members from a total of 11 government ministries and offices came together to explore market prospects of different green technologies, assess the ROK's current technology gaps compared to the global leaders, and identify domestic issues driving R&D activities.

- The group placed emphasis on making sure that the ROK's R&D efforts drive upon opening opportunities for domestic industries to enter the global green goods and services market; the underlying rationale is that the global green market is projected to grow annually by 10.2%, reaching a volume of US$ 5.7 trillion by 2020. Although the domestic market was also projected to grow rapidly at an annual rate of 13.2%, in terms of market volume – estimated to be US$ 230 billion by 2020 – it was only to comprise a small portion of the global market. Many of these green markets were to dwell upon existing market structure; for example, electric vehicles were to make up for 31.4% of the global motor industry market by 2020.

- Many of the green technologies that have successfully led market creation were dominated by developed countries including the U.S., Japan, and countries of the EU. Lack of interest and support from government had already led to heavy reliance on technology imports in the ROK; 75% of solar power systems and 99% of wind turbine facilities of the domestic energy producers were established from imported goods. In this light, the group sought to assess the current technological gaps and industrial competitiveness for each of the technology areas. For example, the ROK's technological edge in energy efficiency left room for improvement in terms of localization of relevant products, while low levels of technology was already acting as a significant barrier towards localization efforts for pollution control systems.

- Domestic issues surrounding technological development and adoption in different areas were identified to better understand the budgetary demand in terms of the investment type and timeframe. For example, a majority of the domestic energy source technology goods (e.g., renewable energy systems) were in critical need for improving cost-efficiency and scaling-up of manufacturing facilities to compete in the global market, while goods for energy efficiency were suffering from a weak technology base and lack of pilot testing efforts.

Four-Tiered Investment Plan

Ultimately, four customized budgetary pipelines were prepared for 27 key green technologies.

The first group, which responds to technologies with short-term investment needs, is to see a 30% annual increase in public budget, as a means to support pilot testing and market entrance by year 2012.

The second group, which complies technologies that are to maximize the first-mover advantage, are to receive 20% and 30% annual increases in government investment during the periods of 2008-2012 and 2012-2020, respectively.

The third group of technologies, whereby the government's budgetary support takes a long-term perspective to help the nation become a global technological frontier, will see a steady annual increase of 10% and 15% in budgetary allocation for the periods of 2008-2012 and 2012-2020, respectively.

Finally, **the fourth group** entitled "technologies for sustained investment," responds to technologies that are in need for a substantial amount of basic research to demonstrate proof of concept; public investment into this group is to increase by 5%, 10% and 15% during periods leading up to 2012, 2020, and 2030, respectively.

Strategic Implementation of R&D programs

R&D spending were focused on 27 key green technologies based on the four development strategies laid out in the Green Technology R&D Master Plan of 2009:

(1) boosting investments in basic research;
(2) promoting technology convergence to develop eco-friendly technologies;
(3) greening of existing industries and creation of new growth drivers; and
(4) strengthening green R&D infrastructure and research collaboration with global institutions.

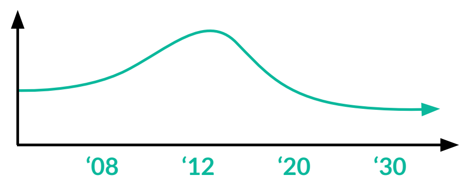
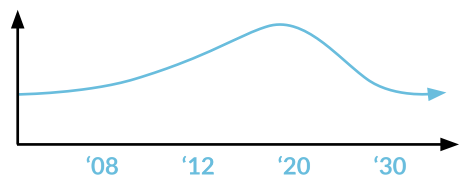
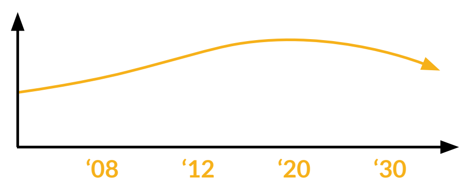
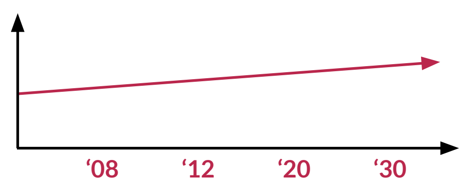
It is important to understand that the emergence of such strategic agenda was well accompanied by many of the existing R&D plans and actions. Although it is true that launch of new R&D programs was actively promoted and undertaken by the line ministries, much of their actions taken were about redirecting the provisions of existing R&D programs closer to meet the objectives set under the green technology agenda. For example, the R&D program for fostering the capacities of individuals engaged in basic research – which was implemented by the Ministry of Education and Science Technology (MEST) long before the emergence of the green technology agenda – prioritized award of research grants to individuals engaged in the fields relevant to green technologies as of the year 2010. Obviously, such public investments were accounted as increased budget allocations for green technology R&D; PCGG and NSTC continued to keep track of such changes in budgetary spending on an annual basis.

3.2 Institutional Framework

Similar to how the Presidential Committee on Green Growth (PCGG) was responsible for deliberating on the national plans related to green growth, the Green Technology Council (GTC) under the National Science and Technology Council (NSTC) was the overarching body in charge of the green technology agenda. The NSTC was launched in 1999 with the missions of establishing pan-ministerial governance on science and technology policy and improving the efficiency of national R&D. Its main activities include allocating and coordinating budgets for major R&D projects and managing the entire lifecycle of R&D activities by supporting the evaluation and utilization of R&D outcomes. Newly established in 2008 under the NSTC, the GTC was given the responsibility of strategy setting and budgetary planning for green technology development. The council played a key role in the formulation of the National Green Technology R&D Master Plan (2009), development of the ROK's concept and scope of green technologies, and prioritization of 27 key green technology areas.

Government ministries that are positioned under the NSTC to support coordinated R&D efforts in the

Table 6: Investment plans for 27 key green technologies

Group Number	Timeframe	Technologies	Timeframe of budget allocation
1	Short-term	Silicon thin-film cells, LED display, light water nuclear reactors	
2	Medium-term	Green cars, green process technologies, high-efficiency secondary battery, non-CO_2 treatment, water-quality assessment and management technologies, alternative water resource technologies, waste reduction, recycling and re-use, and virtual reality technology (8)	
3	Long-term	Climate change prediction and modeling, climate change impact assessment and adaptation, fusion reactors, nuclear nonproliferation and fast reactor core, hydrogen production and storage, fuel cells, accelerated plant growth, integrated gasification combined cycle, eco-space and urban regeneration, low energy buildings, smart grid systems, CCS, and monitoring of toxic pollutants and environmental remediation (13)	
4	Long-term	Non-silicon solar cells, bio-energy generation systems, and intelligent transportation and logistics (3)	

Source: PCGG, 2009c

sectors of themes of their expertise had important roles to play; they supported NSTC's setting of strategic directions, identified projects of high impact, and utilized their network with academia and business entities to help engage in cooperative development of technologies. As the coordinating body, the GTC ensured that government ministries minimize the overlapping of efforts in similar technology areas.

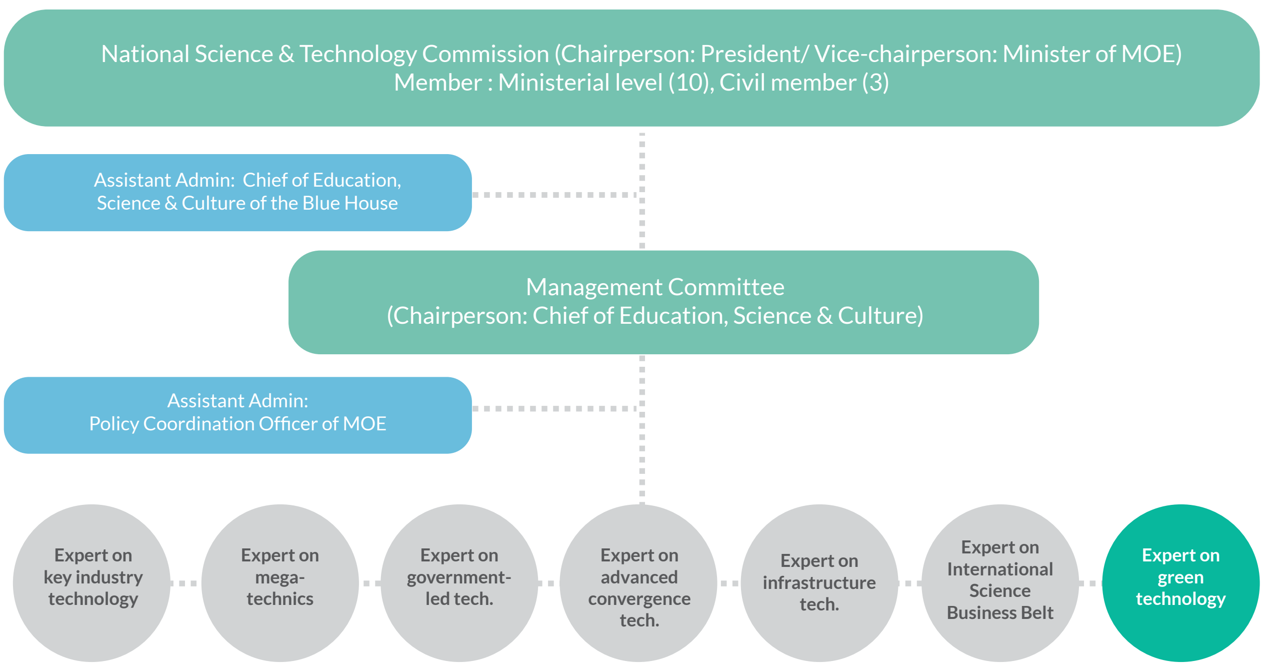
For example, in case of prediction technology, the Ministry of Knowledge Economy (now the Ministry of Trade, Industry and Energy), the Ministry of Environment, and the Ministry of Agriculture, Food and Rural Affairs were to play key roles in different domains. As for energy source technologies, the Ministry of Education and Science Technology and the Ministry of Knowledge Economy were to coordinate their efforts. Disputes that arose from conflicts of interest between ministries were resolved through discussions under the GTC.

An important success factor in the ROK's efforts regarding green technology was the devising of an annual "Comprehensive Green Technology R&D Plan." To effectively achieve the targets set by the National Green Technology R&D Master Plan, a total of 11 government ministries and agencies came together to coordinate their future efforts and agree upon a single comprehensive R&D plan for the coming year. The annual plans of 2009-2012 also incorporated the outcomes of implementation by different ministries from the previous year. This helped the PCGG and NSTC monitor their current progress and outcomes, identify gaps and provide directions for future work. Preparation of the annual plans also opened opportunities to reflect the suggestions made by government-funded research institutes and leaders of the private sector. Agood example is how the coordinated efforts of the GTC enabled government research institutes and the Hyundai Motor Company to collaborate in commercialization of fuel cell stacks to be used in electric vehicles.

History and roles of government-funded research institutes in the ROK

A critical success factor in the development of the government's policies on green technology R&D was the existence of strong government-funded research institutes (GRIs). The role of GRIs was especially important during the catch-up phase of technology innovation when the private sector

Figure 5: Organizational structure of the National Science and Technology Council



Source: NSTC, 2009

had low R&D capacities of their own. This first GRI was established in 1966 – the Korea Institute of Science and Technology (KIST) – as a comprehensive research center covering a wide range of industrial sectors to meet their diverse technological needs. As technologies and knowledge base of the industrial sectors continued to advance and the need for deepening of specific technological capabilities grew in the 1970s, additional GRIs were established with each targeting different industrial sectors or thematic areas.

In addition to GRIs that conduct technological or engineering research, the ROK government also established government think-tanks (which are also GRIs) to meet the diverse needs in public policy development. The Korea Development Institute (KDI) was the nation's first think-tank organization established in 1971 aimed to focus government ministries on the development of economic policies, such as the "Five-Year Economic Development Plans" which were formulated from the 1960s. Similar to the expansion in the number of GRIs, additional policy think-tanks were established following the government's initiation of industry promotion policies, starting with those for the heavy and chemicals industries in 1973. For example, the Korea Institute for Industrial Economics and Trade (KIET) was established in 1976 to provide expertise and policy recommendations for a wide array of industries.

It is important to recognize that the structure of the GRIs, their funding mechanism and operational requirements have evolved continuously to reflect their changing roles and needs of the society.

- As of 2014, the governance structure of the ROK's GRIs can be illustrated as shown in Figure 6. Although each GRIs were originally under the direct supervision of different government ministries, a grouped model of administration was introduced in 1999 as a means of: (1) reducing duplications in research domains and enhancing collaboration between GRIs, (2) improving the independence of GRI's management structure (from the supervising ministries) and thus enhancing their flexibility in responding to evolving innovation needs; and (3) creating a competitive environment (between GRIs). As a result, GRIs are now categorized into those under the National Research Council of Science and Technology (NST) responsible for conducting R&D activities in the fields of science and technology, and those under the National Research Council for Economics, Humanities, and Social Sciences (NRCS) which are think-tank organizations supporting the government's policy formulation.

- GRIs of the ROK have been the main recipients of public budget. Basically, the operational costs (including the manpower costs of researchers) were covered through government's allocation of lump-sum budget, while the direct costs for specific research activities were provided by the supervising ministries on a project basis. While the lump-sum budget helped improve the financial stability of GRIs, lack of consensus on their institutional missions among government authorities led to excessive monitoring and control, creating inefficiencies in budgetary spending and leaving GRIs with little room to carry out research based on an internally driven agenda. Accordingly, the government brought about a reform to the funding mechanism in 1996, by replacing the lump-sum system to project-based management system (PBS); GRIs were no longer given a budget envelope to fully cover their operations costs, and provision of research grants by relevant government ministries (which are to shoulder the funding gaps in operational costs) were to be made strictly through a competitive process (against other GRIs, universities, and/or industries). While the introduction of PBS helped create competition and boost the cost-effectiveness of R&D activities, GRIs have complained that the PBS enforces them to engage in short-term projects of less research significance (i.e., applied research or commercialization) as a means of securing budget to secure their manpower costs.

- Starting from 1982 when national R&D programs entered a stage of refinement and fast-paced implementation, the government established management agencies to effectively administer and periodically evaluate the performances of R&D activities (at program or project levels). For example, in the field of industrial technologies, the Ministry of Commerce, Industry and Energy established the Korea Institute of Industrial Technology Evaluation and Planning (ITEP) in 1989. Unlike the GRIs (and government think-tanks), these management agencies have operated as affiliated organizations of the relevant ministries under direct supervision.

The ROK's past success in establishment and active engagement of GRIs for government policy formulation and bringing about technological advancement was to be replicated under the green technology agenda. For example, the Green Technology Center of Korea (GTC-K) was established under the KIST in 2013 as a think-tank that provides advice on devising the nation's policies on green technology. In addition, KISTEP was designated in 2009 as the management agency in charge of managing government budget and expenditures on green technology R&D activities.

Figure 6: Governance structure of the GRIs

3.3 R&D Programs and Fostering Green Talents

Ministries that individually hold responsibility for priority areas and the necessary budget envelope for promoting green technology were directed to align their R&D expenditures with the four development strategies laid out by the Green Technology R&D Master Plan (2009). This section provides some examples of the related actions undertaken (provision of R&D grants) at the program and/or project levels.

3.3.1 Expansion of Basic Research and Promotion of Technological Convergence

While advanced countries have gradually achieved positive outcomes in science and technology, the ROK followed suit in haste. It is thus lacking in certain core technologies, which are the critical building blocks of all technology systems.

As a latecomer developed economy, the nation's past R&D efforts have been geared heavily toward applied research and commercialization, leaving much room to be desired in the field of basic research. Strategic expansion was accordingly deemed important, especially as the nation's pursuit of low-carbon green growth sought to move away from the labor- and capital-intensive growth paradigm and promote high value-added businesses with a technological edge that cannot be easily replicated or surpassed. The government's endeavors toward strengthening basic research with long lead-in times to commercialization were reflected in its commitment to budgetary expansion; the share of budget allocated to basic research was to increase from 17% in 2007 to 35% in 2012. It is noteworthy that the ROK government sought to exploit opportunities of technology convergence in carrying out basic research, as a means of accelerating the development of core technologies.

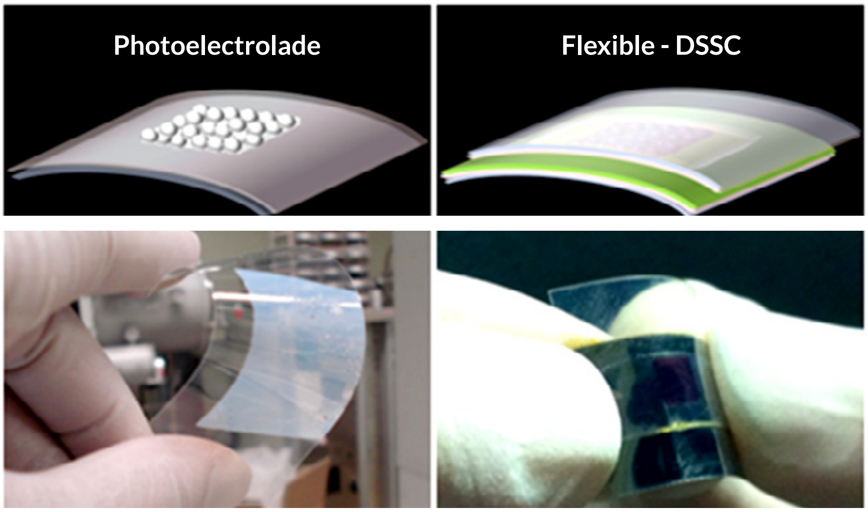
Global Frontier Project (Ministry of Education, Science and Technology, MEST)

The Global Frontier Project is MEST's representative medium- and long-term R&D initiative to secure the core technologies of the highest level. MEST supports research clusters or centers composed of multiple research entities from the public and private sectors in conducting basic research on high-risk and high-impact areas that are pre-selected through expert group meetings, assessments on global issues and future trends, and public hearings. The project places an emphasis enabling technological convergence by the grouping of knowledge and expertise from various disciplines. The project targets 15 research clusters (2010-2021) with research grants that annually amount to 5-15 billion KRW each, over a maximum period of nine years.

Example Project: Center for Multi-scale Energy Systems

The Center aims to develop breakthrough technologies for renewable energy systems, particularly solar and fuel cells that can compete with fossil fuels. "Multi-scale" is a new concept proposed by the Center that refers to streamlining the energy system design and architecture at nano- micro-macro-scales to improve efficiencies. The concept is a good example of converging nano technology (NT) with existing energy technology. If the research proves to be successful, the Center expects to reduce the costs of solar energy generation to US$ 0.5/W. Launched in 2011, the Center plans to operate for nine years on an annual budget of approximately US$ 10 million funded by the Global Frontier Project, and engaging 420 researchers from universities and national research institutes.

Figure 7: Flexible photo-electrode and dye-sensitized solar cells (DSSC) being developed by the Center for Multi-scale Energy Systems



Source: Multienergy, 2014

Example Project: Advanced Biomass R&D Center (ABC)

The Advanced Biomass R&D Center has the primary objective of developing technical, scientific, and engineering solutions for producing economically viable and environmentally sustainable biomass-derived biofuels. The Center mobilized US$ 110 million from 2010 to 2019 through its initiative, the Global Frontier Project, employing more than 300 researchers from universities as well as public and private research institutes and companies. The Project aims to find breakthrough solutions to make biomass-derived drop-in fuels economically competitive against petroleum-based fuels. The research topics include recycling of waste resources (e.g., organic waste, municipal waste water, and livestock waste) and mass cultivation of micro-algal biomass for production of biofuels. The Center's efforts represent technology convergence – integrating bio technology (BT) and chemical technology (CT) to develop bio-chemical materials that can replace petroleum-based energy products.

Figure 8: Concept of bio-mass derived biofuels

Source: ABC, 2014

Generic Industrial Technology Development Project: Transportation Systems (Ministry of Trade, Industry and Energy, MOTIE)

This project operated by MOTIE has been channeling research funds into areas that have been prioritized by the nation's evolving economic growth strategies, with the aim of concentrating support on the development of core technologies that can help create the nation's new engines of growth and enhance the competitiveness of the flagship industries. In response to the emergence of the nation's low-carbon green growth paradigm, open calls for research proposals (in 11 pre-selected industrial areas) started to place emphasis on the development of technologies relevant to GHG emissions reduction, resource efficiency, and pollution abatement; this was especially the case in the area of transportation systems where a majority of research grants targeted the commercialization of green cars, including electric vehicles and fuel cell vehicles. A total of 2-3 billion KRW was provided to each research project with 3-7 year periods. Matching fund requirements from the private sector recipients vary (25%-50%) according to the number of SMEs participating in the research initiative.

Example Project: Development of fuel cell stacks for fuel cell electric vehicles (FCEV)

The fuel cell stack is the heart of the FCEV, where hydrogen and oxygen found in the atmosphere are combined to create electrochemical reactions in order to generate electricity. Despite its importance, the ROK's auto industries have fully relied on imported fuel cell stacks in developing their FCEVs. This research project aims to develop core technologies required in manufacturing the components of a fuel cell stack and designing the stacking process. Led by the Hyundai Motor Company, a consortium of automotive parts manufacturers, universities, and government research institutes is conducting this five-year R&D project, known as the "Core Industrial Technology Development Project." These research efforts are in line with the government's plans to help realize the mass production of FCEVs by the year 2015.

3.3.2 Technologies for Greening of Strategic Industries

Strategic industries of the ROK that have been subject to much of the government's development support (i.e., petrochemicals, steel, automobiles, shipbuilding, IT and electronics) have been identified as those that have significant production induced impacts and job creation capacities, along with high levels of contributions to the expansion of the nation's export volume. Most of these strategic industries are heavily energy-intensive and account for a large portion of the nation's carbon emissions and pollution, which in turn indicates how they are to become central to driving low-carbon green growth transformation. Securing transformative technologies to reduce emissions and improve environmental performance of existing industries is therefore a priority.

Some examples of technological opportunities are the application of IT technology to conventional power systems for automation and digitalization, which can induce energy efficiency; introducing geothermal heat pumps to agricultural production to boost yield and reduce costs; and utilizing architectural materials with better insulation properties to improve energy loss of buildings.

The government has sought to ensure that emerging technology goods and services in the process of industrial greening are fostered as the nation's new engines of growth. Accordingly, the allocation of public R&D budgets prioritized several areas including clean energy production, energy efficiency, green buildings, and green transport, which have the highest potential for creating immediate markets.

Figure 9: Fuel cell stacks for FCEV application

Source: Hyundai Motors, 2015

Example Project: Development of energy-efficient hull design and thrust system technology for green ships

Under the Kyoto Protocol of the UNFCCC, the International Maritime Organization (IMO) is required to regulate the GHG emissions from ships. Accordingly, the IMO developed the Energy Design Index (EDI) to promote the use of energy-efficient equipment and engines for reducing GHG emissions; the plans is to prohibit the navigation of ships with EDI higher than the stipulated IMO standard. In order to cope with such strengthening of international regulations, the project aims at developing technologies that seek to:

(1) reduce energy consumption;
(2) reduce frictional resistance;
(3) improve propulsion efficiency; and
(4) replace conventional diesel engines (i.e., clean propulsion systems).

3.3.3 Eco-friendly Technologies

Rapid economic growth has had a severe impact on the ecosystem's capacity to regenerate and provide long-term service in the ROK. Over the past 60 years, the nation's landscape experienced dramatic changes due to intensive afforestation, land clearance, industrial activities, and subsequent pollution. Large sections of the coastline and salt marshes have been converted into industrial zones, urban centers, and tourist attractions.

Fundamentally, green technologies must provide comprehensive solutions to avoid or minimize the adverse impacts of economic growth on environmental sustainability. Although it is true that the boundaries of green technology are much wider than those set around conventional environmental technologies focusing on pollution control management, green technologies embrace the concept of sustainable development in that they seek to improve the quality of human life through development within limits tolerable to sustain ecosystems services. The 27 key green technologies prioritized by the government include a multiple number of eco-friendly technologies that are relevant to serve such purposes; those categorized as prediction technologies and end-of-pipe technologies are the most representative examples.

Program for Technological Advancement of Environment Industries (Ministry of Environment, MoE)

This program seeks to meet the increasing demand for pilot testing of environmental technologies that have proven potential for competing in existing markets or opening new immediate markets. Ultimately, the program aims to enhance the technological edge of the nation's domestic industries, especially SMEs that have limited resources to invest in technological innovation. Proceeds of the research grant prioritize short-term engagements (one year) for technology commercialization or field application in five key areas:

(1) air quality control;
(2) ecosystem restoration and management;
(3) environmental risk assessment;
(4) eco-friendly manufacturing; and
(5) improvement of living conditions.

Funding for commercialization projects is granted based only upon confirmed requests for technology purchases, while funding for field application is awarded to consortiums of private firms, universities, or research institutes.

Example Project: Development of Bio-pellets with High Heat Value and Density

Bio-pellets are an established renewable energy resource consumed widely in Europe, the U.S. and the Asia-Pacific region. The ROK's domestic demand for bio-pellets is expected to grow rapidly, from 1 million tons in 2014, to 5 million tons in 2020, a trend which is largely driven by governmental regulations concerning the reduction of GHG emissions, and thereby increasing the utilization of renewable energy systems for power generation. However, the use of bio-pellets is limited in that they have significantly lower heat values as compared to fossil fuels. In addition, biomass availability is low in the ROK, which has led to high reliance on cheap bio-pellet imports. Recognizing that storage and transportation account for approximately 40% of the costs involved in production of bio-pellets, this research project aims to develop bio-pellets that have higher densities and heat values (15% increase), which will help improve the profitability of the domestic bio-pellet industry.

Figure 10: Bio-pellet manufacturing facility

Source : Korea Woodpellet Corporation, 2015

Example Project: Hybrid air purifying system for simultaneous removal of PM2.5, VOCs and malodorous gaseous from the petrochemical industry

A wide range of industries in the ROK have located their manufacturing facilities and technology centers in industrial complexes. Oil refinery and petrochemical plants that account for over 50% of these facilities are the main sources of the nation's air pollution from VOCs (volatile organic compounds), along with particulate matter (PM2.5). Understanding how acute or long-term exposure – especially for the workers and residents of industrial complexes – can have detrimental effects, the government imposed stringent ambient air quality standards for key pollutants (Air Quality Preservation Act, 1990), which has hence helped improve the ROK's air quality. However, the nation continues to wrestle with an increasing concentration of ultrafine dust which originates from both within Korea and overseas (i.e., China), which has become a major threat to public health. Therefore, this research project led by an SME aims to develop an air filtration system that can simultaneously remove PM2.5, VOCs and malodorous gas released from petrochemical processes. The newly developed system targets a 99% removal of malodorous gas (NH3), VOC (toluene), and particulate matters (PM2.5) at an influent air flux of 5 CCM (cubic meters per minute).

3.3.4 Establishment of Infrastructure for Green R&D

Global competition for technological dominance has changed the environment surrounding R&D activities. In a society where technology has become a critical factor for economies to maintain their competitive advantage, simply keeping pace with the number and speed of new innovations has become increasingly difficult. Modern R&D efforts often override past experience and abandon prior knowledge, and creativity has become a strategic signpost to achieve technological breakthroughs. Based on such awareness, the ROK government has continued stepping up its efforts to foster creative and highly motivated human resources, as well as establish strong cooperative arrangements to undertake R&D activities.

Green growth policies are expected to reshape the demand for skills in the areas of science, technology, and engineering. For example, architects will need to expand their knowledge of environmentally friendly design; heating engineers will seek ways to extend the application of energy-conserving technologies; and accountants will need to understand how to weigh the environmental costs and benefits in business operations. In addition, strengthened government regulations on environmental performance may either create or reduce the number of jobs in specific fields.

For example, demand for nano-science engineers and environmental consultants will be on the rise, while the demand for engineers in manufacturing conventional petroleum-based products may lose momentum. Recognizing such impacts of green growth transition to the skills market, the "Comprehensive National Plan on Green R&D" set new directions for existing and new R&D programs, which focus on:

(1) fostering and attracting green technology specialists;

(2) establishing green R&D clusters composed of industries, academia, and research institutes;

(3) creating platforms for green technology commercialization; and

(4) promoting the exchange of green knowledge with leading global research institutions.

Program for Development of High-tech Cities (Ministry of Land, Infrastructure and Transport, MOLIT)

Cities of the ROK form the hubs of the nation's economy. While they primarily served as centers of trade and industrial activities in the past, cities are today transforming into centers of modern services and innovation. However, major cities of the ROK continue to face rising environmental challenges as a consequence of rapid industrialization; the nation's shift toward high energy consumption, air pollution, and water stress in the course of economic growth is clearly evident in the ROK's urban areas. In this light, the Program for Development of High-tech Cities led by MOLIT aims to seek technological solutions to creating eco-friendly living conditions and driving the revitalization of cities. Promoting the concept of livable, competitive, and sustainable cities, research grants are channeled to three key areas:

(1) commercialization of green buildings;
(2) low carbon urban transitioning; and
(3) application of advanced spatial data analysis.

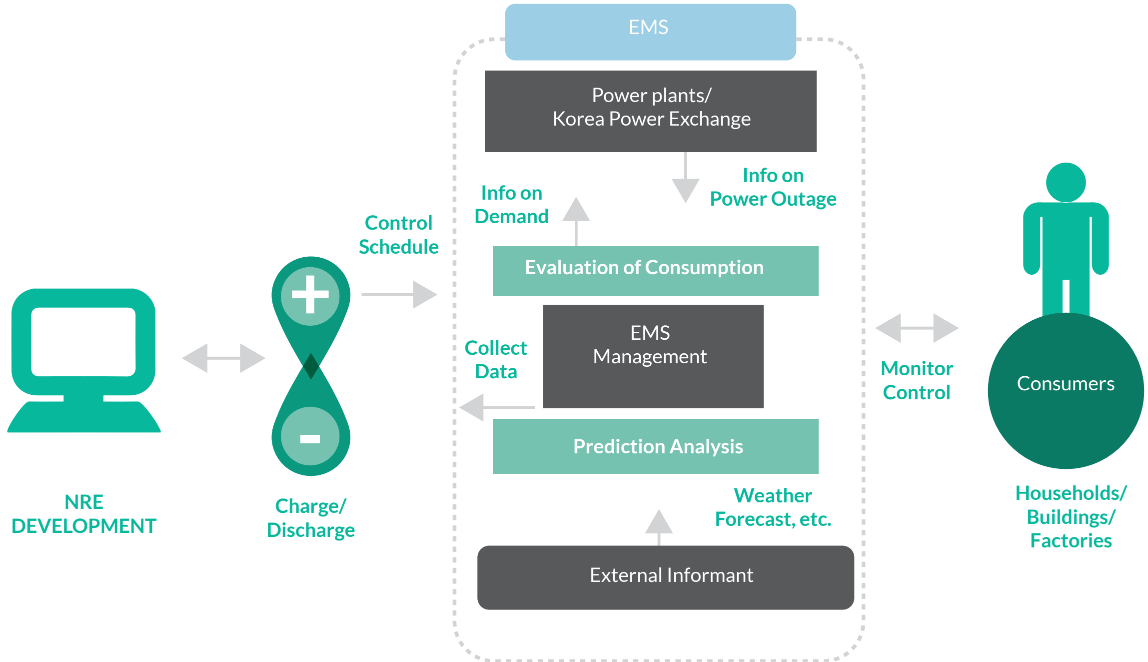
Example Project: Low-carbon smart city energy management system development

Load shedding occurred in a number of areas across the ROK in September 2011, as unexpectedly high temperatures triggered a surge in electricity use. Unprecedented blackouts affected hundreds of thousands of people, causing considerable economic losses. Such power cuts resulting from a temporary overuse of electricity highlights the necessity of the Electricity Management System (EMS), a system used to monitor real-time use of electricity and optimize the performance of the generation and transmission system. In this regard, this research study aims to develop EMS at the city level. Not only will the EMS monitor the overall use of various types of energy (electricity, thermal power and gas) in urban areas to prevent emergent energy shortages; but its application is anticipated to help improve energy efficiency by 30%, which will lead to a significant reduction in CO_2 emissions. The system is scheduled to be pilot tested in Ansan city, in a group of facilities including the City Hall, daycare centers, community health centers, district offices, water treatment facilities, and local community centers.

Example Project: Establishment of a GHG emissions assessment system and integrated certification system for green buildings

Green buildings can offer multiple benefits in addition to cutting GHG emissions, such as lower operating costs, increased productivity, and reduced absenteeism, by means of better architectural design, construction, and systematic maintenance. Formulating a robust framework and methodology for evaluating the environmental performances of new and existing buildings is thus critical for promoting green building practices. Given the 50-year average operational lifespans of buildings, performance evaluations must be based on life-cycle assessments on various aspects, including resource consumption efficiencies and GHG emissions intensities. In response to the national emission-reduction targets – which require a 26.9% reduction in emissions from BAU levels by 2020 for the building sector – the project aims to deliver a methodology and establish a database required for assessing life-cycle performances of building structures in the ROK. By developing a green rating tool for buildings (Green Building Index), the project will help raise awareness among developers, architects, contractors, and the public on the need for complying with the more stringent performance standards.

Figure 11: Overview of the EMS platform



Source: Park and Kim, 2013

Table 7: Areas of ministerial support in development of eco-friendly technologies

Eco-friendly technologies (within 27 key green technologies)			Relevant ministries of support
Main	Sub Category	Detailed technology	
Prediction technology	Prediction of climate change and assessment of its impacts	Climate change prediction and modeling	MoE, MOTIE, Korea Meteorological Administration (KMA)
		Climate change impact assessment and adaptation	MoE, Ministry of Agriculture, Food and Rural Affairs (MAFRA), Rural Development Administration (RDA)
End-of-pipe technology	Monitoring and control of air pollution	Carbon capture and storage (CCS)	MEST, MOTIE, MoE
		Non-CO_2 monitoring and treatment	MEST, MOTIE, MoE
	Water quality management	Water quality assessment and management	MEST, MoE, Ministry of Land, Infrastructure and Transport (MOLIT)
		Technologies for securing alternative water resources	MEST, MOLIT
	Waste and environmental preservation	Monitoring of toxic pollutants and environmental remediation	MEST, MoE, MOLIT

Platform Technologies Program for Climate Change Response (Ministry of Environment, MoE)

The Platform Technologies Program was launched by the MoE in 2013 with the mission of delivering technologies required for effective climate-related policy interventions. As a one-of-its-kind program designed to focus primarily on supporting the government's climate change related decision-making process, its outputs were targeted to have a wide range of applications across different activities. These activities include the operation of a robust MRV (Measurement, Reporting and Verification) system, downscaling climate projections, reducing uncertainties in GHG emissions reduction models, formulation of climate change adaptation measures, and optimization of cost benefits in GHG abatement measures. Ultimately, technological advances supported by the program were able to strengthen the scientific basis of the nation's climate change response and rebutting misinformation on global warning.

Provision of research grants prioritize the development of platform technologies in four key areas, which are:

(1) improvement of the national GHG inventory system;
(2) integrated assessment of emissions control costs and their benefits;
(3) climate change impact and vulnerability assessment; and
(4) climate change adaptation management.

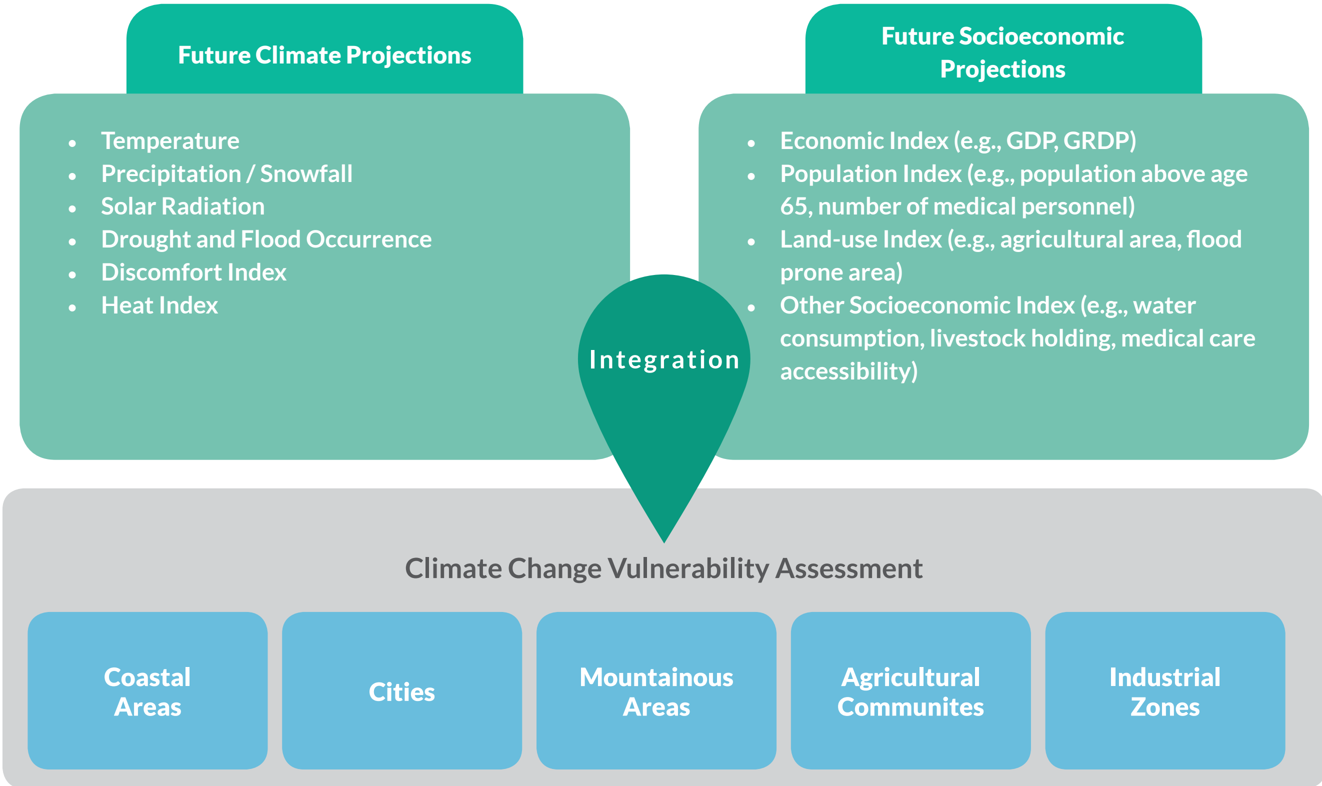
A total of 83.5 trillion KRW has been allocated over an eight-year period (2013-2020).

Example Project: Development of integrated climate change vulnerability assessment framework considering socio-economic scenarios

Climate change adaptation is a comprehensive process of preparing for and adjusting proactively to the impacts of climate change. The ROK is projected to experience greater fluctuations in temperature and precipitation as a result of the changing climate, underscoring the need for reducing the nation's levels of exposure to climate-induced risks and for improving adaption capacities. According to the Framework Act on Low Carbon, Green Growth, relevant government ministries are to jointly establish a mid-term "National Climate Change Adaptation Plan." The plan for 2011-2015 has stressed the importance of conducting sectoral climate change vulnerability assessments, which prioritizes measures that can help improve the adaptive capacities of local governments, businesses, local communities, and individuals.

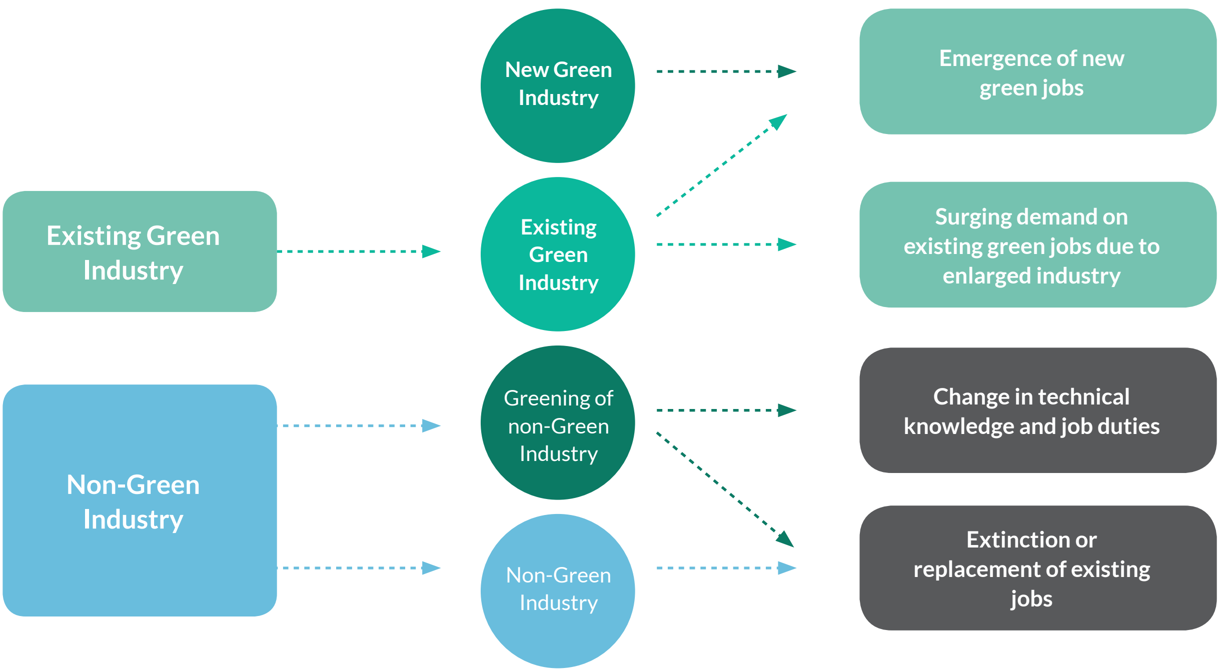
The objective of this research project is to develop an integrated vulnerability assessment framework that considers future socio-economic scenarios in addition to future climate projections. The development of this new framework is based on the notion that socio-economic scenarios such as changes in the nation's GDP, population, and industrial structure are vital factors that determine future vulnerability. Thus, it is essential that identical sets of socio-economic variables are taken into account in vulnerability assessments of different sectors. The project also plans to pilot test the new framework in selected areas (e.g., city, agricultural land, industrial areas, coastal areas, and mountainous areas).

Figure 12: Vulnerability assessment framework



Source: KEI, 2015

Figure 13: Impact of greening of industries on the job market



Source: Joint Work of Relevant Ministries, 2009

Fostering of Energy Talents Program (Ministry of Trade, Industry and Energy, MOTIE)

The program aims to meet the rising demand for qualified talents in utilizing clean energy technologies and alternative practices, by means of establishing undergraduate and graduate curriculums that specialize in energy. A unique feature is that these curriculums are to be fully led by the private sector; industrial leaders will ensure that the selection of project recipients meets the actual demand for skill sets in the market, contribute to curriculum design process, participate as lecturers of curriculum courses, and help the talents secure jobs upon graduation.

Support toward nurturing highly qualified specialists in specific fields of the energy sector also takes the form of large-scale grants directed to research laboratories of graduate schools. Entitled the "Green Energy Technology-Future (GET-Future) laboratory," these research teams focus on fostering of talents that align to the demand as identified by the national energy strategies and R&D plans. The research grants awarded cover expenses for opening of lectures, developing course materials, conducting field training, opening scholarships, payrolls for researchers, and carrying out applied research. The total budget allocated to the program was 295 billion KRW (2001-2012) for four priority fields of the energy sector, namely energy efficiency (27.4%); renewable energy (24.6%); electricity (41.6%); and nuclear energy (6.4%).

Table 8: Areas of ministerial support in development of eco-friendly technologies

Area	University and Program Title	Participating Firms and Institutions
Energy Efficiency Improvement	Zero Energy Building Technology Program (Konju National University)	Korea Energy Management Corporation, Korea Institute of Energy Research, Samsung C&T
	ICT Convergence Zero Energy House Program (Hannam University)	OCT Acomm, TOP Architects & Associates
	Eco-friendly Power Apparatus Program (Dongguk University)	Korea Electrical Manufacturers Association, Dongwoo Electric Corp.
	High Efficient Energy Nano Material Process Program (Sogang University)	Dongwoo Fine-Chem, Hyundai Oilbank
	GHG Reduction, Green Production Technology Program (Soongsil University)	LG Display, Daejoo Electronic Materials
	GHG Reduction Technology Program (Chosun University)	Hanyoung ENG, Korea Institute of Industrial Technology
Renewable Energy	PV Energy Generation Platform Technology (Dankook University)	Hyundai Heavy Industries, Shinsung Holdings
	Wind Turbine and Floating Structure Program (Chonbuk National University)	Korea Institute of Energy Research, Korea Institute of Machinery and Materials
	Ocean NRE Infra-system (Korea Advanced Institute of Science and Technology/ KAIST)	Hyundai Heavy Industries, Khan
	Fuel Cell Material and System Program (Chonbuk National University)	Fuel Cell Power, Sebang Blobal Battery
Electricity	Program of Power Electronics and ICT Convergence Technology for Smart Grid (Myongji University)	LSIS, Hyosung
	Flexible Power Grid Technology Program (Korea University)	Hyosung, LSIS, LS Cable & System
	Smart Distribution System Program (Hankyong National University)	Hyundai Heavy Industries, LG Electronics, POSCO

Source: MKE, 2011

Example Project: GET-Future Laboratory for Advanced Lithium-ion Batteries (Hanyang University)

Since the commercialization of lithium-ion batteries which was merely 20 years ago, there has been little technological progress in terms of improving its lifespan and performance. This limitation has created a critical bottleneck to expanding the use of electric vehicles; despite the attractive features of reduced pollution, noise, and fuel costs, electric vehicles travel only up to 150-200 km on a single charge. Accordingly, the GET-Future laboratory of Hanyang University engaged in a project to develop lithium-air batteries for powering electric vehicles. Lithium–air batteries have very high energy storage capacities (i.e., 10 times higher than conventional lithium-ion batteries) but their application has been hampered by the restricted number of charge–discharge cycles. In 2012, the GET-Future laboratory successfully identified a stable electrolyte that allows lithium–air batteries to operate at multiple cycles, bringing the technology a step closer to becoming viable. Upon commercialization, lithium-air batteries are expected to give electric cars a range of up to 800 km on a single charge.

4. Assessment

4.1 Quantitative Assessment

In response to the technology innovation agenda under the Five-Year National Plan for Green Growth and the National Green Technology R&D Master Plan, government investments in green technology R&D activities increased steadily, reaching 3.04 trillion KRW (approximately US$ 2.8 billion) in 2013.

- This figure accounts for about 17.9% of the total national R&D budget of 16.9 trillion KRW won (approximately US$ 15.4 billion).

- Average annual growth rate in green technology R&D expenditures was 15.8% during 2008-2013, which surpasses that for the total national R&D expenditure that stood at 9.0% over the same period.

- As of 2013, R&D investments in 27 key green technologies was estimated at 2.31 trillion KRW (approximately US$ 2.1 billion), accounting for 76.2% of 3.04 trillion KRW investment in green technologies.

- The average annual growth rate of the investments in 27 key green technologies during 2008-2012 was recorded at 17.1%.

Such outcomes in terms of government R&D expenditure demonstrate how the "principle of selection and concentration" has once again led the nation's technology innovation agenda. The government has fulfilled its targets to double its investment in green technology, from 1.4 trillion KRW in 2008 to 3.04 trillion KRW in 2013 (note that these numbers do not strictly coincide with the planned budgets given in Section 3.1).The number of R&D project engagements relevant to green technology also increased in a similar proportion over the same period, from approximately 4,000 to 8,000.

Understanding that the stages which R&D, as of 2012, are generally divided into are basic research; applied research and experimental development; and analysis of expenditures, reveals that about half of the government investment in green technology was allocated to experimental development, accounting for about 48.6% or 1.32 trillion KRW (US$ 1.2 billion). Basic and applied research were accountable for 22.3% and 19.6% of the total expenditures, respectively. These figures illustrate how the ROK has continued to place the focus on technology commercialization rather than nurturing knowledge-based assets through basic research; the 35% target for basic research by 2012 was not even met. However, it is important to recognize that the growth in the absolute amount during 2008-2012 was found to be most significant in basic research (187%), which far exceeds that of both applied research (29.4%) and experimental development (59.4%). This outcome is a reflection of the strategic agenda on "increasing the volume of basic research" as laid out by the National Green Technology R&D Master Plan.

A breakdown of investments by different ministries as of 2012 shows that the Ministry of Knowledge Economy (now the Ministry of Trade, Industry and Energy) topped the list with 1.27 trillion KRW (approximately US$ 1.2 billion), accounting for 46.9%. This was followed by the Ministry of Education and Science Technology with 0.5 trillion KRW (18.6%) and the Ministry of Land, Transport and Maritime Affairs with 0.3 trillion KRW (11.0%). Such outcomes illustrate how the Ministry of Knowledge Economy (MKE) played a pivotal role in supporting green technology R&D among various government ministries; the Ministry was principally in charge of promoting basic research in the fields of energy and industrial process, as well as accelerating technology commercialization to foster the nation's new growth engines (e.g., secondary cells, LED lights, green cars, renewable energy). However, in terms of absolute growth in the volume of investment during 2008-2012, the Small and Medium Business Administration (SMBA) and the Rural Development Administration (RDA) recorded the highest growth rates of 308% and 424%, respectively. SMBA focused its efforts on enhancing the environmental performance of industrial processes by SMEs, and supporting the technology and knowledge-based start-ups. RDA's research areas of focus were climate-resilient agricultural production and energy efficiency of the agricultural sector.

Analysis of R&D investments in green technology by recipient types as of 2012 reveals that GRIs received the largest portion, equivalent to 827.6 billion KRW, which accounts for 30.5% of the total investment. Research laboratories of universities, large corporations, and SMEs followed to take on shares of 19.3%, 18.5%, and 18.8%, respectively. In terms of the growth in absolute volume of investment, universities and SMEs have received a frontal support; their growth rates reached 127% and 107% during 2008-2012, respectively. The volume of investments into GRIs and large corporations peaked in 2011 before experiencing a 3-5% decrease in 2012.

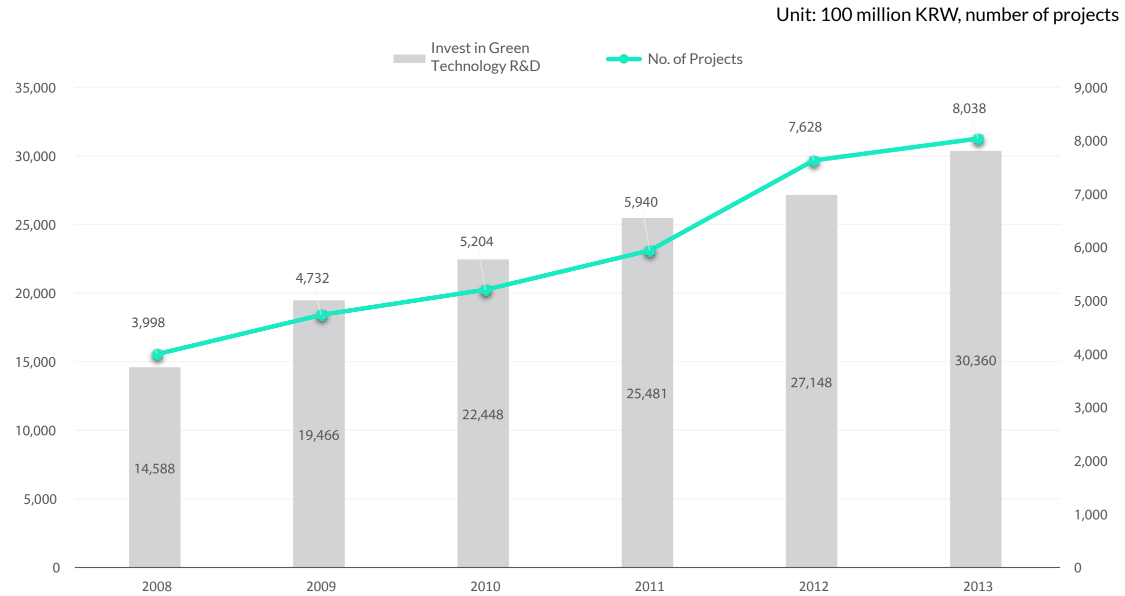
The ROK's endeavors to place green technology at the center of the nation's green growth strategy is

Figure 14: Investment in national R&D projects relevant to green technologies

Source: GTC-K, 2013

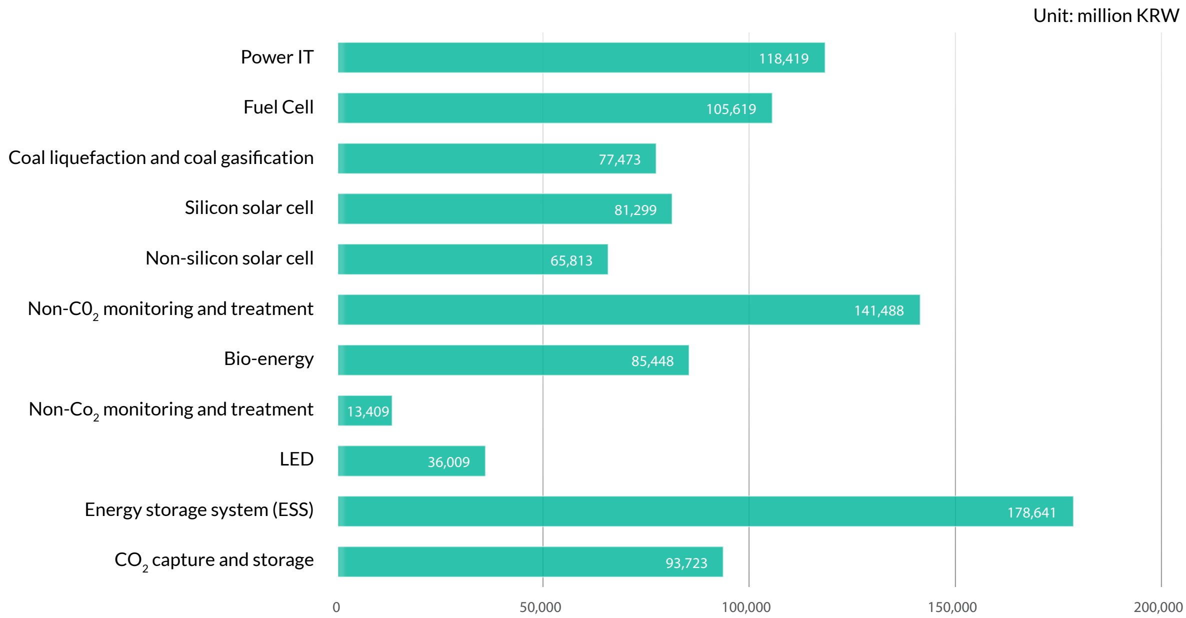
to be given much credit; the PCGG was successful in providing clear signals on the need for technological innovation to achieve a green growth transition, while coordinating with different ministries to boost their R&D activities in green technologies. These efforts paid off in terms of narrowing the nation's technological gap with the global leaders and increasing the volume of foreign exports. According to the assessment by KISTEP, the ROK's technological levels relative to the world's leaders in 27 key green technology areas range between 63.5%-90.1% as of 2011 (average at 77.7%). In turn, this means that the ROK is approximately 4.1 years behind globally leading the advancement of green technologies. As compared to the year 2009 when the nation had only identified one technology area where their competitiveness exceeded 80% of the global leaders, five different areas were identified as of 2011, which include Si-based solar cells, advanced light water reactors (nuclear energy), LED lights, carbon capture and storage, and smart-grid systems.

Figure 15: Public investment in green technology by years



Source: GTC-K, 2013

Figure 16: Public investment in green technology by areas in 2013



Source: GTC-K, 2013

Table 9: Trends in green technology investment by R&D types

Unit: 100 million KRW

Research Type	Basic Research	Applied Research	Experimental Development	Others
2008	2,202 (15.1)	4,118 (28.2)	7,854 (53.8)	414 (2.8)
2009	3,792 (19.5)	3,606 (18.5)	10,426 (53.6)	1,643 (8.4)
2010	5,557 (24.8)	4,070 (18.1)	11,552 (51.5)	1,268 (5.7)
2011	5,433 (21.3)	4,786 (18.8)	12,895 (50.6)	2,386 (9.3)
2012	6,318 (23.3)	5,330 (19.6)	13,192 (48.6)	2,307 (8.5)
2013	8,027 (26.4)	5,992 (19.7)	14,320 (47.2)	2,022 (6.7)

Source: GTC-K, 2013

Table 10: Trends in green technology investment by different ministries

Unit: 100 million KRW

	2008		2009		2010		2011		2012	
	Amount	Share	Amount	Share	Amount	Share	Amount	Share	Amount	Share
Ministry of Knowledge Economy	7,003	48	9,343	48	11,303	50.4	12,572	49.3	12,721	46.9
Ministry of Education, Science and Technology	3,666	25.1	4,307	22.1	4,520	20.1	5,342	21	5,041	18.6
Ministry of Land, Transport and Maritime Affairs	1,811	12.4	2,584	13.3	2,746	12.2	2,592	10.2	2,998	11
Ministry of Environment	1,129	7.7	1,415	7.3	1,500	6.7	1,189	4.7	1,509	5.6
Small and Medium Business Administration	498	3.4	865	4.4	912	4.1	1,320	5.2	2,031	7.5
Rural Development Administration	108	0.7	333	1.7	622	2.8	582	2.3	566	2.1
Others	373	2.7	619	3.2	845	3.7	1,884	7.3	2,282	8.4
Total	14,588	100	19,466	100	22,448	100	25,481	100	27,148	100

Source: GTC-K, 2013

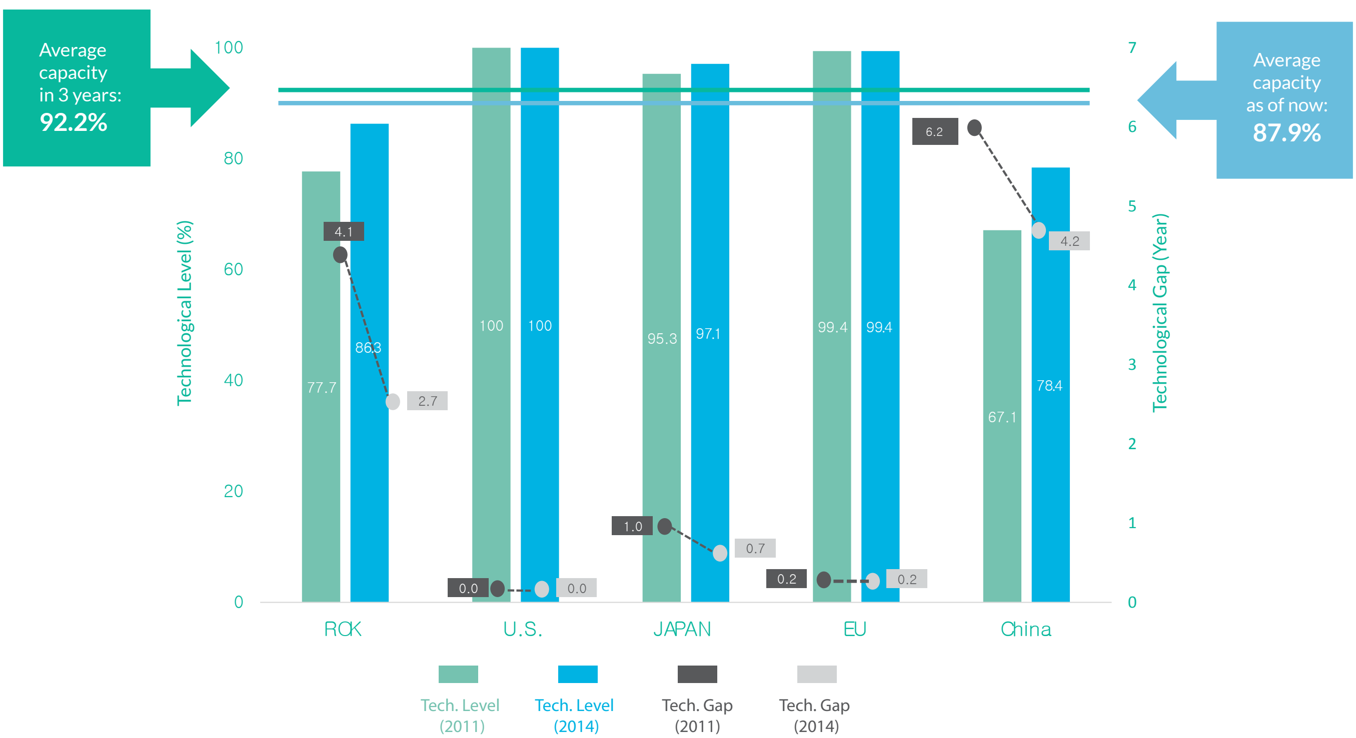
Table 11: Trends in green technology investment by recipient types

Unit: 100 million KRW

	2008		2009		2010		2011		2012	
	Amount	Share	Amount	Share	Amount	Share	Amount	Share	Amount	Share
National/ Public Research Institutes	385	2.6	751	3.9	1,057	4.7	1,048	4.1	1,065	3.9
Gov-funded Research Institutes	5,539	38	6,953	35.7	8,427	37.5	8,571	33.6	8,276	30.5
Universities	2,306	15.8	3,195	16.4	3,430	15.3	4,811	18.9	5,243	19.3
Large Conglomerates	2,984	20.5	3,814	19.6	4,647	20.7	5,256	20.6	5,014	18.5
SMEs	2,458	16.9	3,634	18.7	3,739	16.7	4,346	17.1	5,099	18.8
Government Ministries	34	0.2	88	0.5	51	0.2	66	0.3	4	0.01
Others	883	6.1	1,031	5.3	1,098	4.9	1,383	5.4	2,448	9
Total	14,588	100	19,466	100	22,448	100	25,481	100	27,143	100

Source: GTC-K, 2013

Figure 17: Comparison of current and future technological gaps with the global leaders



Source: Hong, 2011

Outcomes of technological advancement were found to be most prominent in the fields of secondary cells and LED lights. For example, the lithium-ion battery market is an area where domination by Japanese companies continued for over 20 years, after Sony was the first to successfully commercialize the technology in 1991. As of 2013, the ROK took over the greatest share of the global market at 36%. Leading manufacturers of the ROK including LG Chemicals and Samsung SDI are now key players in the market, and have recently been successful in securing contracts with global auto-makers manufacturing electric vehicles. Recognizing how lithium-ion batteries dominate the most recent group of electric vehicles in development, the ROK is well-placed to benefit from the explosive growth in demand.

In the case of LED lights, which are often described as one of the most exciting technological advancements in the lighting industry owing to their extremely high energy-efficiency and long durability, the ROK belatedly joined the league of source technology developers along with Japan and Germany. The government's intensive investments in R&D have helped narrow the nation's technological competitiveness to 85% of the level of the global leaders. Technological advancement was also supported by government's expansion of ESCO projects and policy incentives directed toward energy-saving buildings, which contributed to creating a significant domestic market for LED lights. The LED lighting industry's volume of foreign exports increased from 1.4 trillion KRW in 2009 to 5.6 trillion KRW in 2012.

However, such positive outcomes were not equally present in all of the key green technology areas. Most importantly, the renewable energy industry which was an area where the government was confident in seeing a sharp increase in production, was only successful in narrowing the technological gaps (to 85% of the global leaders). The ROK's total production capacity of solar cells and PV modules is still smaller than that of the largest Chinese manufacturer "Yingli"; this is attributed to the low price competitiveness, which is estimated to fall 20%-30% behind China.

The key limitation to government's endeavors was the failure in scaling-up the domestic market volume of renewable energy goods which is to provide the foundations for entering the international market. The importance of stable domestic markets to the export performance cannot be overemphasized; they provide a springboard for growth of exports and cushion to absorb the risks prevalent in the export markets.

The government's role in terms of promoting the growth of domestic renewable energy market has been rather limited. Although legal and institutional frameworks for boosting the renewable energy use have been strengthened, the ROK's share of renewable energy in total final energy consumption stood at 3.17% as of 2012. This figure is significantly lower than Japan and the UK that share similar climatic and geographical conditions. Domestic markets that have failed to achieve an economy of scale were unable to provide sufficient opportunities for renewable energy industries to pilot test the performance of their goods for export. Recovery of the global renewable energy market in the future is unlikely to have any immediate effect on the export figures of the ROK.

4.2 Qualitative Assessment

The ROK's emphasis on R&D has long been the main driver bolstering the nation's global competitiveness. The OECD has recently highlighted through the "Science Technology and Industry Outlook 2014" that the ROK was the world's most R&D-intensive country in 2012. The Asian Development Bank has also reported that the ROK comes in second place among 22 Asian economies in terms of the Creative Productivity Index (CPI), which is a measure of the progress in fostering creativity and innovation by taking into account inputs into outputs such as patents per capita, published scientific papers and export sophistication. Shared understanding on the needs for R&D activities from the public and private sector lifts off from the notion that anything on the global market will eventually be manufactured in emerging economies including China at lower costs; the only way for the ROK to stay ahead is to continue improving the quality and technological edge of their products.

The government's budgetary spending to foster green technology innovation was most meaningful in that it helped kick-start a vicious cycle of environmental protection and economic growth. For example, technological innovation of the LED industry – which is primarily led by SMEs in the ROK – has helped accelerate the use of LED lights for saving electricity in a large number of public facilities, including government buildings, hospitals and universities nationwide. Although the share of LED light bulbs has been recently reported as falling far behind from being on track to meet the government's set target of 60% by 2060, facilities such as the office buildings of the Ulsan City Government (81% as of 2013), and University of Seoul (92% as of 2014) have made significant progress. Incheon International Airport announced in 2014 that its investment in LED lighting since 2009 has led to a 18,831MWh reduction in electricity consumption, equivalent to 8,832 tCO_2 eq. reduction in emissions. Such outcomes along with the expansion in the volume of exports have raised the total revenues of SMEs in LED industry from 0.23 trillion KRW in 2007 to 2.99 trillion KRW in 2012. The total number of employees engaged in manufacturing LED lights in the ROK increased from approximately 4,750 to 19,900 over the same period.

Not often are the outcomes of R&D investments achieved in the short term, as seen through the example of the LED industry. Therefore, the effectiveness of the ROK's spending in green technology innovation needs to be evaluated from a long-term perspective. However, several limitations can be identified in the context of the directions taken by government strategies and actions. First, it must be noted that parts of the government strategies have embarked on anticipations on technology commercialization that have proven to be unrealistic and idealistic. For example, the PCGG has acknowledged in 2012 that several key green technologies are unlikely to create significant markets even in the long-term (environmentally friendly nuclear nonproliferation and fast reactor cores) or have significant commercial benefits (climate change prediction and modeling).

Changing trends in market creation and technological innovation has also made evident that the 27 key green technologies have failed to include some technology areas with greater potential, including wind energy. Such findings demonstrate the need for governments to carefully understand the risks involved in innovation planning, as well as the need for making periodic monitoring and adjustments for strategies to adapt to the changing market trends.

One may question whether the ROK's investments in green technology actually followed the principles of "selection and concentration," considering the breadth of technology portfolio which covered 27 key green technology (and the 75 green technology) areas. Given the size of the ROK's domestic market, financial resources made available and research capacities in successfully bringing about technological innovation, it is fair to point out that government has been perhaps overly ambitious in its attempts to become a "global leader." Denmark, which is a nation that concentrated its efforts in fostering wind energy technologies from the 1980s and became the only net exporter of oil and gas in the EU is a good example of success. Acknowledging that denser activity facilitates greater specialization and there are high possibilities for technological spillovers from one R&D sector to another, the government must seek to further prioritize its efforts in the future.

Although a significant portion of the government's budget was channeled to promote the R&D activities of SMEs, large corporations with sufficient funds to finance technology innovation have also benefited from the green technology agenda. The government must understand that unlike the 1970s-1990s when there was a clear need for fostering a selected number of corporations to lead the nation's strategic industries, the private sector of the ROK is now responsible for more than 70% of the nation's expenditures on R&D activities. Such circumstances open windows of opportunities for the government to use its public funds to promote technological innovation of high-risk and long-term commitment, and R&D efforts that can bring about shared public benefits and resolve market imperfections. Especially in the field of basic and applied research, there is a clear need for the government's interventions to support creative ideas that are likely to bring about groundbreaking innovations. Success in such engagements can only be made possible when the actors of research and technology work in a culture where failure is reasonably tolerated.

It is without doubt that the ROK government's selection of 27 key green technologies has primarily focused on creation of the nation's new growth engines. Technologies that have greater relevance in regard to improving environmental sustainability for resolving issues that are closely related to social well-being (e.g., food-waste management) have not been well accounted for despite increasing public interest and demand. Innovation in such areas of technologies have high potential to generate immediate and lasting impacts, given how technology has become such an important facet of our lives. Such limitation in the ROK's strategic priorities dwells on the fact that assessments and surveys that have led to the selection of key green technologies have mainly targeted the manufacturing sector. Portfolios of technologies for R&D investment under the green growth agenda must seek to find a better balance between environmental protection and economic growth as underlined by the concept of green growth.

5. Takeaways and Recommendations

Despite some of the limitations in the ROK's endeavors under the green technology agenda, the nation's experience provides several valuable lessons for emerging countries. First, it is important to recognize that technology innovation has been a critical element to the national economic development plan in the ROK from its earliest stages of economic growth. The government thus has played multiple roles, as a provider of direction (i.e., setting of priority technology areas), target setter (i.e., national strategies and action plans), and as a financier (i.e., government spending on R&D). Such government intervention is most effective during the early stages of a nation's industrial development as the scale and complexity of the required interventions grow exponentially with the deepening of industrial structures. Notwithstanding its weaknesses, the ROK's administration and governance has been key to success in this process. For example, the NSTC's first move in response to the nation's green growth agenda was the creation of the Green Technology Center (GTC). This council formulated year-by-year R&D investment plans and coordinated with relevant ministries to minimize the overlapping of efforts in technology areas, which were periodically reported to the PCGG. Under well-defined targets and priorities, the Ministries were ready to lead innovation actions by capitalizing on GRIs under their supervision and inviting private sector actors within their authorities to take part in R&D activities.

The ROK government allocated a large portion of its investments to green technology under the premise that green industries will unlock new global markets. The key driver of motivation to innovation actors in the ROK has been competition in the international market, which exerts an enormous amount of pressure for technological learning and development. As a country that owns no natural resources for international trade and just competitive human resources, developing technological competence was not an option but a necessity. Developing countries that do not share such given circumstances may look away from the needs for replicating the ROK's model, but it is important to understand that competition can become a critical driver for technology innovation under any given circumstances. Although the relationship between competition and innovation is complex, it is true that innovation is the distinguishing trait of many of the world's leading competitors. Industries that rely heavily on closed markets are more likely to grow immune against pressure for technological innovation.

The main elements to technology innovation are people, knowledge, and money. Nurturing talents and fostering the required manpower for R&D activities has always been at the center of the ROK's innovation strategies. It is true that the ROK's success from taking such a strategic direction owes much to the nation's tradition that accords the highest respect to education and scholarships. In order to foster top-class scientists and engineers, the government implemented policy reforms during the late 1990s that aimed to create "research-focused universities," breaking away from supporting solely teaching-oriented environments. A greater portion of public R&D funds were thus allocated to the research laboratories of universities, and government's evaluation of university education placed emphasis on the volume of research outputs (e.g., academic journals, patents, technology certifications) and the number of their citations. Under the green technology agenda, government once again designated universities to become centers of excellence that participate in cooperative R&D activities between academia and industries. Heightened research capacities of universities helped industrial partners maneuver through an increasingly competitive commercial environment, while the industrial partners provided an opportunity for universities to apply their knowledge in the field as well as foster doctorate and postgraduate students with skills of high demand from industries.

The need to put into practice the principles of "selection and concentration" cannot be overstated, especially for developing countries that seek to develop and harness homegrown technologies. Amid a challenging budgetary environment, developing countries should seek to concentrate their public expenditures on areas that offer comparative advantage. The ROK's strategies on green technologies have demonstrated methods of how investment prioritization can take place; the process involved understanding of the nation's current technological competitiveness, taking note of market demand, projections on technology commercialization and market creation, and grouping of technologies according to their investment needs timeframe.

References

ABC (Advanced Biomass R&D Center). 2014. "Website of Advanced Biomass R&D Center." Accessed May 3, 2015. http://abc.biomass.re.kr/.

Cho, Hyun-dae. 2000. "Analysis on Difference between Developed Country and Less-Developed Country's Government: R&D Activism and R&D System." STEPI Research Report, Science and Technology Policy Institute, Seoul.

Energy Use Rationalization Act. 2014. Republic of Korea Statutes Act No. 12298.

Enforcement Decree for the Framework Act on Low-Carbon Green Growth. 2010. Republic of Korea Statutes Presidential Decree No. 25456.

Framework Act on Low-Carbon Green Growth. 2010. Republic of Korea Statutes Act No. 11965.

GGGI (Global Green Growth Institute). 2015. *A Guide to Innovation System Analysis for Green Growth*.

GTC-K (Green Technology Center of Korea). 2013. *Green Technology in-depth Analysis 2013*. Seoul: Green Technology Center of Korea. Accessed May 3, 2015. http://www.greenplatform.re.kr/frt/greensys/gtcbookMenu01.earchCountry=&searchOrgan=&searchCredt=.

Hong, mi-young, Kee-ha Hwang, Jung-suck Hong, and Kyung-jae Lee. 2011. "Emphasis on Green Technology Level Status and Implications." KISTEP Issue Paper 2011-18, Korea Institute of Science and Technology Evaluation and Planning, Seoul. Accessed May 3, 2015. http://db.foresight.kr/sub03/research/filedown/id/405/field/file_saved_name/rfile/008469da2226fc4ce8b70f22eded974e.

Hyundai Motors. 2015. "Website of Hyundai Motors." Accessed May 3, 2015. www.hyundai.com.

Joint Work of Relevant Ministries. 2009. "Measures for the Creation of Green Jobs and Fostering of Green Technology Talents." Accessed May 3, 2015. http://greenplatform.re.kr/com/file/fileDown.EFA1?fileId=FILE000000000000215&fileSn=0.

Joint Work of Relevant Ministries. 2012. *The Second Five-Year Plan for Green Growth (2014-2018)*. Accessed April 17, 2015. http://www.greengrowth.go.kr/?page_id=2452.

KEI (Korea Environment Institute). 2015. "Website of Korea Environment Institute." Accessed May 3, 2015. www.keei.re.kr.

Kim, Lin-soo. 1997. *Imitation to Innovation:* The Dynamics of Korea's Technological Learning. Boston: Harvard Business Review Press.

Korea Woodpellet Corporation. 2015. "Website of Korea Woodpellet Corporation." Accessed May 3, 2015. www.koreapellet.org.

Lee, Il-hwan, and Sang-ki Jung. 2009. "Policy Plannig on Green Technology R&D Comprehensive Plan." KISTEP Issue Paper 2009-13, Korea Institute of Science and Technology Evaluation and Planning, Seoul. Accessed May 3, 2015. http://www.kistep.re.kr/getFileDown.jsp?fileIdx=2461&contentIdx=1287&tbIdx=BRD_BOARD.

Makower, Joel, Ron Pernick, and Clint Wilder. 2009. *Clean Energy Trends 2009*. San Francisco Bay Area: Clean Edge, Inc.

MKE (Ministry of Knowledge Economy). 2011. "334 Businesses & Institutes Participated in the Project of Fostering Green Technology Talents". Paper presented at the press call, Seoul.

Multienergy (Global Frontier Center for Mutiscale Energy Systems). 2014. "Website of Global Frontier Center for Mutiscale Energy Systems." Accessed May 3, 2015. http://multienergy.re.kr/english/.

NSTC (National Science and Technology Council). 2009. "Green Technology R&D Comprehensive Plan." Agenda presented at the 29th National Science and Technology Council The 3rd Presidential Council for Future & Vision, Seoul, January 13.

OECD. 2006. OECD *National Accounts Statistics*. OECD iLibrary. Accessed April 27, 2015. http://www.oecd-ilibrary.org/economics/data/oecd-national-accounts-statistics_na-data-en.

Park, Chan-ho, and Bum-seok Kim. 2013. "A Study on Integrating Strategy of Low-carbon Urban Planning System." *Korea Special Information Society* 21(2):99-106.

PCGG (Presidential Committee on Green Growth). 2009a. *National Strategy for Green Growth (2009-2050).* Accessed April 17, 2015. http://www.greengrowth.go.kr/?page_id=2450.

PCGG (Presidential Committee on Green Growth). 2009b. *The Five-Year Action Plan for Green Growth (2009-2013).* Accessed April 17, 2015. http://www.greengrowth.go.kr/?page_id=2452.

PCGG (Presidential Committee on Green Growth). 2009c. "Green Technology Development and Commericialization Strategies." Accessed April 17, 2015. http://www.greenplatform.re.kr/com/file/fileDown.fileId=FILE000000000000193&fileSn=0.

Prime Minister's Office, Ministry of Strategy and Finance, Ministry of Education, Science and Technology, Ministry of Foreign Affairs, Ministry of Knowledge Economy, Ministry of Environment, Ministry of Land, Infrastructure, and Transport. 2008. *The First National Energy Basic Plan (2008-2030).* Accessed April 17, 2015. http://energyjustice.kr/zbxe/48310.

Global Green Growth Institute

Korea's Green Growth Experience: Process, Outcomes and Lessons Learned

Chapter 5: Green Lifestyle

CHAPTER 5

GREEN LIFESTYLE

Summary

Promoting green lifestyle presents vast opportunities for green growth in the ROK given the high volume of emissions from the non-industrial sector and its relatively minimal mitigation cost. However, this demands behavioral change across the whole society, an enormous challenge for the ROK whose rapid economic growth has transformed the once frugal culture of consumption to a lifestyle of abundance and waste. From 2009-2013, the ROK has made significant progress in greening the consumption patterns by implementing a right combination of binding and incentivizing policies such as green public procurement, green business certification program, carbon labeling, carbon point system, waste management schemes, and a range of green education and awareness programs. The ROK strategically utilized both top-down and bottom-up approaches by launching a nationwide campaign for emissions reduction and a national strategy for promoting green life practices while forming local green growth committees in various local government units. Despite the society's high level of awareness of climate change and environmental sustainability, the ROK has not seen more proactive efforts from the public to shift to a greener lifestyle and this is unlikely to happen overnight since instilling a paradigm shift in favor of green living would require sustained communication strategies and longer time horizon.

1. Introduction

1.1 Overview

Along with the greening of industrial activities and the development of green technologies, realizing a green lifestyle is an important agenda for green growth. Green lifestyle is a way of life that recognizes the seriousness of environmental degradation and impacts of climate change, thus leading to an integrated set of practices and habits that utilize resources in an eco-friendly and sustainable manner. Green lifestyle is also in line with the principles of "Sustainable Consumption and Production" based on the Environmentally Sound and Sustainable Development (ESSD) model.

The promotion of a green lifestyle is being emphasized in the ROK not only because the volume of GHG emissions from the non-industrial sector (e.g., households and public transportation) accounts for over 40% of the nation's total emissions, but also because the marginal cost of mitigation activities in this area is often substantially lower than that of the industrial sector. Furthermore, there are many benefits to be gained by greening people's daily activities, which can have an immediate and sustained impact on GHG concentrations. Acknowledging that all members of society have a role to play in climate change mitigation, the ROK's green growth policies aim to place the general public at the forefront of green actions, and emphasize that society needs to consume sustainably. These policies are also intended to influence producers to commit to cleaner and greener production.

An aspect of the ROK's concept of low-carbon green growth that is often scrutinized is how it focuses primarily on reduction of GHG emissions and economic growth, with less consideration given to social sustainability. In addition, many of Korea's green growth actions follow a top-down approach and focus on market-driven processes, while elements such as democratic governance and civil society participation are often overlooked. In other words, as opposed to the model of sustainable development that underscores the collaborative efforts of all sectors of society, the ROK's concept

The responsibilities and duties of the general public in pursuing green growth as articulated in the Framework Act on Low Carbon Green Growth (2010):

- Actively practice green lifestyle at home, at school, and in the workplace
- Take interest in the greening of corporate management practices and promoting the consumption of green products and services
- Recognize that all citizens are ultimately the solutions providers for overcoming climate change and the energy/natural resource crisis

of increasing GHG emissions in the ROK. As of 2011, the total volume of GHG emissions in the ROK, excluding land use, land-use change, and forestry (or LULUCF), amounted to 697.7 million tons of CO_2 equivalent, increasing by approximately 141.9% from the 1990 levels (GIR, 2014). The nation's GHG inventory comprises five different sectors (energy, industrial process, agriculture, LULUCF, and wastes), among which the energy sector emits the largest volume (597.9 tons CO_2-eq). A closer look at the emissions from the energy sector reveals that fuel combustion from energy industries[2] (44.7%), and manufacturing/construction (31%) account for a large portion of the emissions. Transportation (14.4%) and other economic activities (9.9% for households, commercial businesses, public sector, agriculture, and fishery) are responsible for approximately 24.3% of emissions by the energy sector (GIR, 2014).

It is true that the various sectors' shares in the nation's total emissions have experienced a gradual decrease over the past two decades, largely due to the changing patterns of consumption that replaced the use of petroleum and coal to more convenient forms of energy such as electricity and gas (GIR, 2014). However, it should be noted that the non-industrial sector is also responsible for a fairly large portion of the nation's total emissions. As the structure of the national GHG inventory makes it difficult to understand emissions from non-industrial processes, the ROK's emissions projections have been re-categorized into six different areas in Table 2: emissions from industry; transportation; buildings; public sector; LULUCF; and waste management. Projections show that although the share of the non-industrial sector is likely to decrease in the future, its absolute volume will continue to increase. Recognizing how the non-industrial sector is responsible for over 40% of the nation's total emissions, mitigation actions have a key role to play in meeting the total emissions reduction targets.

An analysis of energy use from the perspective of consumption behavior shows how the ROK has experienced significant lifestyle changes in the course of economic development. Energy consumption in households and commercial businesses has rapidly transitioned from the use of petroleum and coal to the use of electricity and gas. While the amount of coal consumption – which was the primary source of energy in the past – decreased from 9 million TOE in 1990 to 0.94 million TOE in 2009, natural gas consumption increased substantially from 2.4 million TOE in 1990 to 14.6 million TOE in 2012. What is most remarkable is how electricity consumption increased five-fold over the past two decades, from 0.656 MWh/person in 1990 to 3.481 MWh/person in 2009. Such rate of increase in consumption is approximately 3.2 times higher than the rate of increase in the total energy consumption of households over the same period.

- **Transportation:** The number of registered cars in the ROK increased by about 6.6 times, from 1.9 million in 1990 to 12.6 million in 2009. Accordingly, the consumption of gasoline and diesel fuel during this period increased by 2.8 times and 1.9 times, respectively. While it is true that such increase of energy consumption in the transportation sector was not as significant as that of the energy sector during the period – which is a result of government efforts to promote the use of public transportation (subway and bus) –

1 | Following the introduction of "low-carbon green growth" as the nation's new vision in 2008, changes were made to the nation's framework on ESSD. The contents of the "Sustainable Development Act" were transferred to the new "Framework Act on Low Carbon Green Growth." With the establishment of the Presidential Committee on Green Growth, the Presidential Commission on Sustainable Development (PCSD) was downgraded to ministerial level (Ministry of Environment). Such actions have raised questions on whether the concept of "low-carbon green growth" is able to capture the essential components of sustainable development.

2 | Energy industries represent processes relevant to the production and sale of energy (e.g., electricity and heat).

Table 1: Past GHG emissions in the energy sector

Category		1990	2000	2005	2010	2011
Energy	Amount of Emissions (million tons CO_2)	47.8	134.9	177.2	256.1	264.1
	Share (%)	20.3	33.2	38,4	45.6	44.7
Manufacturing and Construction	Amount of Emissions (million tons CO_2)	76.5	129.8	134.9	161.3	182.7
	Share (%)	32.5	31.9	29.2	28.7	31.0
Transportation	Amount of Emissions (million tons CO_2)	34.8	68.6	80.4	85.4	85.0
	Proportion (%)	14.8	16.9	17.4	15.2	14.4
Others	Amount of Emissions (million tons CO_2)	76.5	73.3	69.5	59.0	58.4
	Share (%)	32.5	18.0	15.1	10.5	9.9
Total Emissions by the Energy Sector	Amount of Emissions (million tons CO_2)	235.6	406.6	462.1	561.7	590.2
	Share (%)	79.7	79.5	81.1	84.1	84.6
Total Amount of Emissions		295.7	511.3	569.5	667.8	697.7

Note: "Others" include commercial businesses, public sector, households, agriculture, and fishery .

Source: GIR, 2014

there is still high potential for reducing energy demand. The GHG emissions from privately owned automobiles currently accounts for a large portion of total emissions from land transport, indicating the need for government policies to further promote modal shift.

- **Building:** In 2010, the building sector was responsible for approximately 20% of the total consumption of energy nationwide, among which the proportion of the energy consumption in residential buildings, commercial buildings, and public buildings accounted for 53%, 37%, and 10%, respectively. During the 1990-2005 period, the average annual rate of increase in the energy consumption for this sector was 2.9%, fueled by energy consumption from residential buildings (3.9% annual growth in the same period). The ROK's economic growth has led to greater energy demand for space heating and use of electronic goods, which constitute 54% and 19%, respectively of energy consumption in residential buildings as of 2010. These figures indicate the high potential for energy-saving through behavioral and lifestyle changes.**Waste Management:** The ROK has many success stories in the waste management sector. The amount of waste treated decreased substantially from 83,962 tons/day in 1990 to 48,934 tons/day in 2012 due to the decline in the volume of waste generated (waste disposal per person decreased from 1.96kg/day to 0.98kg/day over the same period). Likewise, the volume of recycled waste increased consistently as a result of government policies that enabled proper sorting, disposal, and collection of recyclable wastes. However, food wastes – which are primarily (70%) generated by households and small restaurants – have continued to increase annually (approximately 3%) since 2000 as a consequence of increased income and spending patterns. As food waste is a major source of GHG emissions and environmental pollution, there remains much room for improvement in terms of reducing food waste.

Relevant Problems

In terms of environmental awareness, the 1988 Olympic Games in Seoul was a big turning point for the ROK when concerns over Seoul's poor air quality helped raise public awareness of the importance of environmentally friendly growth. However, tangible support from the public only began to be manifested in the late 1990s as increasing numbers of reports revealed the consequences of environmental pollution to human health, and how environmentally friendly growth offers better living conditions for the public. Moreover, given the prolonged impacts of skyrocketing oil prices on Korea's economy and the nation's extreme vulnerability to such market shocks, the government conveyed a strong public message that "energy saving means economic growth."

Table 2: Emissions projections for 2014-2020

Category Detailed Plans		2014	2016	2018	2020
Industry	Amount of Emissions (million tons CO_2)	373.6	395.1	415.4	439
	Share (%)	53.8	54.8	55.6	56.6
Transportation	Amount of Emissions (million tons CO_2)	95	96.7	98.2	99.6
	Share (%)	13.7	13.4	13.1	12.8
Construction	Amount of Emissions (million tons CO_2)	154.5	158	162.8	167.6
	Share (%)	22.2	21.9	21.8	21.6
Public sector/others	Amount of Emissions (million tons CO_2)	17.4	17.3	17.6	17.9
	Share (%)	2.5	2.4	2.4	2.3
Land use, land-use change, and forestry (LULUCF)	Amount of Emissions (million tons CO_2)	30.2	29.6	29.1	28.5
	Share (%)	4.3	4.1	3.9	3.7
Waste	Amount of Emissions (million tons CO_2)	14.9	14.7	14.7	14.2
	Share (%)	2.1	2.0	2.0	1.8
Total		694.5	720.8	747.1	776.1
Industrial sector	Amount of Emissions (million tons CO_2)	373.6	395.1	415.4	439
	Share (%)	53.8	54.8	55.6	56.6
Non-industrial sector	Amount of Emissions (million tons CO_2)	312.0	316.3	322.4	327.8
	Amount of Emissions (million tons CO_2)	44.9	43.9	43.2	42.2

Source: Joint Work of Relevant Ministries, 2014

Table 3: Energy consumption and waste disposal in households

Category	Statistics	1990	2000	2005	2010	2012
Energy Consumption	Coal (thousand tons)	19,217	1,192	2,010	1,859	1,833
	Petroleum (thousand tons)	67,510	105,148	75,758	51,651	43,542
	Natural Gas (m^3)	740	8,594	11,908	11,838	13,267
	Electricity (GWh)	28,147	91,753	142,248	181,813	186,619
Waste Disposal	Total amount of municipal waste treated (ton/day)	83,962	46,438	48,398	49,159	48,934
	Disposal per person (kg/day)	1.96	0.99	1.01	0.99	0.98
	Amount of waste recycled (thousand tons/year)		27,240	30,757	35,289	36,943

Note: Figures for municipal waste treated and waste recycled in 2012 are figures for 2011 .

Source: KEEI, 2013; KOSTAT, 2011; KECO, 2014

However, as described in the previous section, increases in household income have inevitably led to increasing energy consumption. Per capita household energy consumption now exceeds European levels, and it is not expected to significantly change in the short term as government continues to keep energy prices low. Despite many issues surrounding non-industrial energy consumption in the ROK, a key problem lies on the failure of the public to translate their growing levels of environmental awareness into tangible actions. In other words, there are various obstacles and challenges to be overcome to proactively incentivize the public to live a greener lifestyle.

- A study undertaken by the Korea Energy Economics Institute (KEEI) in 2008 revealed that public awareness of climate change indicated a perception level of 70.28 points, comprehension level of 59.57 points, and confidence level of 52.01 points, while the action level was found to be significantly low at 30.85 points. These figures suggest that a relatively positive public reception of climate change issues does not automatically translate to concrete actions, especially on individual behavior and lifestyle.

- The Green Life Capacity Index (GLCI) developed by Samsung Economic Research Institute (SERI) in 2010 identified significant gaps in facilitating voluntary actions for the greening of lifestyles in Korea. The GLCI factors in various indicators based on the notion that capacity building on green governance is necessary for both the central and local government to effectively promote greener lifestyles. As shown in Table 4, the ROK ranked above average in the use of regulations and technologies among 29 OECD countries. However, it ranked among the lowest in greening governance and behavioral norms at the local level. This suggests how the discrepancies in the technical capacity of the central and local authorities make it difficult for drivers of change to actually mobilize efforts at the grassroots level.

Policy Options

While there may be various causes behind the lack of proactive efforts from the public to shift toward a greener lifestyle, despite high levels of awareness of climate change and environmental sustainability, the following fundamental problems are evident in the ROK:

(1) Insufficient incentives for inducing voluntary actions;

(2) low levels of education and public promotion to expand green life practices; and

(3) absence of an integrated institutional framework and diversity of programs to stimulate public participation.

Taking these factors into account, the ROK government strategically developed a diverse set of incentives to expand green consumption and energy-saving practices, strengthened foundations for green education and capacity development, and initiated the “Green Start Movement” as a nationwide effort toward reducing GHG emission in the non-industrial sector.

1.3 Challenges and Opportunities for Green Grwoth

Greening of lifestyle practices is increasingly being emphasized as a comprehensive measure to respond to climate change impacts, reduce GHG emissions, and enhance resource efficiency, which are the core pillars of the low-carbon green growth policy in the ROK. The potential for taking relevant actions can be found in a variety of settings, often with low cost implications.

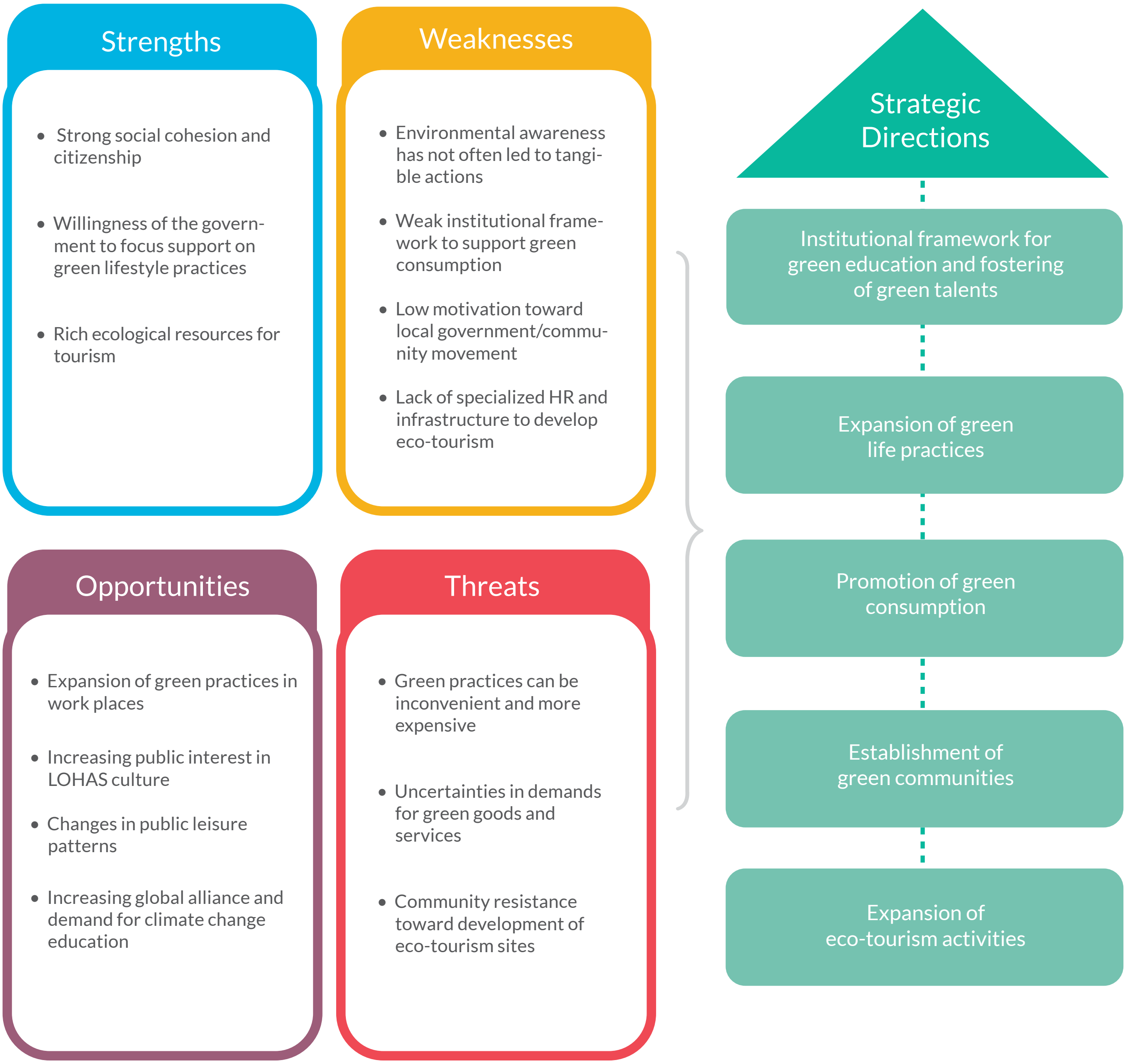
Enabling conditions must be developed under which the public engage in green lifestyle practices on their own terms, rather than under the direction of government regulations. However, as such green lifestyle practices do not necessarily lead to monetized benefits for individuals, government incentives must be channeled to stimulate a virtuous cycle of awareness, action, and responsibility.

Table 4: Green Life Capacity Indicators (GLCI)

Sector	Category	Indicators	Ranking of ROK
Capacity	Green Regulation	Use of public transportation	4
		Share of renewable energy use	28
		Market price of gasoline	3
		Volume of fossil fuel consumption	13
		Expansion of green areas	1
		Quality of regulation	26
		Category Total	6
	Green Technology	CO_2 intensity of electricity generation	20
		Energy efficiency	26
		R&D capacity	14
		Capacities for environmental innovation	16
		Category Total	16
	Central Government Capacity		12
Local Government Capacity	Green Governance	Support toward enhancing environmental conditions	29
		Participation in Agenda 21 activities	19
		Environmental governance	22
		Political freedom of citizens	27
		Government efficiency	19
		Rule of law	21
		Category Total	24
	Green Behavioral Norms	Dow Jones Sustainability Group Index	16
		Capacities for environmentally friendly corporate management	15
		Ecological footprint per person	6
		Volume of household waste generated	7
		Value of damage from natural disasters	29
		Level of exposure to hazardous environment	23
		Category Total	29
	Local Government Capacity		28
Green Life Capacity Index (Rank out of 29 OECD countries)			24

Source: SERI, 2010

Figure 1: SWOT analysis for "promoting a green lifestyle"



Source: PCGG, 2009c

Table 5: Specific tasks and actions under the green lifestyle agenda

Tasks	Actions
1. Foundation for delivering green education and fostering green talents	a. Establish the foundation for greening the education system b. Develop green education and capacity building programs c. Build capacities to implement green education d. Strengthen institutional partnerships for green education
2. Expansion of green lifestyle practices	a. Develop and monitor the green lifestyle index b. Strengthen the implementation of campaigns on green lifestyle c. Engage the private sector in green life practices d. Raise public awareness on green lifestyle through government activities e. Foster the development of relevant institutions
3. Promotion of green consumption	a. Promote green consumption patterns across all sectors of the economy b. Strengthen dissemination of information on green products and services c. Global cooperation for expanding green consumption and production
4. Establishment of green communities	a. Develop a "green community" model and roadmap of action b. Create green communities c. Establish relevant policies and systems
5. Expansion of eco-tourism activities	a. Develop a Korean model of eco-tourism b. Establish infrastructure for expanding eco-tourism activities c. Develop and promoting eco-tourism products d. Revise relevant policies and management structure

Source: PCGG, 2009c

2. Targets and Strategies

At the 1992 UN Conference on Environment and Development (Earth Summit), "Agenda 21," a non-binding action plan, was agreed upon at the national, regional, and local levels for achieving sustainable development. Local authorities were to take steps to implement programs locally, and these programs are commonly known as the "Local Agenda 21 (LA21)." The ROK adopted the LA21 in 1995 with the active participation of local authorities and civil society. In 2000, the "Korea Council for Local Agenda 21" was established to foster exchange of information between local governments, and approximately 90% of local governments had adopted the agenda as of 2002. The recognition of the need for sustainable consumption and production and greening lifestyles in the ROK thus dates back to days long before "low-carbon green growth" was announced as the nation's new growth paradigm in 2008.

The adoption of LA21 helped the ROK to shift away from government-led development planning to a bottom-up governance approach. Indeed, a system where the local government, community members, and private sector cooperate in a balanced manner was a new and experimental strategy. However, it did not lead to significant engagements on the ground due to the still weak legal and institutional foundation for LA21, and limited influence and environmental awareness of community members. In addition, many of the initiatives under LA21 failed to receive sufficient financial support, as they were budgeted as government assistance for civil society groups such as environmental NGOs.

However, this network of government and non-government actors under the LA21 eventually provided a good starting point for expanding green growth initiatives at the grassroots level. In the course of developing the National Five-Year Plan for Green Growth, the government profiled and benchmarked the LA21 along with leading global practices of sustainable consumption and green lifestyle practices, specifically focusing on how public campaigns would lead to measurable actions and outcomes. The comparison between the global best practices and Korea's past efforts highlighted the failure of the central and local governments to create a shared vision and facilitate actions based on a network of civil society groups and community members.

2.1 Local Green Growth Committees (LGGCs) and the Green Start Movement

Under the guidance of the Presidential Committee on Green Growth (PCGG) that played the role of setting strategies and policies at the national level, the Local Green Growth Committees (LGGCs) created by the local governments were intended to establish an independent green growth plan at the local level. The Framework Act on Low Carbon, Green Growth stipulates that local governments (cities and provinces) are to independently establish five-year green growth plans that are tailor-made based on the local circumstances and conditions. Although the Act identifies local governments as important actors to assist the central government's plans and actions for green growth, it fails to specify their roles, functions, and authorities; instead, local governments are to incorporate them separately by issuing "local ordinances on low-carbon green growth."

Establishment of LGGCs

The LGGCs are composed of no more than 50 members. Individuals with extensive knowledge and experience in fields relevant to green growth (e.g., climate change, energy, resource management, and green technology) are appointed as members by either the city mayor or governor. In many local governments, LGGC members include high-ranking public officials of city or provincial offices. The selected members review and deliberate on local strategies, agenda, and action plans relevant to green growth, as well as monitor their implementation. As of November 2009, a total of 16 city and provincial governments have established their LGGCs. In order to enable close collaboration between LGGCs and the central government, one director-level staff (or a section chief) from each line ministry and local government is designated as a focal point called the "chief green growth officer."

Table 6: Distribution of local green growth policies and programs under the National Five-Year Plan for Green Growth (as of 2011)

Three Strategies and 10 Agenda Items		Number of Policies and Programs	
		Seven City Governments	Nine Provincial Governments
Total		**969**	**1,278**
Mitigation of climate change and enhancement of energy security	1. Effective reduction of GHG (Low Carbon Society)	82	148
	2. Reducing the use of fossil fuel and enhancement of energy self-reliance	90	112
	3. Enhancing the capacity to adapt to climate change	162	182
Creation of new engines of growth	4. Green technology innovation	77	94
	5. Greening of industries and fostering of green businesses	79	122
	6. Advancement of industrial structure	63	112
	7. Laying the foundation for a green economy	65	84
Improvement in quality of life and enhancement of national standing	8. Greening homeland and transportation	241	166
	9. Promoting a green lifestyle	**109**	**220**
	10. Becoming a model, world-class nation of green growth	21	38

Source: PCGG and Korea Research Institute for Local Administration, 2012

Table 7: Overview of the Green Start Campaign and Green Start Network

		Details
Green Start Campaign	Concept	Help reduce GHG emissions in the non-industrial sectors such as households, commercial businesses, and public transportation.
	Description	A nationwide campaign that: (1) seeks collaborative efforts from public and private sectors; (2) encourages voluntary citizen participation; and (3) sets forth clear guidelines on how to implement a green lifestyle.
Green Start Network	Concept	A broad network in support of the Green Start Campaign
	Date of Inauguration	October 2008
	Participating Groups/Institutions	Central government, local municipalities, religious bodies, civil society groups
	Status (as of Dec. 2011)	One nationwide network, 16 regional (city and provincial level) networks, 228 local networks
Sample Policies and Programs	- Climate change education programs and green leader development programs - Green labeling, carbon point system, and policies that mandate green procurement - Promotion of bicycle use	
Initiation Strategy	Enhancing Awareness	- Carry out a diverse number of creative policies and programs - Provide free education to enhance public capacity
	Dissemination of Practices	- Provide model guidelines of reducing GHG emissions - Establish a system to expand voluntary participation
	Networking	- Build an effective network to support the emissions reduction activities
		- Carry out actions with measurable outcomes in groups

Source: MoE, 2012b

The LGGCs initiated various policies and programs related to the three strategic directions laid out in the National Five-Year Plan for Green Growth. A large number of initiatives focused on transforming public lifestyles and developing climate and environmentally friendly spaces. Recognizing the limitations of the central government in reaching out and engaging with different sectors of society, especially at the grassroots level, to transform their lifestyles, the LGGCs focused their efforts on closing this gap. A wide range of actions were planned and implemented taking into account the given context of regional development along with public demand and budgetary constraints of local government offices.

For example, the city of Busan actively invested in the creation of green recreational areas (e.g., parks, green streets, and ecologically restored streams), installation of renewable energy facilities (e.g., green energy systems for public welfare buildings), promotion of green transportation (e.g., launching a weekly car-free day program, replacing diesel buses with compressed natural gas or CNG buses, and expanding cycling tracks), and greening of buildings (e.g., subsidizing green rooftops and investments in energy efficiency).

This initiative of LGGC also comes with catchy labels for each city such as “climate-friendly city” (Seoul), “low-carbon city” (Daejeon), “national hub of green industries” (Gyeonggi), “carbon-neutral central administrative city” (Sejong) and “land of the green” (Jeonnam).

The government closely monitored the LGGC initiatives by mandating the heads of local governments to conduct annual performance reviews for submission to PCGG. For example, the performance review for 2011 revealed that 88.3% of the 2,267 initiatives (refer to Table 6) were completed or were on-track for successful completion, while 11.7% were either cancelled, revised or being delayed. The reasons cited for underperformance include the lack of coordination among government offices, deficiencies in budget, low economic feasibility, and failure in securing the required land titles. Such rigorous monitoring and evaluation mechanism enabled the LGGCs to take leadership in building a solid governance structure for pursuing green actions.

Launch of the Green Start Movement

Despite the strengthening of policy and institutional framework at the local level, the central government believed such efforts were not sufficient to earn broad participation by the general public and private sector. Accordingly, the Ministry of Environment (MoE) initiated the "Green Start Movement" as a nationwide public campaign for GHG emissions reduction. The government, private sector, and civil society jointly established a nationwide network called the "Green Start Network" and disseminated specific guidelines for reducing GHG by persuading people to change their habits. For example, households were encouraged to maintain room temperature at above 26°C during summer and below 20°C in winter, to replace conventional light bulbs with energy-saving bulbs (e.g., LED), and to keep electric appliances unplugged when not in use.

The Green Start Network adopted the existing institutional framework under LA21, composed of a single nationwide network, 16 regional (city and provincial level) networks, and 228 local networks. After its inception in late August 2008, the total number of participating organizations in regional and local networks has expanded to 3,900. Some of the main organizations include civil society groups such as consumer associations, religious movements, and women activist groups, and corporate or business entities such as local manufacturers, suppliers, and shop owners (MoE 2009; MoE 2012b). Based on a report from the MoE, the Green Start Movement has led to a significant number of outcomes (MoE, 2012b), namely the following:

- **Expansion of public-private partnerships for action:** A total of 13 MOUs on supporting and implementing climate change mitigation and green lifestyle practices were signed with 46 corporations.

- **Development and implementation of GHG reduction programs:** A diverse range of programs was developed and implemented, such as the "home energy diagnosis," "green office program," "parental education on climate change impact," and the "green touch program" (which aims to conserve energy of personal computers in standby mode).

- **Fostering of "Green Leaders":** Green leaders are green activists who play a pivotal role in leading the Green Start Movement. The development of systematic educational programs for fostering green leaders at different levels (beginner, intermediate, and advanced) honed the skills and capacity of promising green leaders, launching "me first" actions to encourage the participation of the general public.

- **Expansion of participatory campaigns promoting green life practices:** The distribution of action toolkits – which are information materials that set out a number of actions on GHG emissions reduction – helped initiate participatory campaigns in households, schools, and offices.

Excerpts from the Declaration of the Green Start Network

- We shall be at the forefront of GHG reduction efforts, setting examples of "me first" actions to encourage participation of the general public.

- We shall develop various programs to reduce GHG emissions and initiate relevant capacity development and information dissemination activities.

- We shall bring together wisdom to create an enabling condition for expanding voluntary mitigation actions by all members of the society.

- We shall strive to build the Green Start Movement into a nationwide campaign.

Source: MoE, 2012b

2.2 Government Plans and Strategies

2.2.1 Plan on Expansion of Low-Carbon Green Life Practices (2009)

Under the guidance of PCGG, the MoE led the development of national level plans and strategies for promoting a green lifestyle. Marking the one-year anniversary of the proclamation of Low-Carbon Green Growth as the new national vision, the MoE came up with the Plan on Expansion of Low-Carbon

Green Life Practices in August 2009. As the first national blueprint on promoting a green lifestyle, the plan laid out three strategic priorities and ten agenda items that aim to achieve a 10% reduction in GHG emissions by the non-industrial sectors.

The action programs under different agenda items sought to:

(1) be customized to reflect the circumstances of different social groups;

(2) strengthen the use of government incentives – often provided in monetary terms to individuals – to expand public participation; and

(3) focus on building legal and institutional platforms to support the activities of LGGCs and the Green Start Movement.

As shown in Table 8, the 2009 plan served as a comprehensive strategy for individuals, private sector, and public offices to engage in green life practices. The action items were broken down to pinpoint specific groups of society (e.g., students, housewives, and office commuters) or locations where greening of social and economic activities can be realized (e.g., households, workplaces, shops, construction sites, farms, transport, restaurants, schools, and universities). Nationwide incentive schemes for subsidizing green life practices such as the carbon points system and green certification schemes were proposed to be carried out by the central government's line ministries, while basic instruments such as education and public campaigns for green life and production systems were to be led by the Green Start Network.

Table 8: Summary of the Plan on Expansion of Low-Carbon Green Life Practices (2009)

Action Plans		Detailed Plans
A. Building momentum for changing lifestyle practices	1. Customized campaigns and programs	• Nationwide dissemination of the "Wisdom of Green Living" • Holding periodic public-participatory events on green lifestyle
	2. Promoting green living and consumption in households	• Dissemination of guidelines on "Low-carbon Living Standard" • Campaigns on saving water/energy use and reducing the use of disposables
	3. Green workplaces	• "Cool Mapsy" Campaigns • Private sector led programs on greening office spaces
	4. Green transportation	• Campaigns on "Green Driving Practices" • "Ride a Bicycle" programs
B. Strengthening of incentive systems	5. Incentives for practices in households and workplaces	• Nationwide carbon point systems • Incentive schemes for green employees in business
	6. Incentives for procurement and supply chain sectors	• Green product certification • Disclosure of carbon information on goods and services • Green store certification
	7. Government awards and recognition programs	• Green awards to recognize and honor efforts of businesses and individuals
C. Building legal and institutional foundations	8. Fostering of green lifestyle leaders	• Green campus initiative • Green leaders program
	9. Online campaigns and communication	• Internet campaigns on greening life practices
	10. Legal framework	• Establishment and/or strengthening of relevant legal framework

Source: MoE, 2009

2.2.2 Follow-up Plans from the Ministry of Environment

At the 11th meeting of the PCGG in June 2011, the MoE released an additional plan titled "Plan on Expediting Expansion of Green Life Practices." This document was prepared based on the recognition that public participation in nationwide programs is still weak despite continued efforts of different levels of government and civil society networks. The 2011 plan aimed to embed green life practices into the economic activities of the general public to attract greater public interest and participation.

The following action programs were designed to further incentivize and publicize how greening life practices can help reduce household and individual spending:

(1) green card systems for expansion of green consumption;
(2) environmentally friendly food consumption campaigns to reduce food waste disposal;
(3) dissemination of LED lighting for energy saving; and
(4) promotion of urban farming practices. The 2011 plan showed how measurable annual targets were addressed for each action program.

The PCGG held the 10th monitoring and evaluation session in June 2012, where the outcomes relevant to "green lifestyles" were comprehensively reviewed. Of the many programs being implemented by different line ministries and local governments, those relevant to green consumption were not found to be fully on-track to meet the agreed targets. For example, despite the significant achievement made in the number of "green cards" issued (2.7 million), the lack of manufacturers and distributors of goods participating in the green card program was a limiting factor in boosting green consumption.

In addition, public awareness on environmental performance certificates and labels was deemed to be relatively low, indicating how information disclosure has yet to bring actual changes in spending patterns. As a response, the MoE released an additional plan focused on "accelerating green consumption and participation in green life practices," immediately after the June 2012 PCGG session. The 2012 plan prioritized three supplementary strategies:

(1) expanding the use of green cards;
(2) strengthening the foundation for green consumption; and
(3) bolstering public campaigns on greening consumption.

2.3 Target Setting

The ROK's National Five-Year Plan for Green Growth proposed a set of specific targets relevant to establishing a "green lifestyle" among all members of society. As described above, the central government primarily focused on providing directions to the LGGCs, initiating nationwide movements, and introducing incentives to accelerate self-motivated and voluntary participation of the general public. As the emissions from non-industrial sectors of the economy account for over 40% of the national emissions, translating public awareness (on environmental sustainability and climate change) into measurable actions was addressed as a critical agenda to achieving the national GHG reduction targets.

Table 9: Measures to expand green living culture in daily life (as of 2011)

Key Measures	Targets and Benefits
Accelerating the use of "Green Cards"	Green Cards are mileage cards that accumulate "green points," which can be earned by reducing energy use (e.g., electricity, water, gas) and consuming government-certified green goods. The accumulated points can then be used as cash in purchasing goods and services. The additional incentives are given to Green Card holders in using public facilities (e.g., parks and public transportation). • Target: Issue five million green cards by 2015 • Expected outcomes – Reduction of GHG emissions (by two million tons of CO2 equivalent per year) – Expansion of green product market volume to 40 trillion KRW in 2015 – Creation of green value chain (consumption – distribution – production)
Promoting environmentally friendly food consumption	• Agenda Items – Mandatory regulations on restaurants to reduce food waste disposal – Provision of incentives to restaurants that use smaller plates to control food waste – Revision of local municipality ordinances to reduce food waste generation – Training programs and campaigns on "zero-food waste" • Target: 20% reduction in food waste generation by 2012
Expanding the use of LED lights	• Agenda Items – Establishment of a "Roadmap for increasing the use of LED lights" – Mandatory regulations on public facilities to replace existing lights with LED lights – Government support toward LED industries (manufacturers) • Target: Increase in the share of LED light bulbs – 60% of all lighting systems by 2020 (2.5% as of 2010) – 100% of all lighting systems in government facilities by 2020 (8% as of 2010)
Increasing the volume of urban farming	• Agenda Items – Government incentives on urban farming practices – Development of urban farmlands as park facilities – Government support for increasing the market volume of seed/plant providers • Target: Establish 3,000 ha of green urban spaces by 2020 – Install 8,000 urban farm facilities by 2020 – Engage five million people in urban farming (approximately 10% of urban population)

Source: MoE, 2011

Table 10: Supplementary plan on green consumption and green life practices (2012)

Action Plans	Detailed Plans
Expanding the use of green cards	• Increase the number of goods that provide green points upon purchase
Strengthening the foundation for green consumption	• Strengthen incentives for the manufacturers and suppliers of certified goods • Expand campaigns on environmental performance certificates and labels
Bolstering public campaigns on greening consumption	• Hold "me first" campaigns with the manufacturers and suppliers of green goods • Publish "green goods consumer reports"

Source: MoE, 2011

Table 11: Target setting under the agenda of "establishment of a green lifestyle"

Target Indicators	2009	2010	2011	2012	2013
1. Green Education and Fostering of Green Leaders					
Number of green citizens fostered (as cumulative % of population)	-	10	15	20	30
2. Expansion of Green Living Practices					
Number of green citizens fostered	500,000	700,000	800,000	900,000	1,000,000
Number of green households (number of households)	160,000	180,000	200,000	250,000	300,000
3. Increasing the Volume of Green Consumption					
Amount of green purchases (KRW trillion)	2.5	3.1	3.4	3.6	4.0
Number of certified green products	50	100	250	400	500
Number of corporations that have agreed to green procurement	102	120	130	150	170
Number of green stores	387	450	500	550	600
4. Establishment of Green Villages					
Number of green community centers	-	20	50	80	100
Number of green villages	-	12	4	58	16
5. Promoting eco-tourism					
Public awareness of eco-tourism	70	80	95	100	100
Number of green tourism services (e.g., accommodation, tourist attractions)	-	-	10	20	100

Source: PCGG, 2009c

3. Policy Actions and Programs

3.1 Green Procurement and Consumption

Green procurement and consumption provide practical and transformational measures for the general public to pursue green living as part of their daily routines. Along with the rising public awareness of consumer social responsibility, green products are increasingly capturing the attention of businesses and individual customers in the ROK. In particular, products that offer monetized benefits (e.g., energy-efficient appliances) or support human well-being (e.g., organic foods) are gaining popularity in the market. It is worth noting that the growing levels of awareness and participation in green consumption naturally lead to an increase in green production, as producers are likely to redirect their interests to meet the growing demand.

The ultimate goal of the government is to create a virtuous cycle that connects green production, green procurement, and green consumption as an integrated system. In light of this goal, this section aims to introduce and draw some lessons from the ROK's policy and programmatic interventions on green procurement.

3.1.1 Mandatory Green Public Procurement

The program for mandatory Green Public Procurement (GPP) requires public institutions to procure goods (or, aptly named as "green products") with reduced environmental impact throughout the whole cycle of production, distribution, consumption, and disposal. The program intends to take advantage of the purchasing power of the ROK's public institutions given its sheer size (total government procurement was worth 106 trillion KRW or approximately US$ 96 billion in 2012). Unlike programs that are implemented on a voluntary basis, the program is made enforceable on all public institutions running on government budget.

Table 12: Environmentally friendly product certifications of the ROK

Action Plans	Korea Eco-Label	Good Recycled (GR) Mark
Label		
Characteristics	Products with low levels of environmental impacts during production and consumption, or offer the benefits of reducing resource use	Products with proven quality that have been manufactured with recycled materials
Category	Items under 147 categories including stationery, home appliances, and furniture, along with three service products (i.e., hotels, recreation condominiums, automobile insurance)	Items under 17 categories including recycled paper, recycled bottles, and recycled plastic goods
Number of Goods (as of 2013)	10,035 goods produced by 1,952 companies	248 goods produced by 207 companies

Source: MoE, 2011

Implementation

The program defines green products as those that serve the same purpose as conventional ones, but can better contribute to reducing resource consumption and negative environmental impacts. To be eligible, products must meet both environmental and quality standards; environmental standards ensure minimum environmental performance of goods (e.g., safe exposure level, efficient energy and water consumption, and recyclability) throughout the entire life cycle of a product, while quality standards are equivalent to the requirements set by the Korean Industrial Standards Council (KISC). Products that have acquired either the Korea Eco-Label or Good Recycled (GR) Mark (in addition to KS certification) can be referred to as representative products eligible for procurement under the program. While the participating institutions are mandated to purchase green products, decisions are overruled in cases where:

(1) there is no available green product available on the market;
(2) the green product available lacks quality or exhibits poor stability of supply; and
(3) the purchase is considered inappropriate by the head of the institution (e.g., purchase for emergency purposes such as aid delivery, or the available green product is much more expensive).

The public institutions covered by this program are government institutions, local authorities, state-owned enterprises, local medical centers, and metropolitan landfill management corporations. They are required to establish and announce annual green product procurement plans observing the green product procurement guidelines, and submit the procurement records to the Ministry of Environment (MoE) for evaluation. The procurement can be classified into three types: direct purchase, indirect purchase via contract or bidding order such as Vendor-Managed Inventory (VMI), or direct purchase and installation carried out by construction firms at a construction site.

Table 13: Environmentally friendly product certifications of the ROK

Unit: 100 million KRW

Category	2005	2006	2007	2008	2009	2010	2011	2012
Total Amount of Green Procurement	7,870 (43.3%)	8,616 (58.3%)	13,437 (69.3%)	15,840 (51.3%)	16,296 (64.5%)	16,412 (53.7%)	16,455 (59.5%)	17,270 (33.7%)
Central Administration	3,396	2,839	3,569	3,488	2,887	4,132	3,462	5,001
Local Authorities	1,626	2,512	3,889	6,720	5,428	4,826	5,009	5,187
Educational Institutions	2,150	2,336	4,283	4,066	5,481	4,878	4,975	5,581
State-owned Companies, Quasi-government Agencies, and Other Public Institutions	698	929	1,696	1,566	2,500	2,576	3,009	3,490

Note: Figures in brackets refer to the share of green purchase for items where green products have been made available (statistics for the years after 2009 have only taken into account the green purchases made in selected categories).

Source: MoE, 2013b

The MoE is responsible for the overall management of the program. The support of the Public Procurement Service (PPS) is critical as it is the central government organization responsible for procuring commodities and arranging contracts for construction projects involving government facilities. The PPS not only provides technical support to participating institutions during their procurement activities, but continues to update the database on goods eligible for priority purchase through the government's e-commerce system. In addition, PPS keeps track of all procurement records for annual evaluation by the MoE. The Korea Environmental Industry and Technology Institute (KEITI), which is an affiliated institution under MoE, provides working-level support for the program by developing and revising the legal provisions and green product procurement guidelines. KEITI is also the institution in charge of Korea Eco-label certifications.

Outcomes and Takeaways

The number of public institutions obliged to participate in GPP has been fluctuating due to frequent changes in the legal provisions that prescribe the applicability of the policy to public institutions. Despite the fluctuation, approximately 700 to 850 public institutions have continued to participate in the Mandatory GPP program. As shown in the Table 13, the volume of Mandatory GPP spending continuously increased annually and reached 1.7 trillion KRW in 2012; the amount has increased more than twofold since 2005 when the policy was first introduced. Out of the 846 participating institutions in 2012, the Ministry of National Defense and Ministry of Education topped the list in terms of the volume of green procurement. The most popular products in the market – representing 38% of the total green procurement – are personal computers (18%), asphalt concrete for construction (7.4%), windows and frames for buildings (6.2%), and sidewalk blocks (6.2%).

The environmental and economic benefits derived from Mandatory GPP may not be directly evident, especially as environmental externalities are often underpriced and not always observable. From a business standpoint, producing green products minimizes the environmental impact and reduces environmental restoration cost, thereby minimizing social costs. On the other hand, from a consumer's perspective, purchasing green products not only brings social and environmental benefits but may also lead to economic gains. For example, additional cost implications and inconvenience can be outweighed by the direct benefits such as energy savings and reduced costs of waste disposal. According to an assessment conducted by KEITI, the total amount of green purchases made under the program (2005-2012) has led to approximately 4.9 million CO_2 tons of emissions reduction, equivalent to 7.4 billion KRW of monetized benefits.

The government's lack of will to impose fines or penalties upon failure to comply with the legal provisions of the program is a major drawback to expanding the positive momentum gained thus far. The law in force only states how the vendors or suppliers will be penalized in the event of violation, in terms of producing and distributing certified products (e.g., fakes and counterfeit goods), but mentions nothing of the purchaser's compliance. Given the extensive frequency of procurement transactions that are taking place by public institutions, systematic monitoring or auditing of procurement records is difficult to achieve in reality. The legal provisions must adequately regulate the purchasers, in addition to making sure that their purchase records are reflected in the government's annual performance evaluations of public facilities.

3.1.2 Green Store Certification Program

A "Green Store" is a store that meets eco-friendly certification standards, not only from the hardware perspective (e.g., energy-efficient lighting systems) but also the software-related aspects such as store management, product distribution, and staff training. The Green Store Certification Program accredits large retail stores including department stores and supermarkets committed to the environment by promoting the distribution of eco-friendly products and installing and operating eco-friendly facilities. The government's underlying objective is to make sure that large retailers are able to exercise a significant influence over public consumption patterns by helping improve the greening of product distribution, and contribute to meeting the nation's GHG-reduction targets. Large retailers are accountable for approximately eight million tons CO_2 eq. per year which is approximately 14% of the nation's emissions from commercial, residential, and primary industries (agriculture, fisheries, and forestry) sectors.

Implementation

Large retailers designated by the government under the Distribution Industry Development Act and markets that sell agricultural produce, seafood, and livestock products (with floor areas greater than 3,000 m^2) are eligible to receive the Green Store Certifications starting October 2011. As of 2013, small-scale retailers such as community markets and shops that are operated directly by producers of green products have also been made eligible for participation. The certifications are provided based on voluntary applications by interested entities, which are evaluated by a committee comprised of staff from KEITI (the implementation agency) and external experts. The committee conducts site inspection to verify whether the applicant store meets more than 80% of the given standards. As shown in Table 14, the evaluation standards are comprised of four categories that are further divided into 26 specific sub-categories. A simplified and less stringent version of this standard is applied for small-scale retailers.

Outcomes and Takeaways

As of 2014, a total of 216 Green Stores have been certified across the nation. More than 85% of these stores are small and large markets selling agricultural produce that are common in residential areas while the rest are mostly department stores located in major cities. Although the number of certifications may not seem overwhelming yet, the scheme has gained strong support from retail giants including E-mart, Homeplus, and Lotte Mart, which have taken early voluntary actions to improve the environmental performance of their facilities even before the scheme was launched in 2011. For example, E-mart was the first large retailer to do away with the use of plastic bags in 2009, and its green stores have continued to sell highly energy-efficient goods such as LED light bulbs. Homeplus, on the other hand, has started to open new stores that follow the "Green Store" concept as early as 2008; its store in Bucheon city reported that it has been able to reduce GHG emissions and energy use by 50% and 40% respectively, by introducing innovative facilities such as ice thermal storage systems and solar panels. Lotte Mart, which owns the greatest number of Green Store certifications out of the three retail giants, has been leading in green product sales by initiating a program in 2012 that provides additional credits on the purchase of environmentally friendly goods.

Table 14: Green Store Certification Standards

Category	Sub-category (example criteria)	Points Distribution	
		Department Store	Large Markets
Hardware facilities	Architectural design and construction (Building energy certification) Eco-friendly facilities (Use of energy and water saving facilities and equipment)	45	45
Logistics and vehicle operations	Shipping (Use of energy-efficient or low-emission vehicles) Loading and unloading, storage, and display (Level of waste-reduction practices)	13	25
Product sales and packaging control	Product and sales management (Number of green product items for sale) Product packaging control (Use of easily disposable packaging)	52	65
Store operation, training, and promotion	Store operation (Level of resource-saving practices) Office operation (Number of internal training sessions on green procurement)	65	65
Total		200	175

Source: MoE, 2012a

The good examples set by these retail giants have had positive spill-over effects to small-scale stores that have been made eligible to participate in the scheme starting 2013. In order to support small stores with less capacities and resources to qualify for certification, the government has initiated a program in 2013 that provides free technical assistance (i.e., energy and GHG-emissions diagnosis) and financial grants for installing heat-shielding film and switching to LED light bulbs to help them meet the certification criteria. In addition, some large-scale retailers have decided to return their savings in environmental improvement charges[3] accrued from participating in the program to small stores that are willing to enhance their operations to be certified as Green Stores. Such actions were guided by the government as a means of mitigating the growing public concerns over how market domination by retail giants is leading to the dwindling performance of "mom-and-pop stores." Thanks to such coordinated efforts, small stores make up for 38% of all certifications released as of 2014.

The Green Store Program, which was designed and supervised by the MoE, is a response to the low level (38%) of green consumption actions by the public, despite their high interest (81%) in green procurement as revealed by a nationwide survey conducted in 2010. Although the scheme has been widely recognized, the lack of government incentives is a significant barrier to increasing the momentum. Given how applications are more likely to come from existing stores that must transform their practices and/or retrofit their facilities, there is currently a lack of legal and institutional support for this. This was the case of the Daejeon Metropolitan Government, which signed a voluntary agreement with large retailers to create green stores in 2009. The city faced challenges when it could not attract retailers as expected due to the unavailability of strong incentive measures such as subsidies for eco-friendly facility installation, tax cuts, or relevant awards. As a result, Daejon city hosts only eight Green Stores. Launching the nationwide Green Store Certification Program in 2011 was unable to bring about significant efforts in addressing these challenges.

It is important to recognize that Green Stores need to be competitive in the market to ensure the success of the Green Store Certification Program. High-level public awareness programs must seek to enable the concept of Green Stores to boost business reputations, and so companies vying for the label should involve consumers in various eco-friendly activities such as reusing shopping bags, donating recyclable products, engaging in energy-conservation movements in the local community, and purchasing green products. In addition, if such activities would lead to meeting the requirements of the Green Store Certification Standards, more businesses would voluntarily participate and customers would increasingly become aware of their contribution to environmental protection through green consumption. Earning a Green Store

Figure 2: Green Store certification logo

Source: MoE, 2012a

3 | Environmental improvement charges are government fees collected from the owners or occupants of buildings, motor vehicles using light weight fuel, and facilities which directly cause environmental pollution.

Certificate proactively demonstrates that the businesses share their communities' commitment to environmental protection with customers, thereby affirming the role of Green Stores in promoting sustainable development in the local community.

3.1.3 Voluntary Agreement for Green Procurement

The Voluntary Agreement (VA) for Green Procurement is a voluntary social agreement concluded between the MoE and business enterprises to support the manufacturing and purchase of eco-friendly products. The scheme was introduced in response to the growing interest in Corporate Social Responsibility (CSR) and the tightening of environmental regulations on export products, particularly in the EU. Basically, the agreement views businesses as consumers of high-spending capacities that are likely to shape the values and practices of green production-distribution-consumption cycle within the economy. From 30 business entities that signed the VA in September 2005, there are now 150 entities that are participating (or have participated) in the scheme.

Implementation

The specific actions to be carried out by entities that have signed the VA are:

(1) modifying internal procurement regulations;
(2) preparing and implementing a multi-year corporate plan for green procurement; and
(3) conducting training for employees to raise awareness on green procurement.

In addition, they are recommended to create a team accountable for green procurement and to practice the setting of green procurement targets at their own discretion. For example, Lotte Group, which owns 21 affiliated companies participating (or have participated) in the scheme, has designated products with environmental certifications, "Good Recycled (GR)" certifications, and high energy efficiency certifications as priority items. The company's integrated procurement system is supported by a database of product information that flags these priority items, and the total amount of green procurement serves as a basis for annual performance evaluations of all affiliated companies.

Incentives

The duration of the VA is three years. Gaining the support of management-level staff and identifying a sufficient number of products (and their vendors) eligible for green consumption are critical factors of success. KEITI regularly provides information booklets on green products available in the market; products include domestic and imported items with various environmental and energy efficiency certifications. Due to the voluntary nature of the agreement, restrictive measures in the event of a breach are not clearly described. Accordingly, the ROK government offers a package of incentives to

Table 15: Outcomes of the VA for green procurement

Unit: million KRW

Category		2006	2007	2008	2009	2010	2011
Number of entities that have submitted their purchase data		27	41	51	64	78	82
Government-certified Green Products	Korea Eco-Label	99,172	136,945	169,445	195,390	307,550	401,075
	GR Mark	69,069	69,042	69,567	75,187	78,899	20,737
	Subtotal	168,241	205,987	239,012	270,577	386,450	421,812
Products with carbon labels							21,245
Products with high energy efficiency		14,587	37,742	48,599	168,593	415,771	126,940
Products with environment certification (imports)		69,283	1,074,548	124,246	645,990	165,736	248,790
Other products designated individually by participating entities		14,562,841	17,440,479	20,030,154	21,041,533	22,271,778	26,274,527
Total		14,814,952	18,758,756	20,442,011	22,126,693	23,239,735	27,093,314

Source: KEITI, 2012

encourage active participation in the VA such as free training for greening the manufacturing process (by KEITI), awarding the most "green" companies, and giving extra credits to companies when applying for eco-friendly certificates. The Life Cycle Assessment (LCA) and the Design for Environment (DfE) are two approaches offered by the KEITI's training programs for manufacturers. LCA provides a fundamental methodology that evaluates the environmental impact in the complete life cycle of a product. DfE is a decision support tool that helps a designer reduce environmental impacts by improving the product design. DfE incorporates the consideration of national regulations, human health and safety, hazardous material minimization, disassembly, recovery, recycling, and disposal into the design process (Fitzgerald et al, 2005).

Outcomes and Takeaways

Among the 150 entities that signed the VA, 84 entities (56%) have amended their green procurement guidelines, 62 entities (41%) have successfully established a "green procurement system" that identifies green products during the purchasing stage, and 54 entities (36%) have conducted internal training sessions on green procurement. In addition, 65 entities (43%) have reported that they have actively engaged in the promotion of green procurement initiatives through various channels such as corporate environmental reports, brochures, and webpages. Due to the voluntary efforts of participating entities, the total amount of green purchases in 2011 reached 27 trillion KRW. This figure includes purchase of government-certified goods (Korea Eco-Label and GR Mark) and items that have been identified individually by participating entities (e.g., products with a low degree of waste generation, and reduce the use of environmentally hazardous substances). The total purchase volume has continued to increase over the years of implementation; although this is primarily a result of the increase in the number of participating entities, it was also supported by an increase in the number of green products made available in the market.

Voluntary agreements are often referred to as the "third wave" of regulation in environmental policy. It is a scheme that capitalizes on the free will and discretion of individuals and business enterprises, unlike the conventional regulations based on command and control. The policy is low in regulatory costs, high in flexibility, and fosters a cooperative relationship between the government and industry. However, despite its merits, the overall effectiveness is being questioned as the scheme is not enforceable. Although the number of participating entities has been increasing, the government should actively integrate the scheme with other government-led certification programs such as the "Green Store Certification" and "Carbon Labelling System," as a means of strengthening the flow of information between consumers and producers. Stimulating market distribution of green products is critical to entice participating entities to renew their VA upon termination after three years.

3.1.4 Carbon Labeling

Carbon labeling is a system of indicating the amount of GHG emitted during the life-cycle of the product – namely, pre-production, production, distribution, consumption, and disposal. Building upon a system that was pioneered by the UK's Carbon Trust in 2007, various labelling schemes have evolved rapidly around the world. The policy instrument seeks to disclose carbon information and instill environmental awareness into consumer behavior and thereby catalyze change within the supply chain. The ROK was one of the pioneer countries in the Asia-Pacific region to introduce the scheme in 2009 as the government acknowledges the need for the country's products to keep pace with the changing international standards and customer norms.

Implementation

The ROK's carbon label certification has two labels: Carbon Footprint Certification Label (CFCL) and Low Carbon Product Label (LCPL). The CFCL provides the baseline amount of GHG emissions in the product lifecycle as approved by the government. On the other hand, products with LCPL are those that have taken a step further by earning certification for their low levels of baseline emissions as compared to the average of products of the same kind. LCPL products that have proven to be "carbon neutral" are provided with yet another special label launched in 2014 – the Carbon Neutral Product Label (CNPL). A product is considered carbon neutral if the total amount of its life cycle emissions has been mitigated through the purchase of emission allowances or emission reduction activities carried out by the producer.

With the exemption of primary agricultural products as well as forestry and medical products, all other types of products are eligible for carbon labeling. Certification is relatively simple and straightforward for products that do not use energy to perform their function; a general Product Category Rule (PCR) serves as a guideline to define the scope of GHG-emission activities that must be taken into account during a product lifecycle, and provides equations that allow applicants to calculate the baseline GHG emissions for specific products. However, separate sets of PCRs with "design scenarios" apply for products that consume energy, as their emission performance is dependent on the frequency or time of usage, along with conditions for standby mode. For example, the baseline GHG emissions for display monitors are calculated under the assumption that they are under on-mode, standby-mode, and off-mode for 40%, 5%, and 55% of their lifetime period (four years), respectively.

Certifications are provided based on voluntary applications by the producers. Under the MoE, which is the supervisory organization of the certification system, KEITI takes on the role of developing PCRs and undertaking the certification upon submission of applications. The certification of approved products is valid for three years during which KEITI annually conducts post-certification measures to ensure sustained performance of products. Since 2012, MoE and KEITI have been shouldering 50% of the certification fee for SMEs to support their voluntary participation.

Outcomes and Takeaways

The number of certified goods has been increasing at a rapid rate, from 111 products in 2009 to 1,499 products as of September 2014. A total of 172 companies have benefited from CFCL, and and 34 companies from LCPL applications, respectively. In particular, the number of certified goods produced by Korea's top conglomerates has been increasing. In 2013, Samsung Electronics and LG Electronics attained 193 and 92 certifications, respectively. This increasing trend of manufacturers of home appliances pursuing high-efficiency and eco-friendly products indicates positive progress in the implementation of the carbon labeling policy. It should be noted that 41% of the total certifications were awarded to products that consume energy.

In recognition of the five years of successful implementation, KEITI conducted an assessment that reported 228 LCPL products have contributed to GHG reduction of approximately 2 million ton CO_2 eq. during 2012-2014 (Park, 2014). According to the National GHG Emissions Inventory, this figure is equivalent to annual emissions from running 77,000 privately owned vehicles, or annual carbon reductions expected from 301 million fully grown pine trees (which would cover three times the area of Seoul). Success stories on reputational benefits gained from participating in the program have also been reported by some exporters; certifications responded well to the demand for environmental performance guarantees by clients of developed countries including Spain and Australia.

Figure 3: CFCL, LCPL, and CNPL designs

Note: "000g" is to be filled out as the actual baseline emission of products

Source: MoE, 2013a

Although carbon labelling has been successfully initiated in the ROK, public surveys have identified persistent gaps in consumer awareness of carbon labels. Before the launch of the labeling system in 2008, a consumer survey indicated that 69.2% responded positively to purchasing products with low-carbon footprints, and 78.6% of them retained this position even under the given assumption that low-carbon goods may be more expensive than conventional items. However, surveys on public level of awareness indicated that 56.1% (2012), 53.7% (2013), 49.8% (2014), respectively, of the respondents had actually never heard of the term "carbon labeling," revealing that more than half of the population is still unaware of the policy. Moreover, only a small portion of consumers among those who claimed to be aware of the system responded that they actually check on the carbon label upon purchase. But amongst those who were well-informed on the scheme, 90.6% responded positively to buying products with the least emissions, given that all products come with carbon labels.

Based on the perspective that carbon labelling serves as a pivot that links green production and consumption in the market, the ROK still has much more work to do in stimulating the latter portion of this chain. In other words, the system has failed to strike a balance between demand-led (customer pull) and supply-led (production push) drivers; compared to the level of government support channeled to product manufacturers (e.g., free training sessions on PCRs, levying costs for certification, creating booklets that introduce certified items), government actions and benefits offered for strengthening customer pull have been relatively weak. The government must seek ways to build and sustain consumer engagement through various practices such as public campaigns, education, and direct incentives upon purchase. In addition, producers and distributors must recognize that success in marketing of low-carbon goods comes from highlighting their performance characteristics such as cost-saving benefits since a marketing strategy that is purely based on emission performances can only attract those with good understanding of the climate change issue.

3.1.5 Carbon Points System

The Carbon Points System is a nationwide voluntary GHG reduction scheme that incentivizes the reduction of electricity, water, and gas consumption in households and businesses through the provision of carbon points. In exchange for the saved energy, participants earn carbon points that can be converted into various forms of rewards. This scheme is also known as the "Carbon Cashbag System" as points can readily be used as cash. This system informs participants of their levels of contributions to GHG-emissions reduction, which helps raise favorable public awareness of climate policy.

Implementation

Recognizing how consumption patterns are driven by multiple factors under different circumstances, the Carbon Points System provides incentives commensurate to the amount of GHG emissions reduced based on the participant's past resource consumption records. Specifically, calculations are made on the average monthly GHG emissions of individuals based on their electricity, water, and natural gas bills over the period of two years prior to participation. The monthly reductions in emissions achieved relative to this baseline figure

Table 16: Total number of CFCL and LCPL certifications

2006	2009	2010	2011	2012	2013	Sept. 2014
CFCL	111	301	502	735	1,112	1,270
LCPL	-	-	9	72	172	229
Total	111	301	511	807	1,284	1,499

Source: Park, 2014

are monitored and accumulated as carbon points; rewards are provided twice a year into "eco-money cards" held by participants or in other forms to those who do not hold such cards (e.g., cash, gift certificates, public transportation cards, and merchandise such as waste bags). However, only those who have achieved GHG reductions greater than 5% in each of the semiannual periods are entitled to collect the rewards.

The target participants of this policy are members of households and group entities such as buildings, businesses, apartment complexes, and schools. As long as the amount of resources consumed can be verified, the program is open to everyone, including studio apartments and stores in shopping malls. However, if there are two or more individuals to benefit from a single household or a group applicant, points are given to the first individual who has applied for the membership.

Obviously, support from the public utility companies (regional electricity providers, waterworks, and gas suppliers) is critical in collecting relevant data for computing points rewards. A web-based operating platform has been established to automatically access relevant records from utility companies, reducing the cumbersome procedures involved in data input and validation.

The points earned for each semiannual period are capped at 17,500 points as shown in Table 17. The local governments independently decide on the monetized value of each transaction point in the eco-money cards; each point is given a maximum of 2 KRW for individuals of households and 10 KRW for individuals of group entities. Therefore, the maximum amount of monetized benefits for a given semiannual period is 35,000 KRW (approximately US$32) and 175,000 KRW (approximately US$159) for individuals of households and group entities, respectively. Note that the public budget necessary for the incentive award is borne equally by the central and local governments, which is the basis for allowing local governments to operate a flexible reward plan.

Outcomes and Takeaways

After 24 local governments pilot tested the scheme for 4,300 households from November 2008 to June 2009, the Carbon Points System Operating Regulations was enacted in June 2009. This marked the period when local governments began to submit their applications to MoE for participating in the scheme, and by March 2010, all local governments in the nation (232 local governments) had joined the program; the Seoul Metropolitan Government and Gwacheon City Government have decided to operate similar schemes separately from the MoE. As of 2013, a total of 3.88 million households and group entities have participated in the scheme. The figure accounts for a reasonable portion (19%) of the total households in the nation, but is still well below the target subscription rate of 40 percent by 2018 set by the MoE.

Despite the success, the scheme has experienced the following challenges that provide meaningful lessons for introducing similar incentive schemes at a nationwide level:

- Initially, incentives were offered based on the actual amount of GHG emissions reduced (10 g of CO_2 = 1 point) relative to the baseline value of past consumption, which was also to be deducted by the same amount. However, deductions in baseline emissions worked as a hindrance to sustained outcomes, as there is a practical limit to reducing emissions by households. Ultimately, a policy revision in 2011 aimed to fix the baseline emissions in order to sustain the level of mitigation actions. Despite such revision, the incentive scheme was criticized for favoring households with high levels of resource consumption to start with; in other words, households that have voluntarily taken early actions to reduce consumption are less likely to benefit from the scheme. In response, the MoE announced in 2014 that the scheme should periodically reduce the baseline emissions by 3-6% based on the participant's past performances (e.g., 6% reduction for households that have achieved GHG emission greater than 10%).

- One of the most critical shortcomings of the Carbon Points System is the failure to resolve the issue of budgetary burden on local governments. Obviously, a greater number of subscribers means greater budgetary responsibilities, which fails to motivate local governments operating on a tight budget. One city government reported in 2013 that they have failed to fully grant the payment to beneficiaries on time due to budgetary constraints. The Seoul Metropolitan City Government initially opted out from participating in the scheme due to concerns over funding uncertainties.

The Carbon Points System is now firmly positioned as a representative government incentive scheme for reducing GHG emissions from the non-industrial sector. The scheme opens opportunities for citizens to pursue low-carbon green growth by directly taking part in the green initiative. The MoE reported that the scheme has contributed to reduction of approximately 0.7 million tons of GHG emissions per year, equivalent to 1.6 billion kWh of electricity savings. An important aspect that has captured public attention is how the scheme eases the financial burden of households thanks to reduced utility bills, in addition to accrual of carbon points.

The support of the local government is critical as they manage and operate the scheme at their own discretion while reporting regularly to the central government to request additional funding. For example, the subscription rate of Seogwipo City of Jeju Island reached 43.4% as of 2013, thanks to the persistent efforts of the local government to promote the policy; the local authorities even initiated an annual award targeting the participating local towns and villages. Several local governments have drawn agreements with participants to donate their carbon points to those in need within their communities.

3.2 Green Education and Environmental Awareness

The Green Start Campaign is a nationwide campaign launched to engage the public in GHG reduction in the non-industrial sector. As a governance consultative group born out of government-private sector cooperation, the campaign aims to establish and disseminate a low-carbon, eco-friendly living culture; relevant programs under the initiative prioritize shared eco-friendly values and environmental concerns among the citizens to respond to climate change. In many aspects, the campaign envisioned replicating the nation's success from the Saemaul Movement of the 1970s, which was the cornerstone of Korea's rural revitalization. The movement put forward a forceful mantra emphasizing diligence, self-help, and collaboration to encourage citizens to participate in the nation's efforts toward overcoming poverty and achieving economic development. Nurturing of community leadership and social reforms inducing cognitive attitudes toward shared values for communal prosperity was a critical factor of success; the Saemaul Movement led the six-fold increase in the average income of rural households during 1970-1979.

In line with how the Saemaul Movement seeks to overcome obstacles through the active participation of citizens, the Green Start Campaign mobilizes the public to take part in worthwhile activities, whether big or small, such as choosing public transportation or walking instead of driving a vehicle, and switching from hard copies to electronic files. Sustaining continuous public participation in such initiatives requires diversification and extension of incentives provided by the government. It is also desirable for the public to develop a sense of ownership in putting "green consciousness" into practice by actively participating in green policy programs. This section aims to introduce some of the many programs that have been carried out under the Green Start Campaign:

Table 17: Performance standards and payment for the Carbon Points System

Category	Reduction by 5-10%	Reduction by 10% or more
Electricity	5,000 Points	10,000 Points
Water	1,250 Points	2,500 Points
Gas	2,500 Points	5,000 Points
Total	8,750 Points	17,500 Points

Source: PJ Park, 2014

(1) Green Leaders Program to foster leaders who can widely promote the value of low-carbon green growth;

(2) Green Campus Initiative to instill eco-friendly practices in colleges and universities; and

(3) "Cool-Mapsy" Campaign to reduce GHG emissions and save energy in people's daily lives.

3.2.1 Green Leaders Program

A Green Leader is an activist or champion of change who plays a key role in leading the Green Start Campaign. Primarily, he/she supports the development, implementation, and promotion of the Green Start Campaign by working in four specific areas:

(1) assessing the amount of GHG emitted by households and businesses, and providing consultation services at the local community level;

(2) educating residents in GHG reduction and climate change response;

(3) developing and disseminating green public programs that have been customized to the local circumstances; and

(4) developing and implementing green education programs for public schools.

Given how the work of green leaders essentially helps to improve public awareness and participation on climate change mitigation, the level of public participation in the Carbon Points System – a flagship scheme for reducing emissions through lifestyle changes – serves as an indicator to gauge the outcomes of the program.

Implementation

All local governments were guided to formulate strategies for fostering of green leaders and develop operational plans with the support of their local Green Start Network. Accordingly, local governments came up with different concepts on the roles and given responsibilities of their green leaders, along with criteria for monitoring and evaluating the outcomes. The engagement of green leaders by local governments involves the following stages:

1. **Selection and Posting:** Local governments invited individual applications from future green leaders. Invitations are to be disseminated in coordination with the local community centers, NGOs, public schools, and businesses through various forms including emails, public campaigns, and advertisements on local media. Making sure that the selection of applicants strikes a balance between different community groups (e.g., restaurant managers, teachers, students, homemakers, and the elderly) is important for green leaders to have an impact across society as a whole. Eligible applicants are shortlisted and assigned to relevant duty stations based on their background and experience.

2. **Education:** A package of educational programs is provided to the selected applicants. The curriculum is divided into three stages – beginner,

Table 18: Short and long-term goals of the Green Leaders Program

Goal: Establishment of a green living culture by fostering Green Leaders
[Short-term targets, 2010] (Output) Educate 10,000 leaders across different regions and sectors (Outcome) Expand public participation in Carbon Points System to 2.5 million households
[Mid-term targets, 2011-2012] (Output) Develop education programs in specialized subject areas and expand the number of leaders to 30,000 (Outcome) Expand public participation in Carbon Points System to 3.5 million households
[Long-term targets, 2013-2015] (Output) Develop education programs to cover all subject areas related to green growth and expand the number of leaders to 50,000 (Outcome) Expand public participation in Carbon Points System to 5.0 million households

intermediate, and advanced – reflecting the knowledge and skills to effectively fulfill the responsibilities. The Green Start Network is responsible for providing the necessary materials and educators to run the curriculum in local governments, with the support of the central government and educational institutions such as universities and specialized schools. The higher level curriculum covers more detailed and extensive syllabi, such as introduction to global climate negotiations, fundamentals of renewable energy systems, theories of resource circulation, and measures for greening production and consumption. These advanced curriculums ultimately seek to foster educators who can utilize the curriculum for the beginner and intermediate levels. Applicants must attend a minimum number of hours and complete a number of scheduled syllabuses to be granted the letter of certification and be appointed as green leaders.

3. **Engagement:** Green leaders who have completed the training process are expected to perform their respective roles (classified by the level of training completed) of promoting green living at their duty stations. As shown in Table 19, green leaders are provided with the opportunity to engage in a variety of Green Start Campaign activities that may take place within their respective communities.

4. **Supervision and Management:** The local government office develops and operates a database that keeps track of information (e.g., list of names, contact information, and duty stations) relevant to fostering and engaging green leaders. Proper supervision and management of the Green Leaders' activities enables them to monitor their own performance and gain a sense of personal accomplishment from the activities that they are engaged in. Accordingly, a Green Leader Working Group is established within the local Green Start Network, composed of green leaders from at least the intermediate level.

   The working group coordinates between MoE, local governments, and the Green Start Network to build the support necessary for the successful engagement of green leaders. The budget for this program comes from the Green Start Network, which is funded by the MoE.

5. **Evaluation:** This stage seeks to ensure the quality of service provided by green leaders. Individual evaluations are carried out, which provides a basis for future target setting, provision of awards, and needs for receiving supplementary education or changing of duty station. Given the voluntary nature of green leader engagement, a fair and transparent evaluation is critical to avoid unnecessary complaints or misunderstanding. In this regard, the MoE has set out standard criteria for evaluation, which include factors such as number of hours served, the degree of responsibility, personal achievements, and innovativeness of engagement. Green leaders are to provide feedback on ways to improve the effectiveness of their engagement during the evaluation process. In addition to individual evaluation, local governments are also evaluated by the central government on their efforts to foster and engage green leaders. The evaluation is made primarily on a quantitative basis using indicators such as number of green leaders fostered, number of participating households in the Carbon Points System, number of green campaigns held, and amount of GHG emissions reduction.

Outcomes and Takeaways

As of 2011, a total of 29,510 green leaders (25,158 - beginner, 3,274 - intermediate, 1,078 - advanced) were trained across the nation. The number of households that received GHG emission assessments from green leaders (intermediate level) reached 101,962, and the number of people trained by green leaders (advanced level) totaled 494,290 by May 2012. The annual "Green Leader Challenge," which is an event organized by MoE to identify and award activities supervised by green leaders with outstanding achievement, have demonstrated how the green leader program has embedded green living into the community through the provision of a diverse range of activities (refer to Table 20). Most importantly, green leaders have been successful in translating the growing levels of public awareness on climate change into tangible actions.

The green leaders program recognizes that the most powerful lever is education, and enhanced education at all levels of society can therefore make a big difference in improving the future environmental quality. Both the challenge and opportunity in education are anchored on providing a direct and strong sense of connection between the everyday lives of the public and the environmental quality; selfish behaviors of individuals that often arise from perceived self-interest and cultural norms are difficult to overcome in a short period of time. Although the program has enabled the public to take the front seat in hastening the transition to a green lifestyle, sustaining progress demands more standardized and specialized curriculums on fostering green leaders to account for the evolving policies and practices on climate change. The discrepancies among education curriculums in different local governments has hindered creating a centripetal movement across the nation and complicated the process of gauging the individual outcomes of green leaders.

The lack of rewards for green leaders is a demotivating factor for participants. Given how the applicants for the program are requested to invest a significant amount of time and effort just to earn the green leader certificates, some have inquired whether green leaders are provided with regular jobs or monetized benefits for engagement. Although the central government is continuously monitoring the efforts made by the local governments and the MoE is annually holding the "Green Leader Challenge" event, the impacts of these measures are limited and short-term. Understanding how green leaders are to

Table 19: Duties of green leaders by level of training courses

Green Leader	Specific Duties	Sample Activities
Beginner	Initiate green living promotion campaigns at the local level, in line with the directives of the central administration	- "Me First" campaigns for emissions reduction - Green consumption campaigns held in wholesale markets - Holding weekly "Green Days" for green living
Intermediate	Visit households to assess their GHG emissions and provide advisory for emissions reduction	- Household consulting to make the most out of the Carbon Points System - Household assessment on energy use - Public surveys on energy use and GHG emission
Advanced	Provide training for fostering green leaders (beginner, intermediate, advanced)	- Education for fostering green leaders - Climate change education in public schools

Table 20: Examples of activities led by green leaders

Category	Example Activities
Student-led activities	- Campaigns promoting the use of tumblers, handkerchief, and used papers - Awareness programs on the use of fossil fuels and deployment of renewable energy systems - Programs on growing mosquito shoo geranium plants to replace mosquito repellent sprays - Activities to identify standby power consumption of electric appliances in schools
Low-carbon living practices (beginner)	- Assessment of electricity consumption patterns in private and public buildings - Late-night visits for double-income households to collect applications for joining Carbon Point Systems - Recycling of disposed umbrella skeletons in community centers - Establishment of rooftop gardens - Opening of second-hand goods market for saving resources
Low-carbon living practices (intermediate)	- Consulting services for apartment complexes to improve energy efficiency - Urban heat island analyses to inform public on the needs for green urban planning - Provision of community receptacles collecting used cooking oil to be used for making eco-friendly laundry soap
Climate Change Education (advanced)	- Storytelling education programs on climate change for primary school students - Summer and winter school courses on climate change for public schools - Training curriculums and site-visit programs for public school teachers

Source: MoE, 2014f

engage on a voluntary basis – rewarding values such as social responsibility, cooperation, and leadership – is critical to ensure long-term commitment by participants. A systematic process of target-setting and self-evaluation of outcomes can promote a sense of achievement, which is important to keep the participants motivated.

3.2.2 Green Campus Initiative

The Green Campus Initiative aims to transform university and college campuses into eco-friendly, energy-efficient institutions that foster green talents and lead community efforts on GHG-emission reductions. Basically, it is a government-funded project that supports activities related to:

(1) eco-friendly school management;
(2) establishment of eco-friendly facilities within campuses;
(3) curriculum development on environmental sustainability; and
(4) campaigns on eco-friendly living initiatives.

This project aims to increase awareness and participation of students as future leaders who can provide solutions to the rising environmental challenges. In this light, campuses are envisioned as hubs for education and research on green living practices to help achieve low-carbon green growth. Campuses that have been selected to participate in the program will become key channels for disseminating the government's green growth policies in the local communities and help boost public awareness on green lifestyle.

Implementation

The universities and colleges that wish to "green" their campus should submit applications to the Korea Environment Corporation (KECO), which is the implementing agency for the project under the supervision of MoE. The annual call for applications contains evaluation criteria for the selected green campuses, which identifies categories of activities that are most relevant to achieving the objectives of the program. Successful applications lead to the signing of a "Green Campus Agreement," which promises technical support from MoE and KECO – the signing parties of the agreement – in addition to the 120 million KRW grant from MoE over a period of three years. The presidents of universities and colleges participating in the initiative have created a "Cooperative Council" to serve as a platform for sharing of information, ideas, and experiences. The outcome of the three-year implementation are evaluated by the KECO; green campuses recognized for outstanding performance are awarded with ministerial commendations from MoE.

The technical support provided by KECO focuses on the establishment of GHG inventories for universities and college campuses and the adoption of technologies for reducing GHG emissions. Recognizing campuses as high carbon emitters, KECO released the Guidelines for the Establishment of GHG Inventories of Universities and Colleges in 2011, and the Guidelines for the Formulation of Emissions Reduction Plans for Universities and Colleges in 2012. These guidelines provide easy-to-follow instructions on applying different tools and methods (e.g., BAU projections of emissions and feasibility assessment on mitigation actions), which enable and encourage campuses to establish their own GHG inventories and set voluntary GHG reduction targets. The universities and colleges participating in the Green Campus Initiative are eligible for free training from KECO; a total of 10 green campuses selected for the first implementation year (2011) have created their GHG inventories for the year 2010.

Outcomes and Takeaways

A total of 30 universities and college campuses were selected to take part in the initiative from 2011 to 2014. The participating campuses have come up with a series of activities such as upgrades into energy-efficient facilities, energy-saving campaign, green space expansion, and organization of a green school management committee. The MoE has laid out additional efforts to reinforce the project such as hosting a public contest, "Practice of Green Living Contest: Essay, Idea, and UCC" and organizing events to share and promote successful cases among selected universities and colleges. In 2014, three out of ten universities and colleges that completed their three-year implementation period (2011-2014) were awarded the Ministerial commendation for their outstanding performance, such as Seoul Women's University (SWU), which was recognized for requiring all students to attend a semester course entitled "Climate Change and Green Growth." The course seeks to inform students on the need for the

ROK to respond to the impacts of climate change and understand how the concept of green growth seeks to transform trade-offs into synergies.

The success of MoE's Green Campus Initiative has been followed by the development of similar initiatives from local governments. For example, the Seoul Association of Green Campus Initiative was launched in 2013 as a coalition of the 34 universities and colleges located in Seoul that is supported by the city government, the Korea Energy Management Corporation, and the Climate Change Center (NGO). The participating universities and colleges have signed an agreement and released a declaration to reduce their energy use by 10% by 2017 (compared with 2012), which has provided the basis to the primary functions of the association in identifying and supporting a variety of voluntary energy-saving programs within campuses.

A survey regarding the "Green Campus Initiative," involving more than 800 students from the three selected universities, indicated how to maximize student participation by designing effective incentive measures (Green Korea, 2011). A large number of respondents identified the development of a wide range of participatory programs (40%) that meet the diverse needs and preferences as being critical to the establishment of green campuses. Specifically, the activities under the Green Campus Initiative should focus on promoting energy saving (32%) and installation of renewable energy systems (30%). An interesting point revealed in the survey was the question on how to improve student participation in the Green Campus Initiative as a large number of respondents (34%) highlighted the importance of providing monetized benefits for students in the form of tuition fee discounts. Such response implies how the high tuition fees in Korea lead to negligence on resource consumption; the provision of adequate incentives could thus be the most effective tool to improve student participation and induce a spirit of collaboration.

In the ROK, universities and colleges have become the core of R&D activities, aside from performing academic functions. As a result, they now account for 10 of the nation's top 50 organizations with

Table 21: Evaluation criteria for the selection of Green Campus

Category	Elements to be Evaluated	Example Activities
Environment	Sustainable energy	Use of renewable energy; installation of energy-saving facilities
	Resource circulation and waste management	Purchase of eco-friendly products; waste segregation and recycling practices
	Water quality	Rainwater re-use; installation of water-saving facilities
	Air quality	Installation of facilities preventing air-pollution; limiting the use of private vehicles
	Land-use planning	Development of green recreational areas
School Management	Strategies and plans	Formulation of green campus development plans and sustainable college management plans
	Operational guidelines	Development of guidelines and declarations on green campus
	Information exchange	Disclosure of all relevant information on the campus website
	Institutional framework	Establishment or designation of teams or individuals to lead the greening of campus
	Monitoring	Monitoring of outcomes for sustained environmental performance
Participation	Education	Curriculum related to sustainable development
	Research	Research projects related to sustainable development
	Student participation	Engagement of student organizations in the Green Campus Initiative
	Faculty participation	Engagement of faculty members in the Green Campus Initiative
Interaction with the Local Community	Local resident participation	Educational program for local residents; in-campus events on green living practices involving local residents
	Institutional partnerships	Cooperative research with local and international universities; establishment of environmental governance networks with local public institutions, corporations, NGOs, and schools

the highest energy consumption. In addition, the academic community has significant transportation demand, which is a root challenge for urban centers accommodating a large number of campus facilities. Such circumstances have justified the need for the government to take proactive actions on placing campuses at the forefront of reducing GHG emissions. However, recognizing how the potential for emissions reduction in campuses centers on bringing about changes in the operation of physical assets such as buildings, it is true that the ROK's Green Campus Initiative has failed to focus on those that exercise authority over facility operations. As is often the case, facility operations are under the authority of entities that are less likely to interact directly with students and affect the board of management, which has the power to decide on the organization's vision, strategies, and activities. Thus, it is crucial to support a governance structure in a way that would highlight priorities on greening the campus operations.

3.2.3 "Cool-Mapsy" Campaign

The ROK exhibits a clear seasonal pattern of energy and electricity consumption, which typically peaks in winter and summer from running of heating and cooling devices. The government has struggled to meet the increasing energy demand under the changing climate, as depicted by the nationwide blackout in 2011, which was unprecedented in scale and caused by a failure to prepare for the surge in electricity use due to unusually high autumn temperature and uncoordinated maintenance schedules of power generation facilities.

The "Cool-Mapsy" campaign is a nationwide campaign that aims to reduce energy consumption during the summer season and thus contributes to GHG reduction by changing the dress code in the workplace. The campaign encourages employees to dress in comfortable clothes to stay cool at a higher office temperature, while maintaining due formality in the workplace. "Cool-Mapsy" is a combination of the word "cool," which refers to enjoying a cool summer, and the Korean word, "Mapsy," referring to one's personal fashion style; the initiative originates from the Cool-Biz (Cool & Business) campaign proposed in Japan, which also inspired a similar initiative, "Cool Work" in the UK. The ROK government kicked off the "Cool-Mapsy" campaign in 2009, targeting both public and private institutions.

Implementation

After naming the campaign as "Cool-Mapsy" through a public contest, the MoE hosted public symposiums and policy forums consisting of experts in related fields to discuss the dress code culture in response to climate change. In addition to serving the primary purpose of reducing energy consumption (which translates into monetized benefits for employers), dress codes that enable people to better adapt to the changing climate bring about benefits in terms of maintaining better health conditions and improving work efficiency. In order to formulate "recommended dress codes" that are well supported by the public, the MoE recognized the need to understand not just the function-utility, but public preference in terms of style and fashion.

As shown in Figure 4, the Cool-Mapsy dress code advises workers on desirable hairstyles, dressing tips, use of functional cooling items, and footwear including loafers and sneakers. As for the hairstyle of females, the bangs shall not cover the face and the hair shall be trimmed short or tied neatly. Men shall not let their hair on the sides or the rear of their heads touch the collars of their shirts. It is recommended that men do not wear ties, and that they unbutton the neck area, and wear short-sleeved shirts. Brightly colored tops in stripes or patterns are desirable since they look cool and refreshing visually. The pants should have pleats in front of the waist to ensure that they are not too tight, and the bottom hem should be wide enough to breathe and absorb moisture. Clothes made from functional cooling materials such as light linen and bamboo are recommendable since they tend to be stiff and have little contact with the body. Additionally, workers are encouraged to wear loafer-style summer shoes made of thin and light material or light sneakers to decrease the temperature of the feet, making them more comfortable and healthy.

Outcomes and Takeaways

The campaign spread rapidly from the public sector; many welcomed the Cool-Mapsy dress code to serve as a means for upholding the government's commitment to maintain room temperatures of work places at above 28°C. Posters, television advertisements, and social media informed the public how government offices should lead the adoption of the Cool-Mapsy dress code, which helped ease concerns over how civil servants may appear less professional. Government offices including the Seoul Metropolitan City and Chungnam Province have taken proactive steps, allowing employees to wear shorts and sandals to work and encouraging the management-level employees to create an environment where the Cool-Mapsy dress code is well respected. On the other hand, the promotional activities led by the Green Start Network, NGOs, and civil societies played a critical role in earning the participation from the private sector and households. For example, NGOs, fashion schools, and community groups partnered with department stores to hold "Cool-Mapsy Fashion Shows," which helped demonstrate how the dress code can be implemented, in addition to raising awareness of relevant clothing items. In response to the increasing demand, clothing stores launched special sales events on clothing items corresponding to Cool-Mapsy dress codes.

Although an official evaluation of the outcomes of the Cool-Mapsy campaign has not been undertaken yet, it has been widely recognized for reshaping public opinion toward energy consumption and savings. According to MoE, the Cool-Mapsy dress code has the equivalent effect of reducing the sensory temperature by 2°C. This in turn enables the indoor temperature to be increased by 2°C; adoption by all public commercial sectors across the nation is expected to lead to 1.97 million tons of annual CO_2 emissions reductions, which is equivalent to planting 700 million young pine trees. The monetized benefits from increasing the room temperature by 1°C during the summer (58 days of use) can save about 2,600 KRW in electricity bills from each air conditioning system. Health benefits such as preventing headaches, dizziness, and dry skin occurring from overexposure to excessive cooling that may arise from cutting down on air conditioning use are additional factors that have helped attract public participation. Following the success of the Cool-Mapsy campaign in the summer, the MoE has organized a similar campaign entitled "On (which means warm)-Mapsy" for the winter season. Through its promotion to wear innerwear and reduce the use of heaters, it is expected to deliver cost savings by reducing the amount of consumption in spatial heating.

3.3 Waste Management

Waste management is an area where the ROK government has carried out some of its most successful policies since the 1990s. Korea's high population density, rapid economic growth, and industrialization changed Koreans' once frugal and minimalistic lifestyle to a generation of abundance and waste. In response, the government launched efforts to curb waste generation by improving environmental awareness, launching waste-reduction campaigns, enforcing waste segregation, and implementing a volume-based waste fee system. These attempts proved to be effective and significantly decreased waste generation from 2.3 kg/day/person in 1991 to 1.05 kg/day/person by the end of 1997.

When the government first introduced the volume-based waste fee system, clarifying the rationale behind the "pay-as-you-discard" principle to the public posed a great challenge as shown by a surge of

Figure 4: Cool-Mapsy Poster and Lookbook

Source: Korea Climate and Environment Network, 2014 complaints from citizens and reported cases of illegal dumping of wastes. Nonetheless, the policy gradually gained public acceptance through consistent public education and awareness-raising campaigns. As a result, substantial changes were seen in the lifestyle and consumption culture of households. The adoption of a systematic recycling process has enabled the ROK to overcome resource constraints and boost the resource recycling industry.

In developing countries where industrialization is proceeding at a rapid pace, the government needs to demonstrate a stringent waste-management strategy since faster economic growth usually comes with an exponential increase in waste generation. In addition, building public consensus – grounded on a comprehensive public understanding of waste management policy leading to compliance – cannot be achieved in a short timeframe and thus requires sustained efforts on information, education, and communication. Korea's success stories in the field of waste management can provide a number of meaningful insights and implications for developing countries, especially with regard to designing and implementing effective systems based on strong public education and community outreach, backed up by strict policy reinforcement.

3.3.1 Volume-based Waste Fee System

Based on the "pay-as-you-discard" principle, the volume-based waste fee system aims to create a clean and waste-free environment by mobilizing citizens to voluntarily reduce their waste and adopt recycling as part of their daily routine. Unlike previous policies that imposed disposal fees based on the size of the residence or the total amount of property tax, the volume-based system mandates residents to pay a disposal fee that is directly proportional to the volume of waste they discharge through the sales of pre-paid garbage bags. The disposal of municipal waste must be done through the use of these bags that come in different prices according to their sizes. The local governments with the legal mandate for waste treatment have the flexibility to decide the price of pre-paid garbage bags that are to be used strictly within the local regulations. Although the sole profit from the sales of garbage bags cannot cover the entire cost of waste collection, transportation, and treatment, experience has shown that it is enough to make up for a minimum of 20-30% of the total cost in most local governments.

Implementation

The volume-based waste fee system applies to individual households and small businesses generating waste of less than 300 kg per day. The items eligible for disposal using the pre-paid garbage bags are municipal waste (i.e., inorganic waste), which excludes recyclable wastes, food wastes, and large-sized wastes (e.g., electric appliances and furniture). The residents dispose of the pre-paid garbage bags at centralized waste collection sites established in convenient locations of the community. However, in communities that are less densely populated (e.g., detached houses) and thus are not provided with centralized waste collection sites, residents should discharge their wastes in front of their homes at designated days and times of the week. Collection trucks regularly pick up the garbage bags for transport to landfills (some via incineration facilities for volume reduction) for permanent disposal.

The enforcement of waste segregation was implemented along with the volume-based waste fee system in 1995. The recyclable wastes that are to be disposed of into separate receptacles at the waste collection sites are categorized into papers, metal cans, glass bottles, scrap iron, and plastics, respectively. The segregation of food waste from the pre-paid garbage bags was made mandatory in all city and county governments only in 2005. After direct landfilling of food waste was banned by law, the government introduced a separate receptacle for collecting food waste at waste collection sites. However, since charging flat fees for disposal through the use of receptacles does not encourage the reduction of waste volumes, the government expanded the application of volume-based waste fee system to food wastes in 2010 (details to be provided in the following section on Weight-based Food Waste Fee System). The large-sized wastes are disposed of individually on a case-by-case basis; recyclable wastes are collected free of charge by community resource-recovery centers, but non-recyclable wastes are disposed of through the engagement of privately owned waste-treatment companies.

The MoE is in charge of overseeing the operation of the volume-based waste fee system and waste segregation practices. Specifically, it is responsible for revising national laws and operational guidelines on waste management, providing technical support to local governments, and monitoring and evaluating their performance. On the other hand, local governments are at the frontline of implementation, preparing and revising their regulations and policies for enforcement to better meet the unique local conditions. Local governments are given the legal mandate to collect, transport, and treat municipal waste; in 2012, a large portion of the landfills (95%) and waste incineration facilities (94%) were directly owned and operated by the local governments. The civil society groups also have an important role to play, specifically by actively engaging in public awareness campaigns on waste management, ensuring that residents' concerns or complaints are well reflected into the government plans, and monitoring the fairness and effectiveness of local governments' operations and budgetary decision-making.

Private businesses are at the heart of 3R (reduce, re-use and recycle) of resources in the ROK. As a response to the increasing amount of recyclable wastes after the enforcement of waste segregation practices, the government engaged private companies to pursue profit from re-using waste, under the guise of cutting public costs, increasing amount of recyclable wastes segregation practices, the government engaged private companies to pursue profit from re-using waste, under the guise of cutting public costs, increasing efficiency, and fostering waste management industries. The community leaders of communal residences (e.g., apartment complexes) with the authority over the operation of the centralized waste collection site are free to sign contracts with privately owned recycling companies that are willing to buy their recyclable waste. However, in communities of small group residences or detached housing, recyclables collected are often insufficient for private companies to make profit as it is outweighed by costs in waste collection and transportation. As a complementary measure, the local government authorities directly collect, transport, and treat recyclables in such communities. As of 2012, privately owned resource-recovery centers shoulder approximately 62% of total recyclables of municipal waste generated in Korea.

The central government's Waste Control Act (1986) and Act on the Promotion of Saving and Recycling of Resources (1992) provide the maximum amount of fine the local governments are allowed to impose for not meeting the waste disposal requirements. For example, a fine of 100,000 KRW is levied in many communities for the use of unauthorized garbage bags, illegal burning of waste, and mixing recyclable wastes or food wastes in pre-paid garbage bags. In order to effectively crack down on illegal activities, many local governments have installed surveillance cameras in waste collection sites, in

Figure 5: Pre-paid garbage bag and waste collection sites with receptacles for segregated waste disposal

Source: The Jeju Weekly, 2012

addition to operating inspection teams and hotlines for reporting violations. Waste collection trucks refuse the collection of garbage bags that contain recyclables and food waste; waste collectors rip them open for on-site inspection on an occasional basis and place warning labels indicating the need for waste segregation. The rewards for reporting of illegal disposal activities reach up to 10-20% of the fine imposed on illegal activities. As shown in Table 22, the number of reported violations has been decreasing, implying how government enforcement is continuously gaining stronger public acceptance.

Outcomes and Takeways

As of 2012, the volume-based waste fee system has been adopted in almost all administrative districts of Korea; this is equivalent to 20,212 out of 20,180 households nationwide. Of the total municipal waste generated, the share of disposal through the use of pre-paid garbage bags was 43.4%, while the rest accounted for waste segregation practices. Out of the total spending by local governments for collection, transport, and treatment of waste disposed through pre-paid garbage bags, an average of 25.2% was covered by profits derived from sales of garbage bags nationwide, with Ulsan city having the highest share at 54.3%. The sale of pre-paid bags has fallen slightly (under 2%) over the period of 2008-2012, which has been the primary reason to the declining coverage of costs from the sales of pre-paid garbage bags; the nationwide average was 36.2% in 2008.

As shown in Figure 6, the volume-based waste fee system proved effective in controlling the total volume of municipal waste generated in the ROK. Despite a 2.5-fold increase in the nation's GDP from 1994 to 2013, the total amount of municipal waste decreased by 16%. The declining trend is more evident in terms of the amount of waste generated per capita, which experienced an approximately 60% decrease over the same period.

Although the progress has been slow, waste per capita figures continuously dropped in the 2009-2013 period (this is also the implementation period of the Five-Year National Plan for Green Growth), reaching 0.94 kg/person/day, which is far below the average of OECD countries at 1.48 kg/person/day (OECD, 2013). The major underlying factor that enabled the reduction of waste was behavioral changes of the public in relation to the sales of pre-paid garbage bags. In order to reduce their spending on garbage bags, people sought to curb their absolute waste disposal by various means such as consuming efficiently and purchasing goods with less waste. However, it is equally important

Table 22: Number of illegal waste disposal reports and fines charged nationwide

Year	Number of violations			Amount of fines charged (million KRW)		
	Total	Report from residents	Report by government inspection teams	Total	Report from residents	Report by government inspection teams
2009	457,937	65,556	392,381	14,518	1,434	13,084
2009	409,191	30,524	378,667	13,955	1,027	12,928
2010	371,584	27,182	344,402	10,755	749	10,006
2011	351,691	25,741	325,950	12,160	932	11,228
2012	258,193	23,453	234,740	7,219	875	6,344
2013	267,212	25,024	242,188	7,942	963	6,979

Source: MoE, 2015a

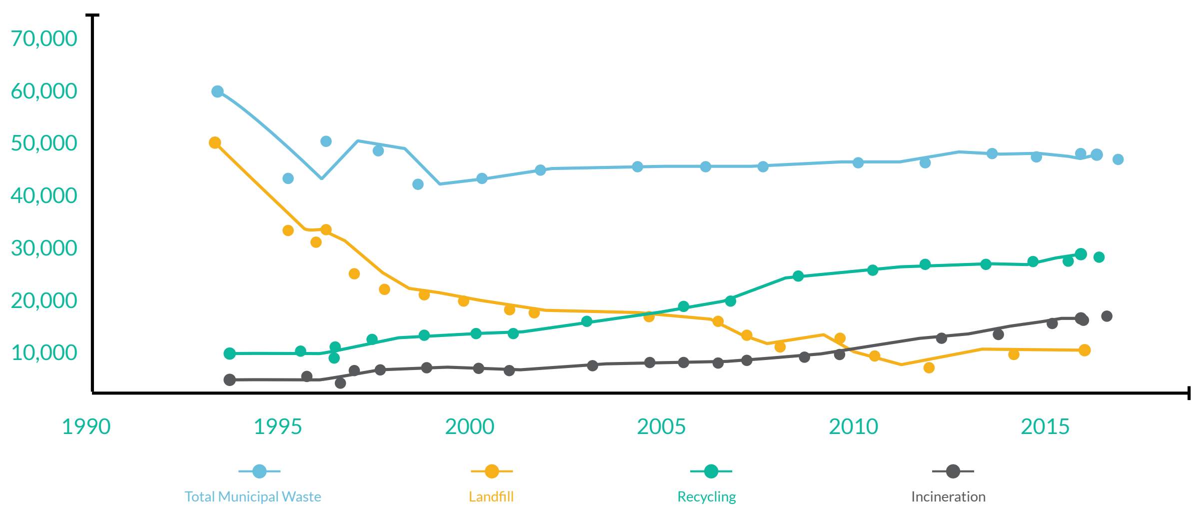
to understand that the government also enforced regulations upon product manufacturers and retailers to keep pace with the changing social behavior. In 1994, the Act on the Promotion of Saving and Recycling of Resources prohibited the use of single-use disposables such as paper cups and plastic tablecloths in restaurants, as well as restricting their free distribution (e.g., free plastic bags and complimentary drinks in paper cups). In order to reduce the use of disposable plastic bags, the government enforced a scheme in 1999 that mandates department stores and wholesale markets to provide refunds to customers who return used plastic bags. More recently, the use of disposable plastic bags has become fully prohibited in large retailers; they should use paper bags or sell pre-paid garbage bags to serve the same purpose.

The volume-based waste fee system was not only effective in reducing waste generation, but was also instrumental in the promotion of recycling. The total amount of waste recycled increased by 26.7% in the year after the enforcement of waste segregation, and annual increases continued until 2008; recyclables cover approximately 60% of the total municipal waste discharged. It is worth noting that increasing rate of resource-recovery is also an outcome of government control over product manufactures. In 1993, the government enacted a law that mandates manufacturers to bear the disposal cost of their products that are not easily recyclable. The law also restricts product manufacturers from over-packaging; for example, this law was strengthened in 2012 to limit the empty package volume of confectionery goods to 20% of the total volume of the product.

The direct benefits that arise from volume-based waste fee system and waste segregation practices are the cost savings from waste management (collection, transport, and treatment) and increased economic value of recyclables. The Korea Institute for Industrial Research reported in 2005 that the total direct benefits accrued from 10 years of implementation (1995-2004) reached approximately 8 trillion KRW, equivalent to US$ 7.3 trillion (Kim, 2005).

However, it is equally important to understand that there are indirect benefits involved, such as lowering of social costs. By reducing the volume of waste, communities are able to prolong the life of existing landfills and postpone the need to locate new disposal facilities. This spares the government from building additional landfill sites and from having to resolve social conflicts regarding the location of new landfill sites. Admittedly, the benefits of environmental protection such as the prevention of landfill leachate and air pollution are difficult to monetize. The implementation of the scheme also paved the way for the promotion of resource-recovery industries, which was initially believed to have limited feasibility in Korea.
Without doubt, the volume-based waste fee

Figure 6: Amount of municipal waste discharge by treatment (ton/day)



Source: MoE, 2014

system succeeded in improving the environmental awareness of the public. The economic burden placed on waste discharge catalyzed public understanding on the need for effective waste management, which extended to enhanced public interest in the nation's environmental challenges and embracement of the "polluter pays principle."

The public campaigns and the government's strong will to punish illegal conduct played a critical role in the process. In the early years of system enforcement, public indifference and disobedience led to problems such as illegal waste dumping and fierce complaints on mandatory use of pre-paid garbage bags. Local government offices suffered from inadequate administrative capacity to fully support the policy implementation. However, building public consensus based on solid government-citizen cooperation helped in gaining public acceptance and ensuring successful policy enforcement. For example, the local government offices trained individuals to be appointed as honorary inspectors monitoring waste disposal activities in their communities. Honorary inspectors also served as champions of change by providing public guidance and education to embed the system across a wide range of stakeholders.
The official inspection teams composed of local government officers also worked seamlessly to identify individuals responsible for illegal conduct, despite the challenging process involved in securing evidence from waste examination.

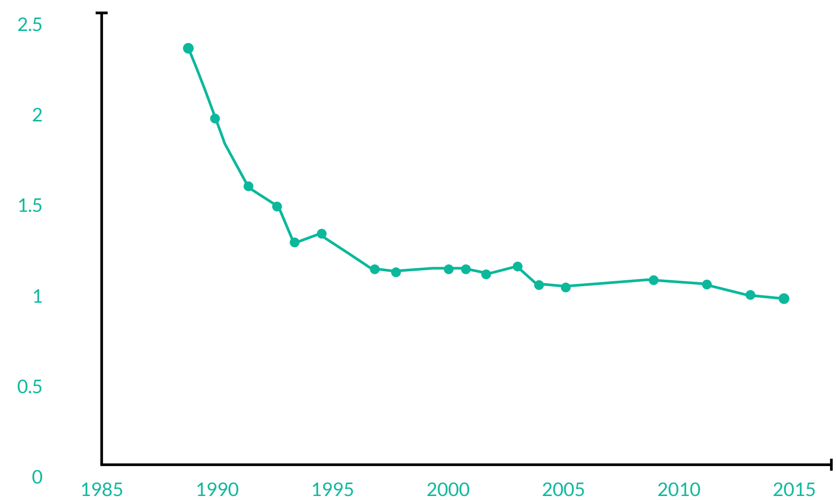
3.3.2 Weight-based Food Waste Fee System

Despite the success of the volume-based waste fee system, the amount of food waste generated continued to increase in the ROK, owing to the rising levels of income, increasing dining out habits, and tradition of preparing a large number of small dishes. The total amount of food waste generated increased from 11.4 tons/day in 2000 to 14.5 tons/day in 2007; disposal per capita also increased from 0.24 kg/day to 0.29 kg/day over the same period. As a response to the continued increase in the amount of food waste generated, the "pay-as-you-discard" model was extended to food wastes for pilot testing in 2010, and made fully enforceable in all administrative districts in 2013. Before the policy was introduced, the disposal of food wastes was either free or charged a flat rate (which made up for less than 30% of their treatment costs) among local governments. The launch of the weight-based food waste fee system enabled a full-fledged implementation of the principle, "waste disposal charge = amount of waste disposed."

Implementation

The weight-based food waste fee system applies to households and small-scale restaurants with floor area less than 200 m^2 in 144 city and county governments (out of a total of 230 local governments) that are practicing food waste segregation. Local governments are to choose one of

Figure 7: Amount of municipal waste discharge per person (kg/day/person)



Source: MoE, 2014

the following three ways of operation to impose fees on food waste disposal:

- **Pre-paid Garbage Bags:** Food waste is disposed of using specially designed and distinctively colored pre-paid garbage bags for collection at centralized waste collection sites (or in front of homes for detached housing).

- **Pre-paid Chips or Stickers:** Residents dispose of food waste into standardized disposal containers that have attached a pre-paid chip or sticker that can be purchased in local wholesale markets. When waste collectors empty the containers, they remove the chip or stickers to allow re-use of food disposal containers. However, the containers without pre-paid chips or sticker attached are not emptied by waste collectors.

- **Radio Frequency Identification (RFID) Tags:** The local government makes available disposal booths specifically for food waste that are equipped with magnetic card reader and weight measuring device. Households provide their information upon disposal using their magnetic cards, which opens the booth to measure the exact weight of food waste. The information on the weight of the disposed food is transmitted to a centralized online management system; the monthly disposal data serves as the basis for charging fees to each household.

The central government has strongly recommended that all local governments adopt the use of RFID tags as it enables accurate imposition of fees and avoids single-use of chips, stickers, or plastic bags. In addition to the method illustrated in Figure 8, several alternative methods have been proposed to make the most efficient use of RFID tags. For example, in communities of single-family detached housing, households are required to dispose of food waste in containers with RFID tags attached to allow waste collectors with portable RFID readers to retrieve and transmit information for imposing disposal fees. Waste collection trucks may be individually equipped with RFID readers and weight measurement device to serve the function of RFID food waste disposal booths. However, given the varying circumstances of communities and local government offices, the central government has been flexible in allowing the use of pre-paid chips or stickers; only in exceptional cases is the method of pre-paid garbage bags can be adopted on a long-term basis.

Setting the food waste disposal fee is to strictly follow the "polluter pays principle" based on the actual weight of the waste disposed. In other words, the monthly fee is equivalent to the unit cost of waste treatment (cost/kg) multiplied by the total weight of disposal (kg). In cases where the waste disposed is measured by volume (e.g., use of pre-paid garbage bags), local governments are to utilize appropriate weight-volume conversion factors. However, it should be noted that the unit cost of waste treatment may vary in different areas, leading to differentiated fees. In addition, the local government may choose to impose fees at a common flat rate among households in selected communal residences. In other words, households are to share an equal burden for the total amount of food waste discharge from their communal residence. Local governments also have the flexibility to ease the burden of households by imposing only a portion of the treatment cost as fees to the households. For example, the central government specifically guided local governments to impose 28.1% of their unit treatment cost as fees during the first year of policy implementation. Accordingly, the fee was fixed at 73 KRW (approximately US$ 0.06) for each kilogram of waste disposal. However, the plan is to annually raise the rate so that 80% of the treatment cost can be covered by revenues from fee collection by 2015-2016 in cities and by 2017-2018 in counties. The central government is also considering the introduction of tiered pricing to incentivize households with lower volumes of waste disposal.

The MoE takes charge of the overall management of the weight-based food waste fee system with the support of the Korea Environment Corporation (KECO), which operates the centralized online management system that collects waste disposal data of households. The local government offices are in charge of imposing and receiving disposal fees in their respective regions. In addition, they are mandated to maintain good sanitation conditions of disposal sites by providing cleaning and disinfection services on a regular basis.

In order to accelerate the adoption of RFID tags, the central government has provided financial grants for the installation of RFID food waste disposal booths in local governments that have taken part in pilot projects during 2010-2013. Approximately 11.3 billion KRW was provided to 25 local governments, and funding of 1.6 billion KRW was provided for the establishment of the centralized online management system in KECO. The central government has planned to shoulder 30% of the installation cost in all local governments until the end of 2015.

Outcomes and Takeaways

As of 2014, the weight-based fee system has been adopted by 143 out of 144 city and county governments that account for more than 95% of the entire population. The effectiveness of the system is yet to be determined as it was enforced nationwide only in July 2013. However, a significant number of local governments that have taken early actions through pilot projects have already confirmed that the system has led to a notable reduction in the total amount of disposed food waste.

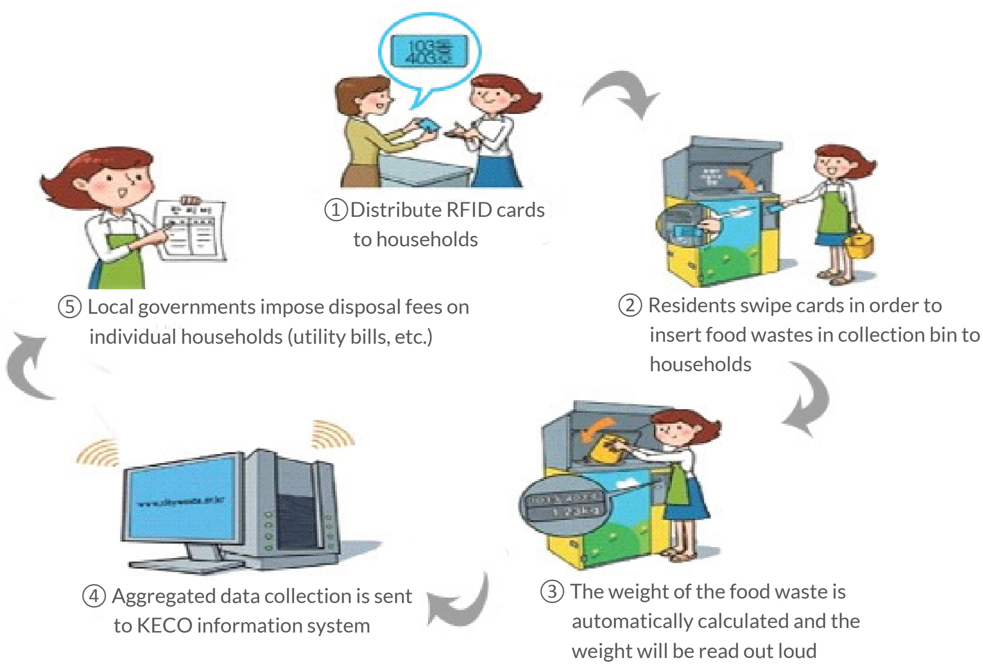
For example, the city of Gimcheon, which was one of the first cities to adopt the use of RFID tags in 2012, reported that the total food waste generated decreased by 47% compared to the previous year. Accordingly, the residents pay less fees from food waste disposal as the average monthly fees per household decreased from 1,500 KRW to 700-800 KRW. Likewise, the city of Gumi reported that food waste reduction has reached 40% after the phased adoption of the system into different city districts from 2012 onwards. This outcome has led to 290 million KRW of savings in public expenditures and approximately 6,385 tons CO_2 eq. of GHG emissions.

As shown in Table 23, public surveys have confirmed that the volume-based fee system is widely supported by the public as awareness of sustainable waste management continues to improve. It is worth noting to understand that the government's sideline efforts to boost the effectiveness of the system have played a crucial role, and these include the following:

- Customized programs on food waste reduction have started in government offices from 2010 as a means of ensuring that the public sector leads by example. For example, the MoE started day-to-day monitoring of the amount of food waste generated and natural gas used for cooking activities in all offices and institutions under their authority. The cafeterias of the central government office complex started to operate "fast-track" dish return counters for guests with zero food waste from their meals. In addition, there was a switch from multi-compartment garnish trays to regular plates to prevent overfilling.

- Public schools and universities were supported by the government to launch customized programs and campaigns on food waste reduction. The

Figure 8: Process of RFID weight-based food waste fee system



Source: MoE, 2012c

implementation of food-waste-fee days, day-to-day monitoring of food waste of students or class groups by instructors, and provision of free drinks to students with zero food waste are some of the notable activities.

- Cafeterias of large private firms, rest areas on expressways, military units, and hospitals were requested by the government to voluntarily implement waste reduction through several means, such as changing the serving sizes and garnishes, allowing takeaways of left-overs, reducing prep-waste and improperly cooked food, and modifying the menu to boost customer satisfaction and reduce the portions left uneaten.

The central government made sure that sufficient grace period was provided to prepare for the enforcement of the weight-based fee system in advance. Most importantly, pilot projects on introducing RFID tags that started as early as 2010 provided insights into the preconditions, which the local government needs to create in order to enable households to adapt to the new system. However, nationwide enforcement was not without hardships and challenges. Differences in the adopted methods of disposal and fees imposed by local governments were at the center of public discontent.

The following lessons learned provide some useful pointers for designing similar systems that embrace the polluter-pays principle:

- Households that are required to use pre-paid garbage bags, chips, or stickers complained that their expenditures for disposal were inevitably higher compared to those of communities with access to the convenient RFID food waste disposal booths. Given how food waste must be removed frequently to keep their homes sanitary and to prevent foul odor, it has been difficult for these households to make the most out of the pre-paid garbage bags and standardized disposal containers that come in substantial volumes.

- Households of communal residences who pay the imposed flat fees have raised complaints that they have not been given opportunities to benefit from reduced waste discharge. Their rationale holds true, based on a survey conducted by a local NGO (Korea Zero Waste Movement Network, 2013), which reported that the amount of waste reduction achieved by households paying individual fees was significantly higher than those of communal residences.

- Cases of illegal dumping of food waste are found to be high in communities using pre-paid garbage bags, which are often viewed inappropriate (compared to the original method of simply segregating food waste into separate receptacles at centralized waste collection sites) as it leads to a greater amount of waste, thus failing to incentivize waste reduction practices. In addition, unpacking food waste from the pre-paid garbage bags prior

Table 23: Comparison of food waste disposal methods

Method	Advantages	Disadvantages	Application
Pre-paid garbage bags	- Convenience in disposal - Simple and easy means of charging disposal fees	- Volume-based measurement - Causes odors and not aesthetically appealing	- Residents with small amount of waste discharge, regions with poor waste collection circumstances
Pre-paid chips or stickers	- Reduces odors and more aesthetically appealing compared to pre-paid garbage bags - Standardized waste containers enable mechanical collection	- Volume-based measurement - Inconvenience in maintaining the cleanliness and functionality of containers	- Single-family detached housing
RFID tags	- Free from odors and aesthetically appealing - Charges fees based on accurate weight of food waste disposed	- High installation cost and operation fees - Requires consistent facility maintenance and management	- Communal residence such as apartment complexes

to treatment has proven to be a costly and time-consuming process.

- The large front-end costs of installing RFID food waste disposal booths has been a challenge to many local governments despite subsidies provided by the central government. Disposal booths have been reported to be costly at over 2 million KRW while their projected lifetime was short (five years). The need for maintenance as verified through pilot installations has kept local governments hesitant in making the necessary investments.

- Under the strong guidance by the central government to increase the coverage of waste treatment cost by revenues from collection of disposal fees, the unit disposal fee has diverged significantly among local governments as they have different operating and contractual conditions for treatment. Transparency in setting adequate fees and improving awareness on the required measures to achieve publicly agreed targets is important to earn the buy-in of the public and their active participation.

4. Assessment

4.1 Quantitative Assessment

The outcomes of the ROK's endeavors to promote green lifestyle practices can be evaluated on the basis of different indicators being monitored by the government. To start with, a simple yet comprehensive approach focuses on the changes observed in the amount of consumption by households and individuals that represent the non-industrial segments of the nation's economy. During the period under the Five-Year Plan for Green Growth, the ROK has made small yet steady improvements in reducing household consumption of basic necessities and these include the following:

- The trend in energy consumption remained consistent prior to the implementation of the Five-Year Plan. The consumption of energy in households amounting to 0.434 TOE/day/person in 2007 experienced a decline over the period of 2008-2009, but increased again in the following years. The ROK's household energy consumption is well below the OECD average, which amounts to approximately 0.6 TOE/day/person. As of 2013, the share of households controlling room temperatures based on government recommendations for summer (above 26°C) and winter (below 18-20°C) seasons was found to reach 82.2% and 76.9%, respectively.

- Water consumption per capita decreased annually from 340 L/person/day in 2007 to 332 L/person/day in 2012. Although not a significant amount, this progress is deemed notable, as the ROK's level of household water consumption is well below those of many developing countries. As of 2013, 24.3% of the households used water-saving equipment such as toilets and shower heads.

- The amount of household waste generated fell below 1 kg/person/day in 2010. Although household waste accounts for only approximately 13% of the nation's total waste as of 2013, it is another sign of positive progress. Note that the industrial waste (excludes municipal waste) and construction waste comprise the rest of the share of total waste, with 39% and 48%, respectively. The ROK's total waste generation exhibited a continued annual increase during 2010-2012 at a rate between 2.0-2.3%, but the rate decreased significantly to 0.02% in 2013. As of 2012, the average household waste generation of OECD is approximately 1.45 kg/person/day.

From the perspective of greening household patterns of consumption and lifestyle, the ROK was found to have made significant progress during the 2009-2013 period. Based on the data released by Statistics Korea (KOSTAT), many of the indicators relevant to green household practices, such as public use of transportation, and community activities, exhibited positive changes. In particular, the number of "certified environmentally friendly products" and "products with carbon labels" was found to have grown significantly in response to the increased public awareness of environmental sustainability and climate change.

In terms of public transportation, the reduction in the average distance traveled by privately owned vehicles and increased domestic sales of small-sized cars helped reduce energy consumption. The growing number of people taking part in the Carbon Points System was an indication of the public's growing interest in emission-reduction activities, as reflected in Table 25.

As described in the introductory section of this chapter, a key challenge identified in the ROK was the lack of proactive initiatives from the general public to translate their growing levels of environmental awareness into tangible actions. In order to identify the changes in the level of public engagement, KOSTAT carried out a comprehensive survey on the status of green lifestyle practices in 2011 and 2013. The survey of 2013 drew responses from approximately 19,000 persons (aged over 20) selected randomly. As shown in Figure 10, the survey was divided into three categories, including

(1) green households
(2) green transportation
(3) green communities

- Responses from the "green households" category indicated that public efforts toward reducing household energy consumption have continued to improve, yet public participation in government policies and programs that promote low-carbon goods and services remained low. As opposed to how the public is well engaged in energy-saving actions based on long-established perceptions that the nation imports nearly all of its energy needs, participation in newly introduced programs aimed at GHG emission reduction was still relatively low.

- The survey on public engagement in "green transportation" was aimed at understanding the progress made in terms of reducing non-essential travel (demand management) and improving transport patterns and behavior. Responses indicated that voluntary actions that are closely tied to providing financial benefits to individuals (e.g., reduced costs for fuel purchases and vehicle maintenance) have increased, indicating the importance of framing incentives based on personal benefits to generate voluntary participation. However, public participation in the government-led programs such as the "weekly car-free day" failed to reach levels targeted by the government.

- Combining the selected responses from the "green transportation" and "green communities" categories enables a better understanding of the progress made by the average middle-class commuters. An important indicator is the percentage of public transportation use, which is only 29.1%. There are many different causes that account for the high public resistance toward making a modal shift; challenges are multi-dimensional but the primary cause is the increasing commuting distance of the working class, which is a result of rapid and continuous urbanization and rising costs of residential spaces. Enhancing the accessibility and convenience of public transportation system is thus a long-term goal of many city governments in the ROK.

- On the other hand, the number of people participating in green practices at their respective work spaces was found to have increased. Particularly, there was a notable increase in the amount of energy-saving practices, such as turning off the lights during lunch hours, due to the support of corporate leaders, who agreed to take the lead in government-led initiatives.

- Responses in the "green community" category provided a good insight into the levels of public awareness and participation in environment-related policies and programs. It is interesting to note that while public awareness on initiatives related to green lifestyles was found to be low, public understanding and interest in climate change issues was relatively high. Without doubt, the level of public engagement in greening of lifestyle practices improved in 2013 relative to 2011, but its impacts are yet to be strongly felt. Many have responded that they "are still not sure of how to participate (44.3%)" and "do not have sufficient access to relevant information (21.8%)". progress of government strategies and plans in achieving targets, measurements for evaluating impacts should be made available.

Table 24: *Public survey on food consumption and weight-based food waste fee system*

Unit: %

Statement	2010	2011	2012	2013	2014
Waste management is a serious issue in the ROK.	84.5	89.3	87.0	87.9	87.3
I am aware of the weight-based food waste fee system.	68.8	73.8	80.4	86.9	85.5
The weight-based food waste fee system is necessary for waste reduction.		84.6	83.1	85.1	87.6
I agree with the implementation of the weight-based food waste fee system.	56.9	65.5	62.5	65.2	70.2
I intend to exert efforts on food waste reduction.	87.4	86.8	85.2	94.0	96.0

Source: MoE, 2015b

Table 25: *Changes in household consumption in Korea (2007-2012)*

Indicator	2007	2008	2009	2010	2011	2012
Household Energy Consumption (TOE/day)	0.434	0.432	0.418	0.429	0.434	-
Household Water Consumption (L/person/day)	340	337	332	333	335	332
Household Waste Generation (kg/person/day)	1.02	1.04	1.02	0.96	0.95	0.95

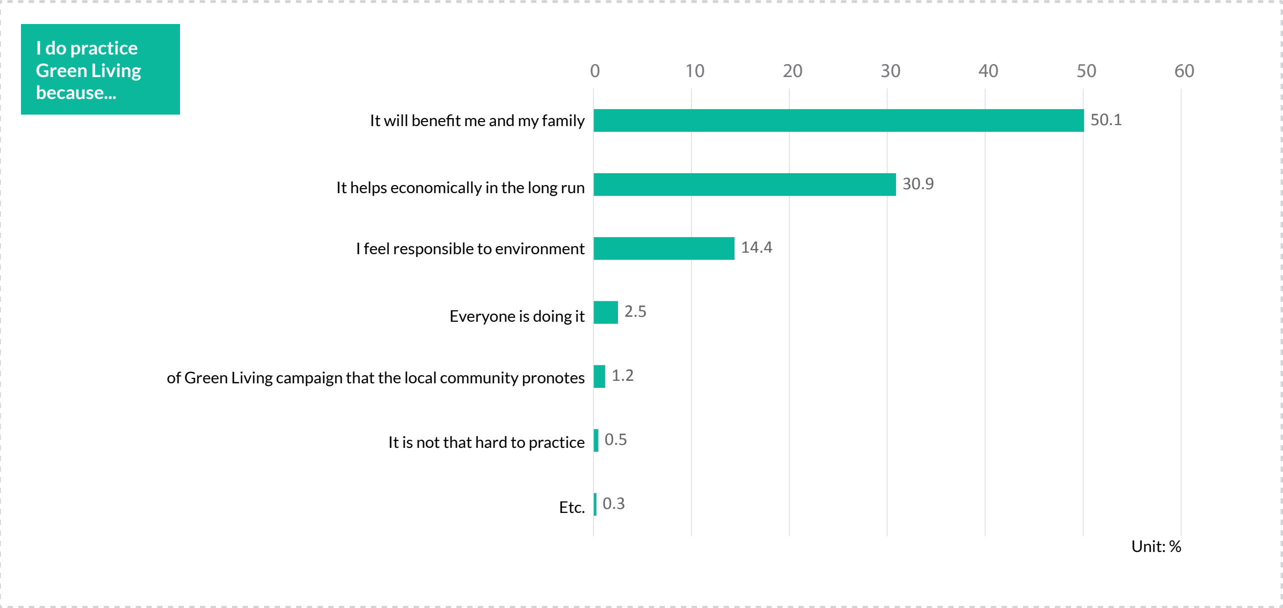
Source: KOSTAT, 2013

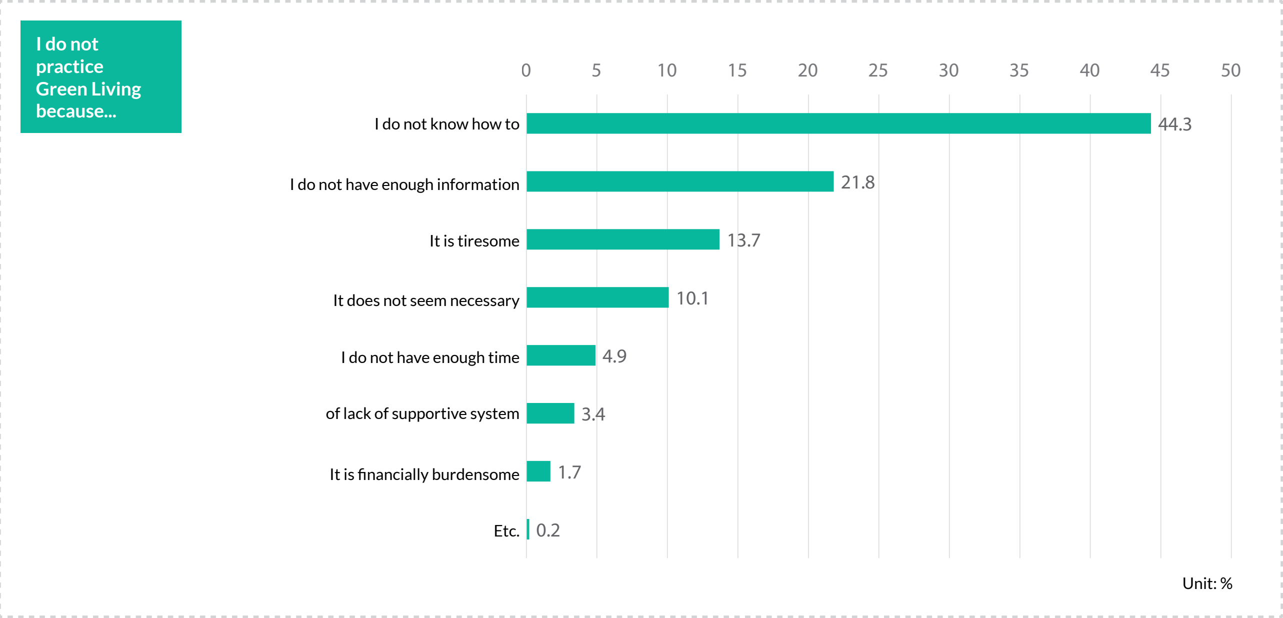
Table 26: *Changes in indicators relevant to green household practices (2007-2013)*

Indicators			2007	2008	2009	2010	2011	2012	2013
Green Households	Eco-friendly Products	Number of certified environmentally friendly products	5,105	6,005	6,531	7,904	7,777	9,140	9,803
		Environmentally friendly vegetable produce (% of total vegetable produce)	8.3	10.5	11.0	12.6	8.3	7.8	-
	Energy Efficiency	Number of goods with carbon labels	-	-	111	301	511	807	1,022
	Waste Recycling	Recycling rates of household waste (%)	57.8	59.8	61.1	60.5	59.1	-	-
	Pollution from Households	Amount of daily food waste disposal (kg/person/day)	0.30	0.31	0.29	0.28	0.27	-	-
Green Transportation	Efficient Use of Privately Owned Cars	Energy consumption in transport (TOE/person/day)	0.763	0.731	0.731	0.748	0.741	0.743	-
		Average daily distance traveled by privately-owned vehicles (km/day/vehicle)	40.9	35.5	35.7	34.2	32.6	-	-
	Use of Eco-friendly Transportation	Share of small-sized cars (% of total number of cars registered)	6.3	7.5	7.9	8.3	8.9	9.6	9.8
		Share of hybrid and electric cars (% of total number of cars registered)	0.00	0.03	0.08	0.14	0.30	0.52	0.62
Green Communities	Promotion of Green Lifestyles	Subscription to the Carbon Points System (% of total households)	-	-	4.2	9.6	14.1	16.2	17.7

Source: KOSTAT, 2013

Figure 9: Results of the Green Living Study: Overall Practice of Green Living

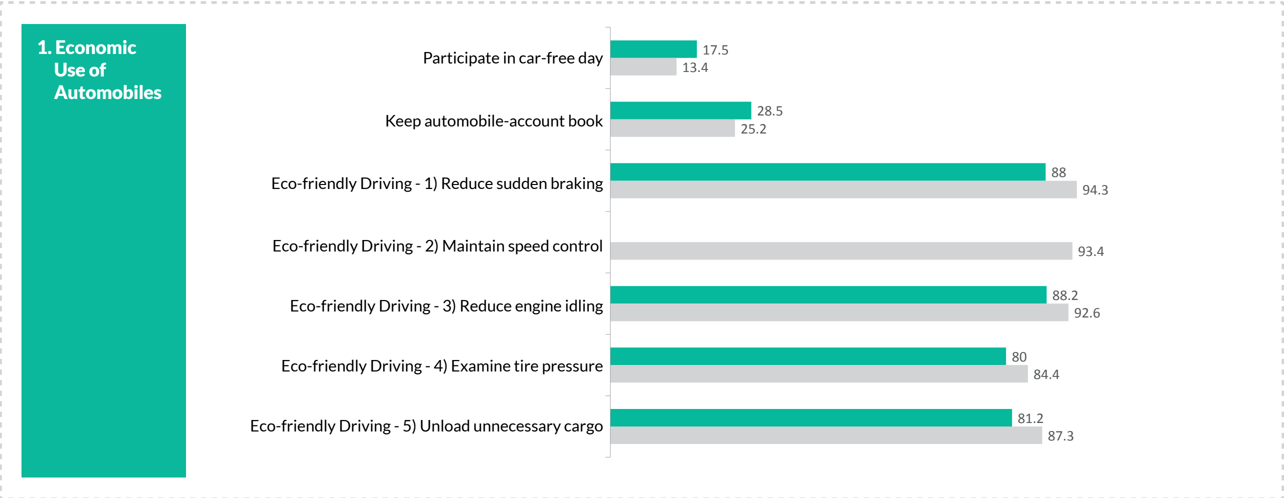


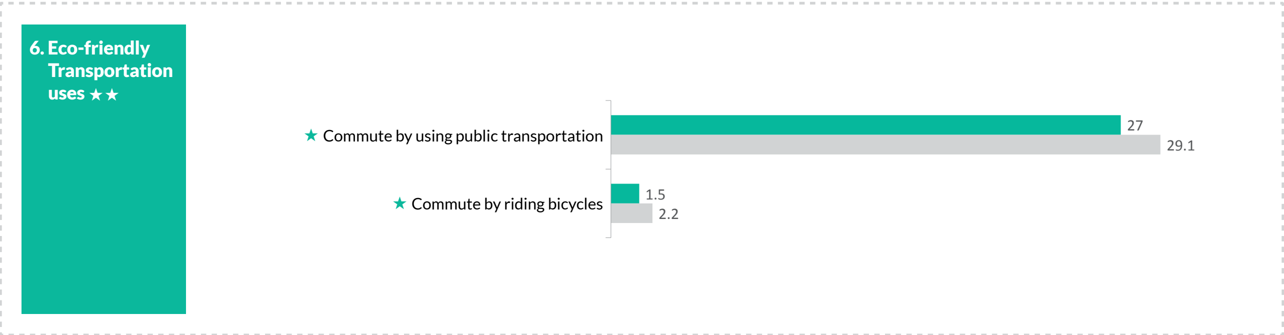


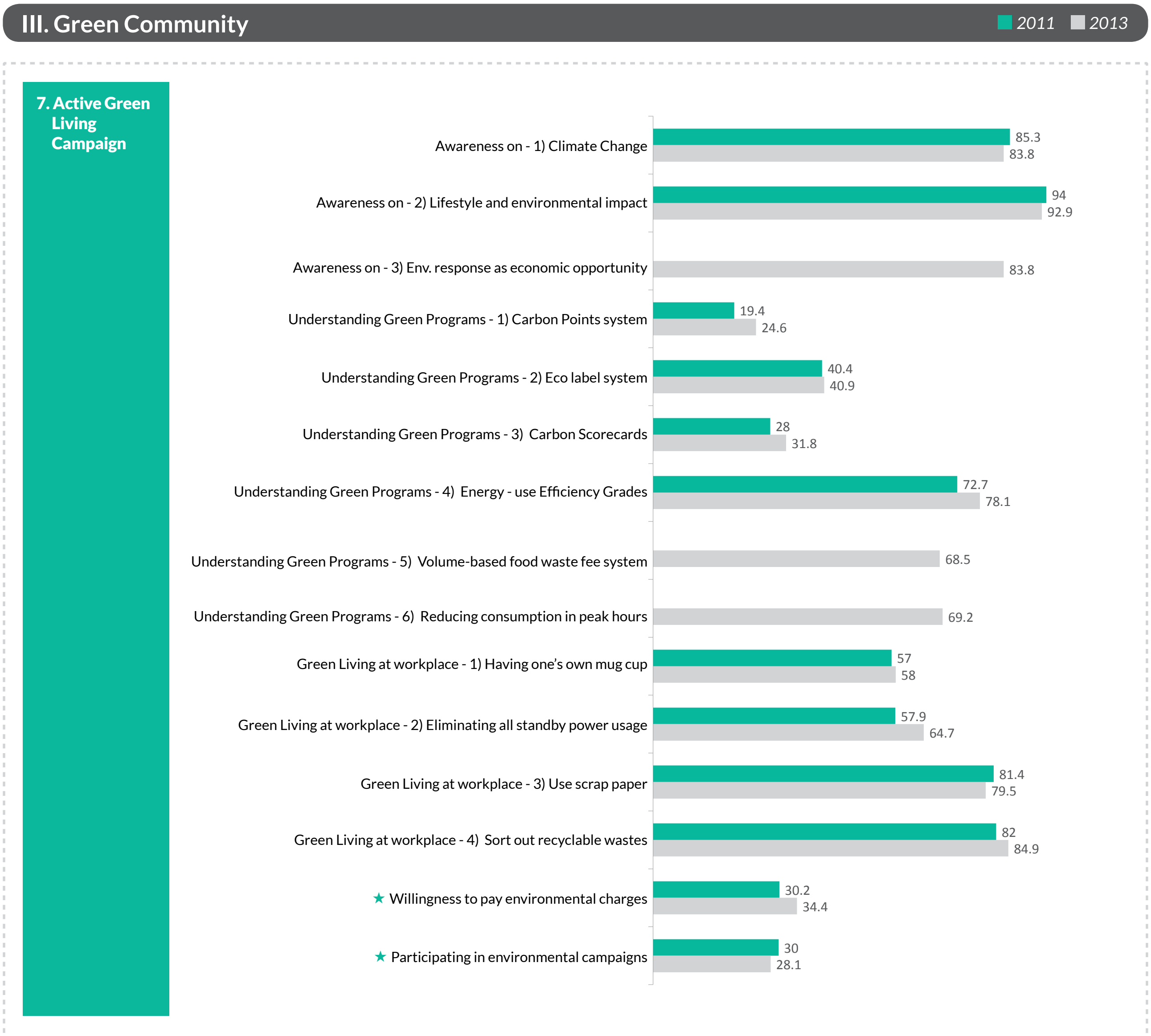
Source: KOSTAT, 2013

Figure 10: Green Living Practice Indicators

II. Green Transportation







Source: KOSTAT, 2013

4| The percentages refer to the proportion of individuals/households out of total population who are practicing or making attempts to practice green living of corresponding index
5| Indicators with ★ used figures from 2010 and 2012
6| Indicators with ★★ used figures from 2010 Housing Census Report and 2013 Green Living Census Report

4.2 Qualitative Assessment

The ROK has acted vigorously to resolve the environmental challenges neglected in the early days of its economic development. The central government has been well-equipped with regulatory and economic instruments, and the local governments have played a bigger role in implementing policies on pollution abatement. In response to the government's continued efforts to cope with the growing pressure on the environment, the general public has grown increasingly concerned about sustainable and eco-friendly living. Therefore, it could be inferred that "greening lifestyle practices" was not an entirely new concept to the general public, and the intended transformational changes by the Five-Year Plan sought expansion of existing public engagements, to GHG reduction, resource saving, and environmentally friendly actions in homes and workplaces. Despite the favorable foundation on which to build a strong momentum in society, the government has failed to fully meet its initial expectations in promoting a green lifestyle.

The lack of promotion and communication with the public persists as an obstacle to many government-led policies and programs in the ROK. As indicated by different indicators and public surveys described in the previous section, the low level of public participation stems from the lack of knowledge and confidence among the people. A good example is the development of "certified environmentally friendly products" and "products with carbon labels." Despite an explosive growth in the number of products with green labels, the market consumption of these goods remained low, indicating how the labels have had a limited impact on the decision-making patterns of consumers. In order to realize the full potential of consumers, government initiatives should have clarified what their objectives are, why they are needed, how they can be supported, and what benefits they are willing to offer. Tapping the use of print, broadcast, and internet media is one powerful way to spread these messages. Thus, the government should design tailor-made information, education, and communication strategies for different types of stakeholders to better convey its message to specific target groups.

Another factor behind the low-level of public participation in "green" initiatives is the insufficient provision of adequate incentives. The Carbon Points System is a good example of how the government has felt short of fully incentivizing voluntary participation. Individuals or households participating in the system receive monetized points commensurate with the amount of savings in electricity, water, and gas consumption. The monetized points were accumulated in a special type of personal credit card, called "Green Card," which were issued by the commercial banks. Despite the benefits of gaining extra credit points, what was missing in the Green Cards was the customary rewards that regular credit cards have to offer (e.g., mileage provided upon purchase of specific goods or services). In reality, many consumers were already holding credit cards that provide incentives that outweigh the benefits of Green Cards. As a result, the amount of Green Card transactions was low in comparison to the number of cards issued. This example highlights how incentive schemes need to be carefully tailored to market circumstances. In addition to making incentives appealing enough to bring about behavioral changes, the government must focus on ensuring that beneficiaries understand why and how their incentives are linked to the interests of society as a whole.

Living a green lifestyle is often inconvenient and can even have significant cost implications. Given how a majority of the Korean population belongs to what is dubbed as the "affluent generation" (born after the Korean War), behavioral changes have become much more difficult to instill in society. In this regard, the role of the family and academic institutions in incubating the values of green living from childhood to adolescence is critical. The ROK's endeavors to strengthen the academic curriculums on climate change, environmental sustainability, and green growth in public schools have significantly contributed to raising public awareness. Participatory programs were also successful in enabling students to take interest and engage in improving the environmental performance of their campuses. However, such efforts need to be further systemized to achieve lasting outcomes.

The development of visual aids and other innovative teaching materials that are age-appropriate, building the capacities of public teachers, allocating budget to extracurricular activities related to green lifestyle practices, and encouraging colleges and universities to offer courses on climate change and green growth are some of the ways to accelerate green education.

The members of civil society who took part in the "Green Start Network" in the ROK are forerunners in bringing about the successful transition toward green life practices among households. For example, capacity building programs that specifically targeted the housewives helped raise societal interests on "ways to reduce household spending through DIY recycling" and "how to prepare environmentally friendly and healthy dining at homes." Based on this experience, it is worth noting that the greening of lifestyle practices often starts at understanding people's consciousness, and especially how they perceive one another. In other words, individuals often choose to practice green actions as an expression of social ethics and responsibility, thus gaining the respect and appreciation of others.

Developing such sense of social accountability and personal sense of fulfillment from being socially responsible into a "social trend" is crucial to reach a wider audience. Despite its economic success, Korea needs to further concentrate on improving the society's level of cultural ethics from a green growth standpoint. Acknowledging that leadership extends beyond mere entitlements and requires full commitment to fulfilling social responsibilities, the public figures, opinion leaders, and social media must take the initiative of valuing green lifestyle as "cool" and "fashionable." Public sentiment should be stirred to the point where absence of engagement in green practices is perceived as a breach of social norms and customs.

The fact that the government has not yet formulated a comprehensive and balanced set of indicators to monitor the performance of green lifestyle practices is a significant setback. As presented in the previous section, KOSTAT has been releasing indicator figures relevant to green lifestyles but such data failed to take into account two important targets in the Five-Year Plan – greening the education system; and fostering of green citizens. Rather, the indicator sets have placed emphasis on the level of participation in government-led programs and the number of green goods and services made available in the market, which does not necessarily represent the actual amount of GHG emissions reduced or the volume of green consumption. To objectively monitor the progress of government strategies and plans in achieving targets, measurements for evaluating impacts should be made available.

5. Takeaways and Recommendations

Strategies and policies relevant to the "greening of lifestyles" are aimed at transforming people's individual habits. Given the multi-dimensional and context-dependent nature of human values and behavior, a wide range of programs is needed to target different groups from multiple levels of society (e.g., individuals, households, communities, workplaces, corporations). The ROK's experience illustrates the importance of collective efforts from the central and local government authorities, and sharing of leadership among all sectors of society. However, it is also important to recognize that such collaboration was fundamentally supported by widespread public awareness on issues relevant to climate change and environmental sustainability. Thus, decision makers should first focus on raising awareness and strengthening advocacy, before mainstreaming green living practices into government policies and incentives. The process requires meaningful engagement at different levels of society with a possible focus on bottom-up approach as it tends to be more organic and therefore more effective in mobilizing actions.

A prerequisite for widespread participation in government-led programs is the widespread recognition and acceptance of the public. Given how programs are developed based on the existence of a perceived problem or opportunity, the target participants' understanding of the given context is extremely important in shaping their actions. As such, the lack of understanding is unlikely to lead to public participation; for example, the general public needs to be fully convinced that the changing climate is brought about by human-induced GHG emissions in order for mitigation actions to gain public momentum. Therefore, significant efforts should be made to publicize government-led programs prior to implementation. This process should clearly articulate the expected societal and individual benefits of participation.

Public authorities often do not wish to wield the instruments necessary for transforming life practices, primarily because they do not have sufficient leverage to effect change within society. The importance of government incentives cannot be overlooked; they can play a critical role in changing individual and community practices, just as much as how they influence investment decisions in the market. The ROK's experience has demonstrated that incentives can be designed either as direct incentives (e.g., accumulation of monetized points from energy saving) or indirect incentives (e.g., tax breaks for cars participating in the "weekly car-free days" program). The government must commit to allocating the budget necessary to administer incentive schemes properly and in a sustainable manner, with the respect to abide by the initially agreed terms even if the budget decreases or the expected outcomes do not immediately materialize. While it is true that excessive provision of government incentives may lead "green life practices" into the trap of populism, well-designed incentive schemes can have powerful impacts, even under budgetary limitations.

Under the ROK's Five-Year Plan for Green Growth, the agenda item for promoting a green lifestyle was actually articulated (in Korean) as the "green revolution of life practices." The use of the word "revolution" implies the call for transformational changes in people's lifestyles, thus challenging the conventional unsustainable practices.
In order to achieve this, the public should be equipped with the proper tools to strengthen its capacity to effect change. Capacity-building programs were thus undertaken at different levels throughout the five-year period, which include "capacity-building curriculum on low-carbon, green growth vision for the general public," and "academic courses on green growth and climate change for schools and communities." Countries may seek to replicate ROK's approach to build public consensus and capacities to trigger significant lifestyle changes in favor of green growth.

The fundamental dilemma hindering growth in developing countries is that the demand for economic growth far outweighs that for environmental and social sustainability. Since market capital and government budget are both limited in developing countries, sustainability policies and practices are not given sufficient attention during the process of resource allocation. The ROK's concept of low-carbon, green growth opens an opportunity to bridge the gaps between growth and sustainability. In particular, the greening of lifestyle, where changes gradually take place over a long period of time, must be initiated during the early stages of implementing green growth policies. Considering the reality of developing countries, which do not have sufficient capital for investment, support from the developed countries through ODA or international climate fund must be provided to the developing countries (Kang et al., 2014). In order to achieve this, developing countries must show clear determination to adopt policies in favor of green lifestyle and must actively contribute to furthering international cooperation to attract more investment capital. Promoting green lifestyle should be part and parcel of any green-growth programs (in the form of capacity-building and/or policy development, etc.) as opposed to a stand-alone activity.

References

Energy Use Rationalization Act. 2014. Republic of Korea Statutes Act No. 12298.

Enforcement Decree for the Framework Act on Low-Carbon Green Growth. 2010. Republic of Korea Statutes Presidential Decree No. 25456.

Framework Act on Low-Carbon Green Growth. 2010. Republic of Korea Statutes Act No. 11965.

Fitzgerald, Daniel P., Jeffrey W. Herrmann, Peter A. Sandborn, and Linda C. Schmidt. 2005. "Beyond Tools: A Design for Environment Process " *International Journal of Performability Engineering* 1 (2):105-120.

GIR (Greenhouse Gas Inventory and Research Center of Korea). 2014. *National Inventory Report 2013.* Seoul: Greenhouse Gas Inventory and Research Center of Korea.

Green Korea. 2011. "Report on Green Campus Initiatives - Participation of University Students." Green Korea Working Paper 01-10-12-02, Seoul. Accessed April 30, 2015. http://www.greenkorea.org/?p=14339.

Joint Work of Relevant Ministries. 2012. *The Second Five-Year Plan for Green Growth (2014-2018).* Accessed April 17, 2015. http://www.greengrowth.go.kr/?page_id=2452.

Joint Work of Relevant Ministries. 2014. *The Roadmap to Achieve Greenhouse Gas Emissions Reduction Target*. Accessed April 16, 2015. http://me.go.kr/home/file/readDownloadFile.swSkhpiWBaLSszfbjL9pZ1qEU2afoHQY8mxDy0.meweb2vhost_servlet_engine1?fileId=97193&fileSeq=1.

Kang, Kyung-min. 2014. "Car-free day in Seoul has become almost obsolete." *Hankuk Kyungjae*, February 9. Accessed April 16, 2015. http://www.hankyung.com/news/app/newsview.php?aid=2014020999741&intype=1.

Kang, Sung-Jin, Soo-jung Kim, Yoo-kyung Kim, and Ji-hwan Kim. 2014. "Experiences and Lessons of Green Growth." Knowledge Sharing Program: Development Experience Modularization Project 2014-12, KDI School of Public Policy and Management, Sejong.

KECO (Korea Environment Corporation). 2014. "Performance of Waste Recycling." Statistics Database, Environment Statistic Information, Korea Environment Corporation, Seoul. Accessed April 30, 2015. http://stat.keco.or.kr/keco_web/?sub_num=12.

KEEI (Korea Energy Economics Institute). 2013. *Yearbook of Energy Statistics.* Seoul: Korea Energy Economics Institute. Accessed April 17, 2015. http://www.keei.re.kr/keei/download/YES2013.pdf.

KEITI (Korea Environmental Industry and Technology Institute). 2012. "Green Procurement Performance Report on Industrial Sector 2012." Accessed April 30, 2015. http://www.ecova.or.kr/upload/C%82%B0%EC%97%85%EA%B3%84_%EB%85%B9%EC%83%89%EA%B5%AC%EB%A7%A4_%EC%84%B1%EA%B3%BC%EB%B3%B4%EA%B3%A0%EC%84%9C.pdf.

Kim, Yoon-ho. 2005. "Evaluating 10-year Performance of Volume-based Waste Management." Korea Institute for Industrial Research Report, Accessed April 30, 2015. http://www.prism.go.kr/homepage/researchCommon/retrieveResearchDetailPopup.sionid=EC5DB07857EB0E6627CF9942E637138A.node02?research_id=1480000-200800488.

Korea Climate and Environment Network. 2014. "A poster for On-Mapsy campaign has been released." Accessed April 30, 2015. http://www.kcen.kr/USR_main2013.jsp??=GREEN_BOARD/FILE3/view&bbs_no=13326&page=1&bbs_option_cd=&search_option=0&search_value=%C4%F0%B8%CA%BD%C3.

Korea Zero Waste Movement Network. 2013. "Volume-based Waste Management Significantly Reduces Food Wastes." Paper presented at the press call, Seoul, July 16. Accessed April 30, 2015. http://www.waste21.or.kr/board/board_content.asp?menu=2&sub=5&idx=6631&b_type=BOARD5&page=1&b_kinds=title&b_word=%C1%BE%B7%AE%C1%A6.

KOSTAT (Statistics Korea). 2011. Future Population Projection (2010-2060). Korea Statistics Information System. Accessed April 30, 2015. http://kostat.go.kr/portal/korea/kor_nw/2/1/index.board?bmode=read&aSeq=252623.

KOSTAT (Statistics Korea). 2013. *Green Growth Indicator*. Seoul: Statistics Korea. Accessed April 16, 2015. http://www.knrec.or.kr/knrec/index.asp.

MoE (Ministry of Environment). 2009. "Measures to Expand the Practice of Low-Carbon Green Living." Accessed April 16, 2015. http://www2.me.go.kr/web/10104/me/common/board/detail.rator=me&boardId=notice_13_01&currentPage=12.

MoE (Ministry of Environment). 2011. "Measures to Spread the Culture of Green Living in Daily Life." Paper presented at the press call, Seoul, June 9. Accessed April 16, 2015. http://attfile.konetic.or.kr/konetic/xml/market/51A1A1110109.pdf.

MoE (Ministry of Environment). 2012a. "The Standards of Designating Green Stores." Accessed April 30, 2015. http://www2.me.go.kr/web/287/me/common/board/detail.currentPage=1&searchWord=%B1%D7%B8%B0.

MoE (Ministry of Environment). 2012b. "Public Campaign to Create Green Future – Green Start." Accessed April 30, 2015. http://www2.me.go.kr/web/288/me/common/board/detail.rd=%B1%D7%B8%B0%BD%BA%C5%B8%C6%AE.

MoE (Ministry of Environment). 2012c. "Process of RFID Weight-based Food Waste Fee System." Accessed April 30, 2015. http://www.me.go.kr/home/web/policy_data/read.%EC%A0%9C&menuId=10259&orgCd=&seq=5171.

MoE (Ministry of Environment). 2013a. "Website of Ministry of Environment." Accessed April 30, 2015. www.me.go.kr.

MoE (Ministry of Environment). 2013b. "The amount of 2012 Mandatory GGP reached KRW 1,727 Billion." Paper presented at the press call, Seoul, September 3. Accessed April 30, 2015. http://2015.keiti.re.kr/action. sf=&kwd=&lc=10&cat_1=&cp=11&ono=154.

MoE (Ministry of Environment). 2014. "Status of Generation and Treatment of Waste Nationwide 2013." Accessed April 30, 2015. http://www.kwaste.or.kr/sub0401.do.

MoE (Ministry of Environment). 2015a. "Performance of Volume-based Waste Management System." Accessed April 30, 2015. http://www.me.go.kr/home/web/policy_data/read.EC%A0%9C&menuId=10259&orgCd=&seq=6323.

MoE (Ministry of Environment). 2015b. "A survey with 1,000 respondents revealed that 87% of the participants agreed that the volume-based waste management is needed." Paper presented at the press call, Seoul, January 20. Accessed April 30, 2015. http://me.go.kr/home/web/board/read.oardMasterId=1&boardId=478610&menuId=286.

OECD. 2013. *OECD Factbook 2013: Economic, Environmental and Social Statistics*, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/factbook-2013-en.

Park, Pil-Ju. 2014. "Korea's CFP Labeling – Outcome and Future Plan." Paper presented at the International Carbon & Eco Labeling Seminar, Seoul, October 22.

PCGG (Presidential Committee on Green Growth). 2009a. *National Strategy for Green Growth (2009-2050)*. Accessed April 17, 2015. http://www.greengrowth.go.kr/?page_id=2450.

PCGG (Presidential Committee on Green Growth). 2009b. "Summary of the Five-Year Action Plan for Green Growth (2009-2013)." Paper presented at the press call, Seoul, July.

PCGG (Presidential Committee on Green Growth). 2009c. *The Five-Year Action Plan for Green Growth (2009-2013)*. Accessed April 17, 2015. http://www.greengrowth.go.kr/?page_id=2452.

PCGG (Presidential Committee on Green Growth) and Korea Research Institute for Local Administration. 2012. "Review on the Initiation of Local Green Growth and Research on Sustainable Measures." Research Report for the Presidential Committee on Green Growth, Seoul.

Prime Minister's Office, Ministry of Strategy and Finance, Ministry of Education, Science and Technology, Ministry of Foreign Affairs, Ministry of Knowledge Economy, Ministry of Environment, Ministry of Land, Infrastructure, and Transport. 2008. *The First National Energy Basic Plan (2008-2030).* Accessed April 17, 2015. http://energyjustice.kr/zbxe/48310.

SERI (Samsung Economic Research Institute). 2010. "Green Living Innovation; New Answer to Climate Change Mitigation." CEO Information, SERI Research Report, Seoul. Accessed April 30, 2015. http://m.seri.org/doc/mov03.html?menucd=0102&pubkey=db20100818001.

The Jeju Weekly. 2012. "Promotion on Volume-based Food Waste Management." *The Jeju Weekly*, November 30. Accessed April 30, 2015. http://news.jeju.go.kr/contents/index.php?mid=320302&job=detail&ne_seq=48911.

Global Green Growth Institute

Korea's Green Growth Experience: Process, Outcomes and Lessons Learned

Chapter 6: Green Industries

CHAPTER 6

GREEN INDUSTRIES

Summary

Greening its industries is essential for the ROK, given the obvious limitations of its input-driven economy that is highly dependent on exports, and also vulnerable to the tightening of environmental regulations on trade. To tap new growth engines amid the current energy and environmental crises, the ROK intended to green the existing industries and also create new ones. Specifically, it formulated a blueprint for realizing the "green transformation" of the industrial sector focusing on three major targets: green innovation of core industrial sectors; industrial restructuring for low-carbon development; and greening of the value chain. Given the ROK's success in pressuring businesses to incorporate environmental considerations in business operations, considerable progress has been achieved in greening its major industries such as steel, chemical, automobile, and electronics, which consume much energy and emit large amounts of GHG. To advance structural reform, the government has selected 17 industries with the highest potential to create new markets and generate positive spillover effects. Greening the value chain, on the other hand, requires the fostering of green SMEs, promotion of resource circulation in the industrial processes, and the establishment of green industrial complexes incubating high-tech industries and innovative public-private partnerships.

1. Introduction

1.1 Overview

Amid the success in implementing a series of Five-Year Economic Development Plans that began in 1962, the ROK achieved astounding annual growth rate of 9% until the mid-1990s. However, although the nation's economy quickly bounced back from the 1997 Asian Financial Crisis, the average GDP growth rate plummeted to 3-4% per annum after the mid-2000s. It was clear that the deceleration of growth was no temporary phenomenon, but the inevitable outcome of a number of structural economic problems. Most importantly, unlike the days of rapid economic expansion that were fueled by production efficiency generated from production elements – abundant skilled labor, cheap energy supplied from overseas, and capital secured from active foreign investments – the production efficiency of the ROK started to lose competitiveness with increasing environmental challenges and the rise of new developing countries with low-cost sourcing.

To counter the economic slowdown, the ROK's paradigm of low-carbon green growth identified "green industries" as the nation's new engine for growth, and sought to move away from growth that is primarily dependent on increasing the quantity of the factors of production. In other words, green industries were to turn the nation's energy and environmental challenges into opportunities for business, which is an important feature of the ROK's green growth model. In principle, green industries aim to decouple resource-use and pollution from industrial development and promote the growth of sustainable productive sectors and entrepreneurship in developing and transitioning countries (UNIDO, 2011).

Specifically, the ROK's strategies on green industries were two-fold:

(1) greening of the nation's existing industries; and

(2) creation of new green industries that provide environmental goods and services.

The first component – greening of industries – aims to enhance the environmental performance or minimize the production of pollutants during all stages of production including design, procurement, manufacturing, packaging, and distribution. This can be achieved through various measures, including:

(1) increase in production efficiency through the optimal use of resources;

(2) enforcement of waste management and reduction activities; and

(3) phasing out of toxic substances and avoiding creation of pollutants during the manufacturing process and consumption stages.

Although greening of industries is increasingly being adopted as an important element of corporate strategies following the rise of public consciousness on environmental sustainability, stimulating the necessary investments from the private sector remains a challenge. The strengthening of the government's regulatory policies is a key enabler for accelerating the greening of industries.

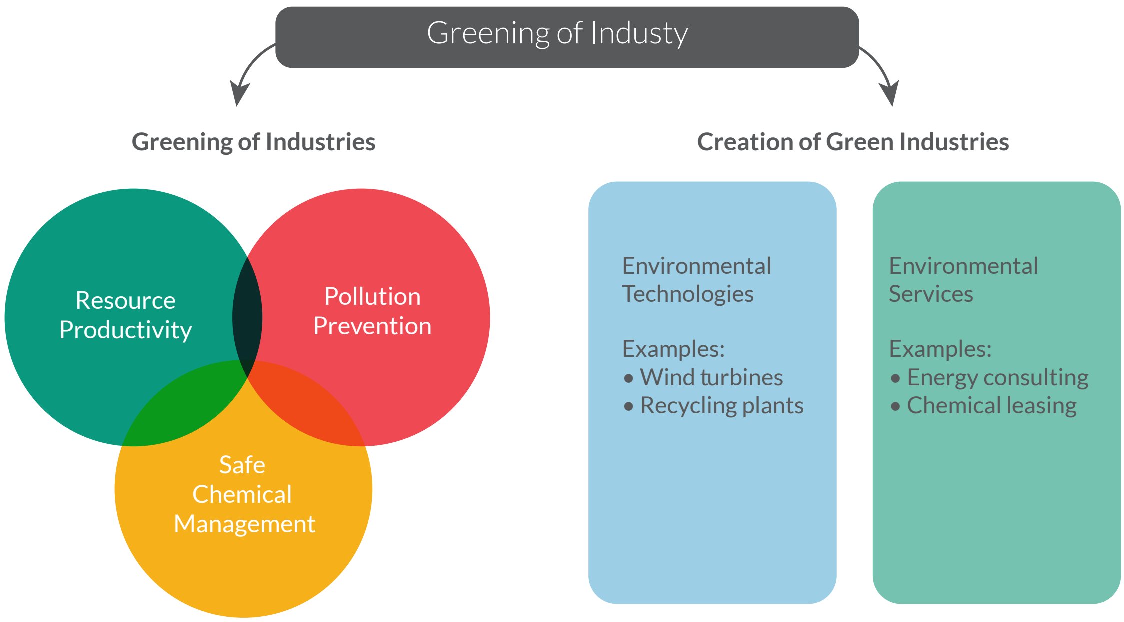
The second component – creation of green industries – involves the development of industries that provide goods and services reducing negative environmental impacts. Examples of such enterprises include those specializing in renewable energy, heat recovery, waste management and treatment, pollution monitoring and analysis, and treatment equipment. Green industries also encompass environmental and energy consultants, in addition to the providers of integrated solutions; for example, Energy Service Companies ESCOs that offer design, implementation of energy saving projects, energy conservation, energy infrastructure outsourcing, power generation, energy supply, and risk management (UNIDO, 2011).

1.2 Baseline Assessment

Root Causes of Challenges

In its early development stage, the ROK's economic strategy was characterized by a top-down approach, where the government took the lead in the accumulation of capital, management of foreign currency, and generation of investments. This policy served the manufacturing businesses well, particularly the conglomerates, as these companies gained a competitive edge in the export market by exploiting high price competitiveness and high-quality labor force. This policy has indeed enabled the conglomerates to become the backbone of the nation's economic miracle. During the 1960s and 1970s, the ROK recorded a significant 40% annual average increase in exports. In the 1970s, exports contributed to more than 40% of the total economic growth.

Figure 1: The ROK's two-pronged strategy for the green industry



Driven by its export-driven growth strategy, the ROK's economy advanced as a manufacturing power, with strong industrial capacity not only to produce basic materials such as steel and petroleum but also value-added products such as electronics and cars. After the 1990s, the ROK succeeded in establishing global production systems and nurtured more industries of world-class standards by boosting R&D investments. As of 2013, the contribution of the nation's 10 key industries represented 60.6% of the added value, 64.5% of exports, and 46.7% (2012) of employment from the entire manufacturing sector. The share of the ROK's manufacturing sector in the total GDP as of 2012 was 31.1%, which is significantly higher than other OECD countries.

One major factor behind the ROK's rapid industrialization was the effectiveness of its input-driven strategy. However, after the foreign exchange crisis in 1997, the nation's fast-aging labor force and low birth rates, reducing corporate spending on facility investments, and limited competitiveness of small enterprises (as compared to large conglomerates) have led input-driven growth to reach its limits. Moreover, the nation's technological catch-up strategy – characterized by imitating and enhancing the technologies of the leading players – was starting to lose its efficacy, as the world's technology-driven markets started to evolve around the introduction of new (not similar) and innovative products. According to the Korea Institute for Industrial Economics and Trade (KIET), the average technology localization rate of the ROK's manufacturing sector was 72.9% in 2012, but the rates for the manufacturing industries leading the nation's economy remain much lower than this rate; for example, 36.4% for semiconductors, 65.2% in telecommunication devices, and 61.5% in display systems.

Heavy reliance on exports and trade is a recognized weakness of the ROK's economy, especially given the current volatility of the global business landscape. In terms of the contribution of exports to the nation's total GDP as of 2012, the ROK recorded 56.5%, which was slightly higher than Germany (51.8%) but significantly higher than Japan (14.7%), U.S. (13.5), U.K. (31.5%), and France (27.4%). This makes the ROK's economy highly vulnerable to external shocks, given the myriad external factors such as oil price shocks, global market instability, and the like. For example, despite the recent slump in oil prices, the sluggish growth of the ROK's export destinations and high fluctuations in the global financial market are making it difficult for the economy to exit from the low-growth trend.

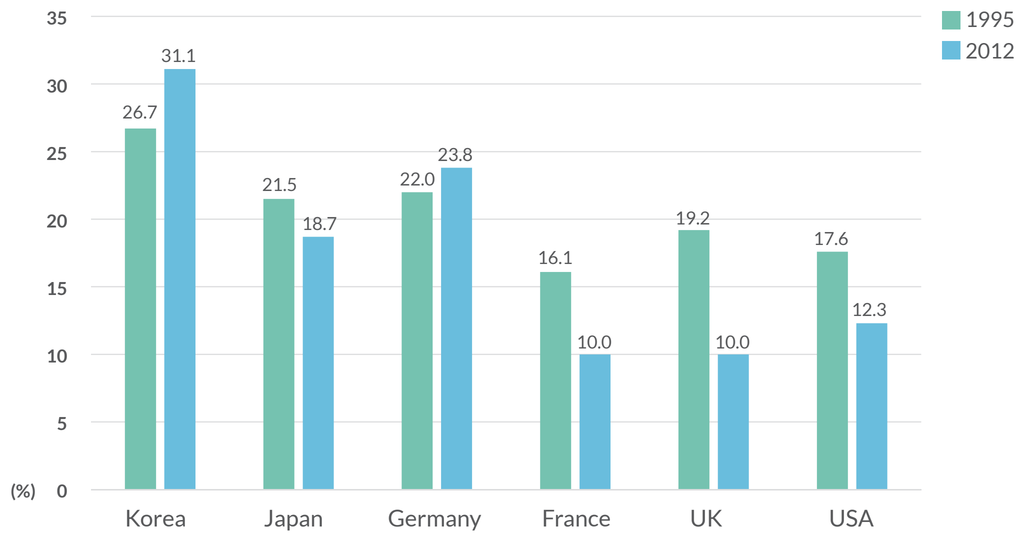
Excessive focus on large conglomerates came at the expense of the small-scale businesses, which explains the heavy dependence of the Korean economy on global trade. With its participation in the WTO's Doha Development Agenda, the expansion of free trade agreements, and the huge influx of FDI, the ROK has embraced globalization rapidly. As of 2013, the ROK's exports and imports ranked seventh (3.0%) and ninth (2.7%), respectively. While this implies opportunities for employment and revenue generation, excessive trade dependence can cause serious problems at times of sharp downturns in the global economy – indicating how the strategy of bolstering growth through exports has reached its limits. The need for building up the nation's service industry as a way to ensure the domestic industry must now play a greater role in promoting sustainable growth. In 2009, the ROK's reliance on trade was 92.3%, which is significantly higher than the U.S., Japan, and U.K.

- China's economic rise has significant implications for the ROK's export-oriented economy, as its manufacturing sector not only competes with the ROK in light industry (i.e., textiles), but also in technology-intensive fields such as IT, machinery, and aviation. While the share of ROK's exports in the world market increased marginally from 2.3% in 1994 to 3% in 2013, China's share rose sharply from 2.9% to 11.7% during the same period.

- A significant portion of the ROK's imports – 33% as of 2014 – are fuel and raw materials such as crude oil, natural gas, coal, and iron ore, the prices of which are heavily affected by global demand. In 2013, the ROK imported 915.1 million barrels of crude oil, equivalent to US$ 99.3 billion (19.2% of the nation's total import volume); if global oil prices increase by US$ 1 per barrel, the increase in the ROK's spending on crude oil imports rise by US$ 900 million.

- For the ROK, which has been struggling to break away from lackluster growth, the need to reduce GHG emissions represents a heavy burden. However, in the context of international

Figure 2: Technology trade balance of the ROK compared to the global leaders (as of 2007)



Source: UNSTATS, 2014

Table 1: Indications of how input-driven growth has reached its limits in the ROK

Demography	The growth rate of working-age population was 2.3% in the 1980s, but this rate has since shown a rapid decline, falling to 1.1% in the late 1990s and 0.5% from the early 2000s.
Investment in Manufacturing	The average annual growth rate of corporate spending on facility investments was 24.8% during the 1970s; after falling to 8% in the 1980s, negative rates of growth were seen in the late 2000s and mid-2010s.
Productivity	The productivity of the service industry as compared to the manufacturing industry was 96.3% in 1995, but this figure fell significantly to 46.6% in 2013. Especially, the productivity of small businesses as compared to large conglomerates was only 34.1% in 2001 and 30.3% in 2013.

Source: UNSTATS, 2014

climate negotiations, the ROK cannot avoid the responsibility given its economic size and emission rates. In terms of GDP, ROK is the 14th largest in the world in 2013 and it ranked seventh globally in terms of CO_2 emission rates. The country's emission rate increase is actually the fastest in the OECD.

Relevant Problems

The sluggish growth of the domestic market and investment has been identified as a key challenge to the ROK's sustained industrial development (and thus fostering of green industries). Unlike how the contribution of domestic consumption and investment to GDP growth was above 100% during the 1980s-1990s, it showed a significant fall to around half of that value by the 2000s. Falling contribution from the private sector spending and corporate spending on facility investments were the most notable; contribution from private sector spending decreased from an average of 56.4% during the 1990s to 33.3% during the 2000s (2000-2005), while the contribution from facility investments fell by more than half from 14.6% to 6.9% over the same period. In contrast, the contribution of imports and exports during the 2000s rose by 2.3 times and 1.4 times, respectively, compared to the 1990s. This trend is attributable to the nature of the government's structural reforms, which significantly promoted exports while overlooking domestic consumption and investment.

The continuation of government policies to keep energy prices low has been a critical factor shaping the nation's industrial development, which led to the rise of energy-intensive industries, especially manufacturing. In terms of energy intensity, or the total primary energy supply divided by GDP, the ROK still shows a decreasing trajectory despite continued growth in GDP, indicating how there is much to make up for the nation's industry to transform from being input-driven to productivity-driven. Understanding how the economic structure is difficult to change in the short term, the government's low energy pricing is hampering the effectiveness of its industrial policies promoting structural reform that encourages key industrial players to pursue efficiency innovation and engage in manufacturing high value-added products.

During 1998-2007, which was the decade following the Asian Financial Crisis, the ROK's economy was able to accomplish a trade surplus due to its growing volume of exports. Although the nation's recovery from a severe liquidity crisis (and bailout by the IMF) was encouraged by the growth of technology-intensive industries, the ROK still lags behind most of the OECD countries in terms of technology trade balance,[1] which is a determinant of technological competitiveness. As of 2007, the ROK's technology trade balance was 0.43, which is approximately 12% of the top-ranked country, Japan. Technology trade balance specific to the areas of energy resource and environment is even lower at 0.15, demonstrating how the ROK's industrial sector has neglected

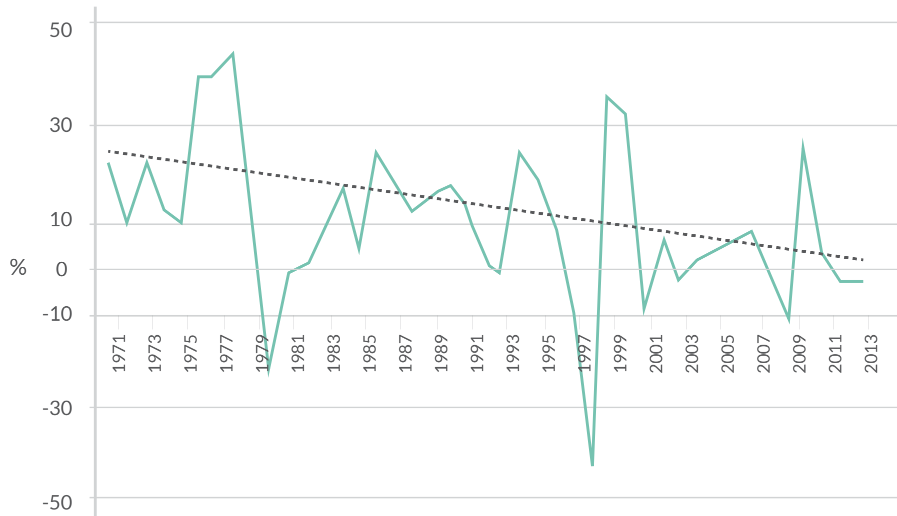
Table 2: Contributions of domestic spending and trade to GDP growth

Unit: %

Category	1970s	1980s	1990s	2000s (2000-2005)
Domestic Spending	109.8	101.1	106.1	65.4
- Total consumption	71.6	65.4	67.1	44.3
- Gross fixed capital formation	38.2	35.7	39.1	21.1
Net Exports	-5.1	-3.0	-4.3	33.5
- Exports	21.4	20.9	45.7	105.2
- Imports	26.5	23.9	50.0	71.7
Others	-4.7	1.9	-1.8	1.1
Total	100.0	100.0	100.0	100.0

Source: KCCI, 2007

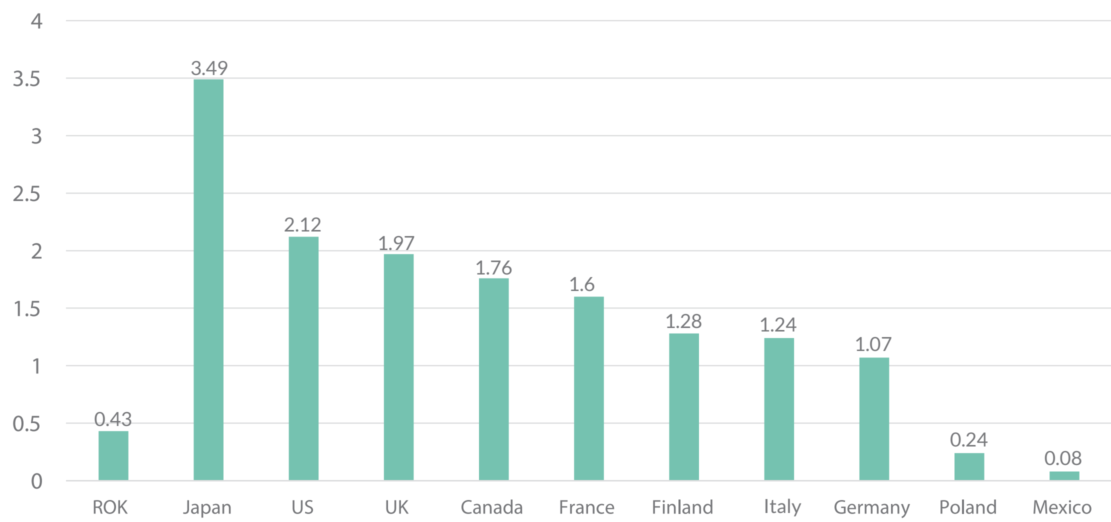
Figure 3: Growth rates of gross fixed capital formation in the ROK (1971-2013)



Source: Bank of Korea, 2014

1 |Technology trade balance is equivalent to the volume of technology export divided by that for technology imports

Figure 4: Technology trade balance of the ROK compared to the global leaders (as of 2007)



Source: Bank of Korea, 2009

Table 3: Share of energy consumed by energy-intensive industries in nation's total consumption (2012)

Unit: %

	ROK	Japan	U.S.	Germany	France	U.K.
Iron & Steel	6.6	6.6	1.2	3.9	2.3	1.0
Chemical & Petrochemical	5.2	4.9	3.7	6.5	4.1	2.9
Non-metallic Minerals	3.3	2.5	1.3	2.5	2.6	2.1
Total	15.1	14.0	6.2	13.2	9.0	6.0

Source: IEA/OECD, 2014

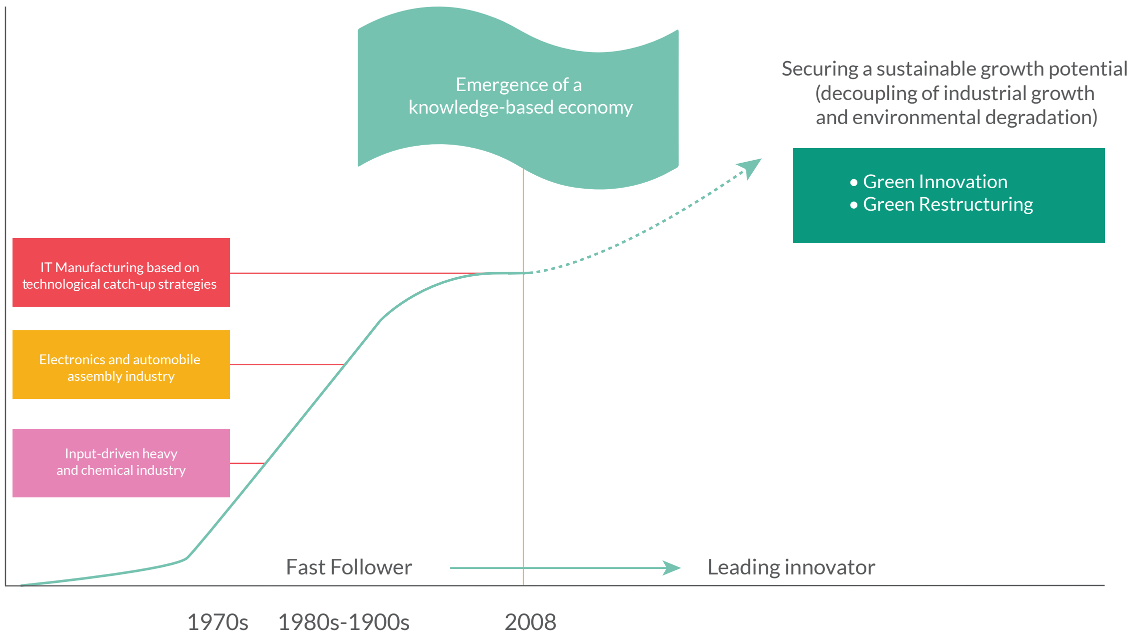
to account for efficiency and environmental considerations during its pursuit of quantity-oriented growth. Despite intensive government efforts to strengthen environmental regulations, the low technological capacity of companies remains a huge obstacle in greening the industrial sector.

Policy Options

Acknowledging the pressing need for developing green industries, the government packaged its strategies into "green innovation" and "green restructuring." Green innovation reduces environmental impacts: by increasing energy efficiency, reducing waste or GHG emissions, and/or minimizing the consumption of nonrenewable raw materials (OECD, 2013). The government placed an emphasis on ensuring that green innovation takes place in a balanced manner across all key industries, and customizing innovation strategies for different industrial sectors according to their specific structural and market conditions. For example, the strengthening of the EU's CO_2 emission regulations resulting from climate change indicates the need for the region's automobile industry to direct its efforts toward the emerging green vehicle market. In response, the government has to raise the standard for auto fuel efficiency and GHG emissions. On the other hand, steel industries that are highly energy-intensive were to prioritize boosting the efficiency of production process over developing new market products.

"Green restructuring" envisions turning the nation's resource- and energy-intensive economy into a low-carbon and knowledge-based economy.

Figure 5: Green industrial development strategy of the ROK



Source: MKE, 2008

Figure 6: SWOT analysis and strategic directions for the green industry agenda

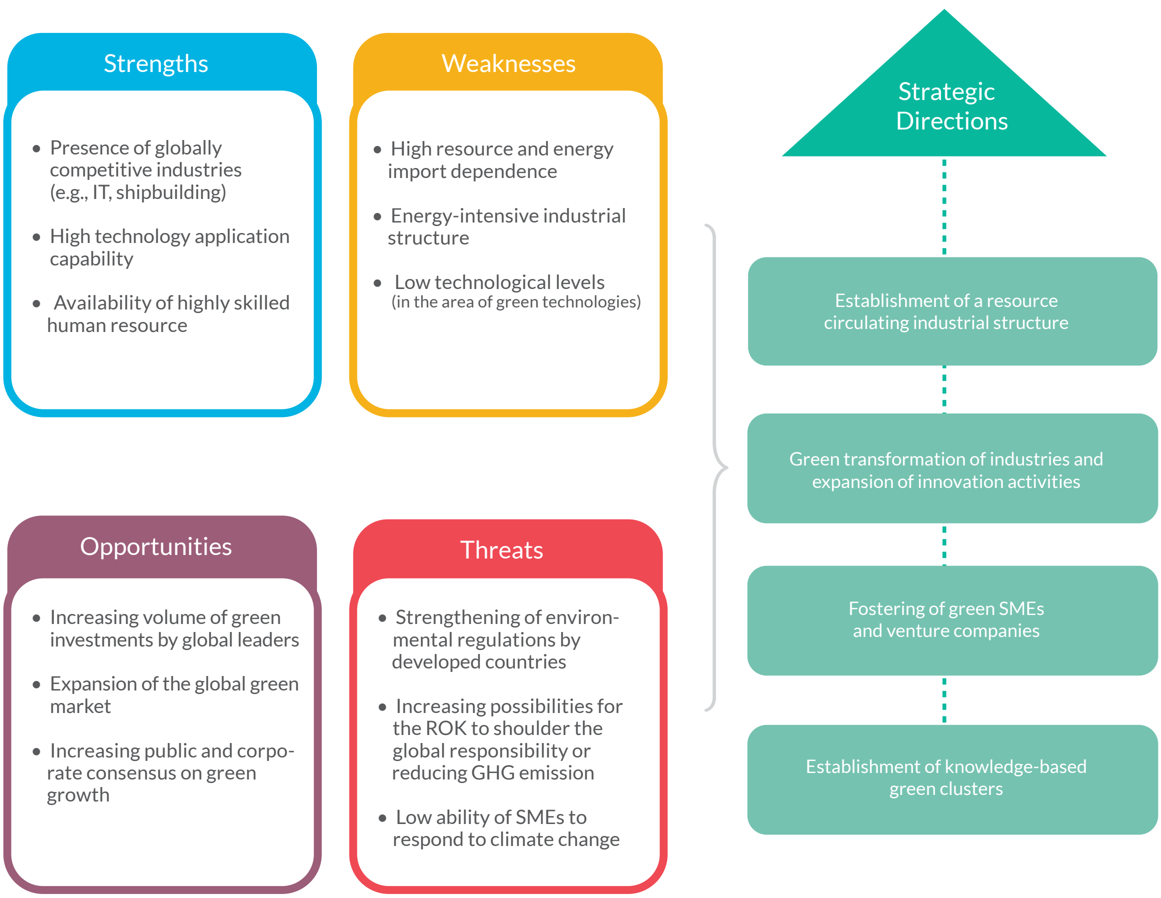


Table 4: Specific tasks and actions under the green industry agenda

Tasks	Actions
1. Establishment of a resource-circulating industrial structure	a. Establish a resource circulation management system b. Promote resource circulation and strengthen its foundation c. Invigorate foster resource circulation industry
2. Green transformation of industries and expansion of innovation activities	a. Green innovation in key industries and expansion of new growth engines b. Green the value chain, including product distribution, marketing, and service c. Green construction industries and create environmentally friendly agricultural industry d. Facilitate the entrance of domestic green industries into the overseas market and increase in exports
3. Fostering of green SMEs and venture companies	a. Enhance response capabilities of small enterprises toward climate change b. Strengthen the small businesses' "greening" capabilities
4. Establishment of knowledge-based green clusters	a. Create knowledge-based green clusters b. Green the industrial complexes

Source: PCGG, 2009b

Understanding how the nation's development constraint lies in manufacturing-oriented growth, the government targeted increasing the share of its service industries, such as emission trading service and energy management consulting.

1.3 Opportunities and Challenges for Green Growth

Greening of industry presents vast opportunities for economic growth. The first component of the ROK's green industry agenda –"greening of existing industries"– brings about environmental effects of reduction in atmospheric pollutants and GHG emissions by enhancing resource and energy efficiency, and the economic effects of reduction in energy costs and reducing energy dependency from overseas. The second component –"creation of new green industries"– is expected to promote economic growth by accelerating the development of the green market through green technology.

The strengths of the ROK' key industries – specifically IT, shipbuilding, and car manufacturing – include high global competitiveness, high-quality human resources, and practical technological advantages. However, its weaknesses mainly include the excessive reliance on imported resources, persistence of its highly energy-intensive industrial structure, and low levels of technology of the green industry. In this light, the Five-Year Plan for Green Growth set forward the following key tasks:

(1) establishing an economic/industrial structure that promotes resource circulation;
(2) greening the industrial sector and boosting innovation;
(3) undertaking green small business ventures; and
(4) building knowledge-based green clusters.

2. Targets and Strategies

2.1 Green Transformation of the Industrial Sector

The Ministry of Trade, Industry, and Energy or MOTIE (formerly the Ministry of Knowledge Economy or MKE) was at the forefront promoting green growth in the industrial sector, which is the driving force of the behind ROK's economy. In setting the direction for nation's low-carbon green growth vision back in 2008, the Ministry acknowledged that the ROK is still on its course to fully achieve the status of a high-income country, thus it should strive to strike a balance between sustained economic growth and sustainable consumption. Based on the premise that environmental protection can only be achieved when driven by strong economic growth, MOTIE formulated strategies that ensured a degree of flexibility in greening its industries.

The Knowledge and Innovation-driven Green Growth Industrial Development Plan, published by the MKE in December 2008, served as a blueprint for executing the "green transformation" of the industrial sector. The knowledge and innovation-driven paradigm promoted by this plan differs from the factor-intensive, catch-up oriented industrial development based on price competitiveness that was unquestionably pursued in the past. In seeking to create markets of high-value businesses through convergence of new technologies and existing industries, the paradigm recognized knowledge and innovation as production factors that are more decisive than tangible assets like labor and capital. Specifically, plans to realize "green transformation" presented three targets:

(1) green innovation of core industrial sectors (Green Innovation);

(2) industrial restructuring for a low-carbon development (Green Restructuring); and

(3) green transformation of the value chain (Green Value Chain).

Green Innovation

The "Green Innovation" agenda targets greening of the industrial sector through the active adoption of innovative technologies. The agenda places an emphasis on the nation's major industries that already have the competitive edge but need to enhance environmental performance to keep pace with the changing market standards; such efforts were anticipated to have spill-over effects across the other industrial sectors. The ROK's major industries include the nine sectors, namely iron and steel, petrochemicals, textile, automobile, shipbuilding, machinery, semiconductor, display, and home appliances.

a) Iron and Steel

The steel industry of ROK experiences difficulties due to the downfall in market demand and increase in Chinese imports, along with strengthening of international regulatory standards related to energy and environment. As a response, the steel industry set a vision to become globally competitive by enhancing its energy efficiency to meet the highest of standards. Specifically, it was to actively adopt technologies for decreasing energy consumption and reusing waste heat, along with developing steel goods that can help cut down on energy use (i.e., light-weight steel for automobiles).

b) Chemical and Petrochemicals

The ROK's petrochemical industry has shown a dynamic growth, thanks to sufficient production capacity guaranteed by steady investment in production facilities and continued technological advancements. However, the industry is strained between the oversupply of goods from the developing countries and enforcement of strict environmental regulations led by developed counties. To overcome the situation, the concept of industrial combines (Russian, Комбинат) was adopted; industrial combines refer to a large industrial zone that accommodates different enterprises that are related to each other by technological or administrative process to enhance the productivity of manufacturing industry. Relevant actions include recycling industrial by-products, and optimization of resource and energy use (e.g., substitution of high-cost raw materials, production of high value-added products).

c) Automobiles

The automobile industry of ROK has stood out in the global market, consolidating its competitive advantage through continuous technological development. The global automobile market, however, is having many active players having the key technology for low-pollution automobiles (green car), and second movers like China and India are catching up fast with low-cost vehicles. Thus, industry-wide effort and governmental support are necessary in order to acquire key source technology for green car in advance, a leader in the next generation market for automobiles. Accordingly, the government established a vision of being one of the top four major players in the automobile industry, and set out a plan to:

(1) develop and mass produce of clean energy vehicles (i.e., green cars);

(2) foster automobile parts suppliers for green cars; and

(3) provide incentives for vitalizing the domestic prevalence of green cars.

d) Shipbuilding

The shipbuilding industry of the ROK still remains the top player in the global market, but is facing new challenges such as the decreasing demand for new vessels from global recession and rise of second movers like China that are increasing market shares based on low-price competitiveness. The ROK planned to overcome this crisis by developing and adopting green shipbuilding technologies. Relevant technologies include fuel-efficient hull design, environmentally friendly propulsion system, and optimized navigation control using remote supervision and control.

e) Machinery

Along with manufacturing, the machinery industry does not consume energy much in itself. However, the tools and construction equipment produced by this industry are intensively utilized by the export-oriented industries of the ROK, and emit a large volume of GHG. The machinery industry inevitably faces a great deal of environmental regulations; developed countries, which possess the competitive edge in the market, are leading the regulatory dialogue and so high environmental standard on machinery goods are serving as a new trade barrier to domestic players. The government's vision (aptly put as "another leap forward for the machinery industry with green technology"), is composed of the following strategies:

(1) securing environmentally friendly source technology (i.e., clean diesel engines);

(2) promoting green management and creating high-value added products; and

(3) creating market demand for green products.

f) Semiconductor

The ROK is currently the third producer of semiconductor in the world, and as of 2013, the semiconductor industry accounts for 2.2% of the national GDP and 10.2% of total export. In the global semiconductor industry, the goal of technological innovation is shifting from productivity improvement to cutting down on energy use and promoting environmentally friendly process. This means that securing technology on reducing GHG and toxic substances, which are generated in large amounts in the semiconductor manufacturing process, is crucial to sustain the growth of the industry. Accordingly, in line with the ROK's vision of becoming the second largest producer of semi-conductors in the global market by 2020, it set up a strategy to respond actively to stronger environmental regulations and develop semiconductors that minimize power consumption (e.g., automotive semiconductor products that help reduce fuel consumption). Also, it sought to strengthen the production of solar cells that efficiently utilize the existing semiconductor manufacturing equipment and technological development of optical semiconductors (LED).

g) Display

Through bold investment and government support, the display industry of the ROK has soared to number one in the global market. However, the reinforcement of regulations by developed countries and climate change conventions have continuously intensified the case for the need to reduce GHG emissions and the development of environmentally friendly, low-cost products. In this light, the ROK formulated a vision of maintaining the number one position in the world display market by increasing energy efficiency of existing product lines, utilizing efficient process development, and paving the market for convergence display such as solar window and wall-to-wall display system.

h) Textile

The ROK's textile industry possesses a uniformly developed manufacturing technology and balanced production base from upstream to downstream, including thread, fabric, dye processing, and clothing. The Korean textile industry, ranking eighth worldwide, accounts for 7.9% of the number of employees in the manufacturing sector. Similar to other industries, it also imports one-third of its raw materials from abroad, manufactures finished goods, and exports two-thirds of the completed products. The government set plans focused on greening the manufacturing process as well as technological development on environmentally friendly fiber (e.g., recycled fiber or non-petroleum fiber) and ultralight fiber (i.e., to be utilized in automobiles or airplanes).

i) Home Appliances

The home appliance industry of the ROK is leading the global market with its excellent production technology and state-of-the-art IT infrastructure. The current challenge is to keep up with the tightening demand of regulations on consumption of service power and standby power, while providing an incentive to purchase highly energy-efficient products, thus creating a steady need for incessant technological innovation. The government made an attempt to support the home appliance industry in maintaining its lead in the global market by actively supporting technological development through legal and institutional reforms that promote the production and consumption of highly energy-efficient products. In addition, it promoted environmentally friendly management practices throughout the home appliance industry, thereby enhancing the environmental competitiveness of enterprises and providing an opportunity for creating new business activities.

Green Restructuring

Manufacturing and energy-consuming industries take up a large part of the ROK's industries, thus requiring high carbon emission reduction costs compared to developed countries. The major drawback for the ROK is the heavy dependence of its economy on manufacturing to boost its exports. The innovations that have been fueling the Korean economy has been largely concentrated on manufacturing, and the added value of service sector also stems from manufacturing.

Considering the fact that the ROK's industrial structure is too much oriented toward manufacturing imported raw materials and exporting processed goods, fundamental restructuring of industries is necessary to cut down on energy consumption and carbon emissions. In this regard, the Knowledge and Innovation-driven Green Growth Industrial Development Plan (2009) highlighted "green restructuring" as its second target, which entails promoting new service industries with lower resource consumption per added value, and service industries that facilitate the green transformation process of manufacturing industries (i.e., energy-use consulting and chemical management services).

The New Growth Power Vision and Development Strategy announced in January 2009 through joint efforts of all line ministries of the government specified the plans toward green restructuring. Following the principles of selection and concentration, the strategy intended to identify and narrow down the new industries and business areas crucial to the green restructuring process, based on three factors:

(1) marketability;
(2) spillover effect; and
(3) relation to green growth.

Such cross-ministerial shortlist of industries and businesses has been created through careful consultation with the private sector and working committees (e.g., New Growth Power taskforce under the Prime Minister's Office, National Science and Technology Council). As presented in the following tables, the ROK selected 17 industries, which are divided into green technology industries, high-tech convergence industries, and high-value service industries. Green technology industries have great capacity to help address climate change and energy crisis, thus could serve as a foundation for future growth. On the other hand, high-tech convergence industries cover new areas that fuse sectors – in which the ROK already has the technological edge – with the large global markets. Lastly, high-value service industries have the potential to create new jobs and achieve high growth rates.

To support the 17 industries, the government pursued the following supply-side interventions:

(1) enhance regulations to facilitate investment;
(2) support the creation of new markets to increase demand of the public sector; and
(3) standardize technology and provide incentives such as certification programs.

For instance, tax relief was to be offered for expansion of green cars (high-tech green transport system), mandatory replacement of LED lighting of public institutions (LED industry), and arrangement of technological standardization for equipment (new and renewable energy). Meanwhile, support in the demand-side focused on expanding government R&D investment and human resource training for industrial growth (e.g., establishment of professional graduate curriculum and expert training programs). Additionally, the New Growth Power Vision and Development Strategy (2009) grouped the 17 industries into short-term (3-5 years), mid-term (5-8 years), and long-term (around 10 years), providing differentiated strategies for each categories.

Table 5: Selection of six green technology industries and main strategies

New Growth Engine (Main outputs)	Main strategies	Category
1. New and renewable energy (thin film solar cells, fuel cell generation system)	• Technological development for thin film solar cells, bio energy, tidal energy, second-generation hydro fuel cells • Promotion of Renewable Portfolio Standard (RPS)	short-term / mid-term / long-term
2. Carbon reduction energy (next generation nuclear plants)	• Development of advanced pressurized reactors (APR+) • Development of core production process for CO_2 collection and utilization	mid-term/ long-term
3. High-degree water treatment (treatment plants)	• Technological development for water treatment (seawater desalination, membrane filtration system) • Projects on unified operations of local water services, expansion of reuse of treated wastewater	mid-term
4. LED application (LED lighting)	• Development of LED core technology • Trial use of efficient LED lighting in public institutions (public buildings, road and traffic facilities)	mid-term
5. Green transport system (green car, World-leading, Intelligent, Safe, Environment-friendly or WISE ships)	• Development of hybrid car core technology • Technological development for offshore plant, ships for frozen waters, and high value-added ships • Reduction of environmental charges for clean diesel, tax relief for expansion of green cars	short-term
6. High-tech green cities (Ubiquitous Eco-Cities)	• U-Eco City trial projects • Creation of the National Spatial Information Act • Reform of regulations for Intelligence Transportation System (ITS) • Preparation of construction regulations for low-energy, environment-friendly apartments	long-term

Source: New Growth Power Vision and Development Strategy, 2009

Table 6: Selection of six high-tech convergence industries and main strategies

New Growth Engine (Main outputs)	Main strategies	Category
1. Broadcasting convergence industry (IPTV services, next generation wireless communication)	• Enhancement of regulatory systems such as the reform of broadcasting communications regulations • Establishment of infrastructure for fostering broadcasting communications • Development of next generation IPTV technology and IPTV public service standard models	short-term
2. IT Convergence system (intelligent automobiles, flexible display)	• IT Convergence application and development of source technology in automobiles and shipbuilding • Development of RFID/USN core technology	short-term
3. Robot application (fire protection robots)	• Development of core technology for intelligent robots • Fostering robot competitions with worldwide authority • Creation of demand for robots through space like robot lands	long-term
4. New materials: Nano-convergence (materials to reduce weight of hybrid cars)	• Development of core technology on nano-convergence materials • Promotion of technological development projects through international cooperations	long-term
5. Biomedicine: medical devices (Stem cell medicine)	• Development of biomedicine like DNA or cell medicine • Development of bio-diagnosis system and medical imaging/bio-diagnostic devices • Expansion of insurance fee on newly developed medical devices and the subjects of elderly care insurances	long-term
6. High value-added food industry (natural food additives)	• Globalization of Korean food (extension of PR and R&D) • Fostering of traditional fermented food industries (e.g., Kimchi Research Laboratory)	mid-term

Source: New Growth Power Vision and Development Strategy, 2009

Table 7: Selection of five high-value service industries and main strategies

New Growth Engine (Main outputs)	Main strategies	Category
1. Global Healthcare (attracting foreign patients)	• Reform of medical law (e.g., allowing brokering for foreign patients) • Adoption of a national certification system for medical institutions • Arrangement of a dispute resolution system for foreign patients	short-term
2. Global education services (attracting foreign students)	• Expansion of governmental support for promoting Korean education programs abroad • Improvement of system and expansion of support for attracting foreign students	short-term
3. Green Banking (CER Exchange)	• Support to the establishment of the CER Exchange • Development of green stock price index and listing of green funds • Development of stock markets for green stocks (Green Industry League)	long-term
4. Contents: Software (Game contents)	• Reform of regulations on the promotion of cultural industry • Improvement of irrational practices in the software business (e.g., expanding the use of intellectual property rights)	long-term
5. MICE tourism (Meetings, Incentives, Conferences, and Exhibitions) (Ecotourism)	• Establishment of infrastructure for MICE industry • Global promotion of domestic performances in festivals • Expansion of domestic tourism infrastructure such as information centers or related personnel	long-term

Source: New Growth Power Vision and Development Strategy, 2009

Green Value Chain

The retail sector, the middle ground between production and consumption, is the main non-industrial sector with the significant potential for GHG reduction. Since it can play a significant role in promoting the production and consumption of green products, it can help pursue green growth in a number of ways.

The influence of retail on manufacturing is especially growing, a good example of which is the SSM (Super Supermarket) stores establishing private brands and dominating the product planning and development process. In this regard, the government put greening the value chain as the third task of the Knowledge and Innovation-driven Green Growth Industrial Development Plan, targeting the greening of the entire process of the value chain from production, distribution, marketing, and retail services.

Table 8: Strategies for promoting and implementing the Green Value Chain

Promotional Strategy	Main implementation measures
Greening of retail sector	• Conduct of a status quo survey on GHG emission in the retail sector for the establishment of GHG inventory • Trial projects on GHG reductions for SSM stores • Subsidies for projects in which retail businesses cooperate with manufacturing or distributing businesses to reduce GHG
Efficient distribution	• Government support to establish a co-distribution center for small and medium retailers • Standardization of and efficiency improvements in packaging, transport, storage, and loading through regulation of Logistics Management System • Establishment of Point of Sale (POS) data service system, which enables retailers and manufacturers to acquire accurate information on sales and consumption trends, thereby leading to cost savings for marketing and improved sales
Efficient reverse logistics	• Utilization of retail as a reverse logistics hub (e.g., installing recycling collection box in SSM store parking lots) • Government support toward the use of radio-frequency identification (RFID) tagging system to improve the efficiency of handling retail returns • Establishment of an online channel for returned products

2.2 Development of Green Venture SMEs[2]

In promoting green industries as a national growth engine, the role of SMEs is critical as the nation's major industries are heavily dependent on SMEs that produce components and parts along the supply chain. Without a competitive SMEs, the large manufacturing companies of the nation are likely to degenerate into those that simply assemble imported parts. This calls for increased government support to foster green SMEs,[3] which can also help create green jobs and advance technology commercialization. Note that green SMEs of the ROK were found to have greater interest in undertaking R&D activities than general SMEs; during the period of 2005-2007, 22.0% of green SMEs made spending on R&D, while the portion was only 9.4% for general SMEs. Moreover, the number of job creations per unit production (one billion KRW) was found to be 9.2 for general SMEs and 12.9-13.3 for green SMEs, according to the Small and Medium Business Administration (SMBA, 2010).

Green SMEs in the ROK face considerable challenges. First, they mostly belong to equipment installation, which has low added value while those SMEs manufacturing core materials and components are very few. As they lag behind in technology compared to developed countries and are less competitive in price than China, these businesses find it hard to penetrate the manufacturing market. Secondly, green SMEs face hardships in financing their activities, as loans from banks are not easily accessible. Banking institutions lack standards and selective capacity for "green businesses" and differentiated financial instruments have not been developed properly. Thirdly, the green SMEs find it difficult to fill the demand for manpower brought by market expansion due to insufficient human resource training and intensification of manpower outflow to large enterprises. Lastly, the limited domestic market and lack of robust information management or marketing capacity for overseas expansion further obstruct the growth of these businesses.

Table 9: Operational characteristics of public buses in Seoul

New Growth Engine (Main outputs)	Main strategies	Category
1. Promotion of green venture firms	• Utilization of university and government research labs as base for green ventures • Expansion of investment on green ventures (e.g., venture funds, venture investment road shows) and dissemination of success stories	short-term
2. Green banking and strengthening of human resources	• Expansion of governmental support for promoting Korean education programs abroad • Improvement of system and expansion of support for attracting foreign students	short-term
3. Enhancement of green technology	• Selection of promising green technology areas for SMEs, and concentration of R&D on these areas • R&D and commercialization of green technologies	long-term
4. Expansion to overseas green market	• Sharing of information on overseas markets and establishment of support center for green SMEs • Operation of support programs for overseas project orders to green SMEs (e.g., grants for pre-feasibility studies)	long-term
5. Expansion of green management practices in SMEs	• Selection of Green-biz and provision of various incentives (e.g., tax support, prioritized evaluation in the case of patent applications) • Establishment of Consulting and Green Supply Chain Management System for green management • Support of R&D activity and facility retrofit for the expansion of "Green Factory" with an enhanced manufacturing process considering environmental pollution and energy consumption	long-term

2 | SMEs make up 99% of business establishments and take up more than 85% of total employment in the ROK. The criteria for defining SMEs in the ROK vary according to sector; for the manufacturing sector, those with number of workers fewer than 300 and capital worth 8 billion KRW (approximately US$ 7 million) or less are considered to be SMEs.

3 | Green SMEs are those enterprises that continue to strive to improve energy efficiency, reduce GHG emissions, and minimize environmental impacts in the process of manufacturing goods and services, and/or practicing green management.

To overcome these problems and increase the contribution of green SMEs to green growth, the SBMA formulated the Support Plan for the Creation and Growth of Green SMEs in 2010. This plan set out a target of fostering 1,000 green SMEs that use core green technology, and 2,000 "Green-Biz" that practice green management. For this task, five strategies outlined in Table 9 were set along with various plans to fulfill these goals.

2.3 Building an Industrial Structure based on Resource Circulation

As energy and resource use issues remain crucial in deciding the future of the economy, developed countries are actively promoting resource circulation policies as part of both economic strategy and climate change response. The rise of the resource circulation industry – characterized by collecting, recycling, and processing waste materials – is a fast emerging trend, with the aim to prevent the depletion of raw materials and reduce the environmental overload from waste by minimizing waste resources.

In line with this objective, the ROK has prepared strategies and measures to promote sustainable resource circulation. The ROK's waste management policy has evolved through the decades to respond to the needs of time – from safe processing in the 1980s, expansion of recycling in the 1990s and early 2000s, and to resource circulation from the mid-2000s. It has achieved considerable success in slowing down waste production and increasing the recycling rate due to the consistent promotion of the Reduce, Reuse, Recycle, and Recover (4R) policy and expansion of waste management infrastructure (refer to Chapter 5 for further information on the ROK's waste management practices). However, qualitative progress specifically on maximizing the added value of waste materials through resource circulation is still insufficient, and thus offers rooms for improvement. In other words, the government should further promote upcycling by enhancing the quality and increasing the added value of recycled and recovered materials and products, or collecting and recycling the rare metal from home appliances.

The implementation plan for the "foundation of resource circulating economy/industrial system," a task set out in the green industry agenda of the Five-Year Plan, was presented as the First Basic Plan for Material Cycles (2011-2015). This plan – formulated under the cooperation of Ministry of Environment, Ministry of Public Administration and Security, Ministry for Food, Agriculture, Forestry and Fisheries, Ministry of Knowledge Economy, and Ministry of Land, Transport and Maritime Affairs – has integrated the separate resource circulation plans of each institution, establishing itself as a government-wide resource circulation guideline. The Basic Plan earned its status as an official plan as the article on its revision every five years was inserted into the existing regulation (Enforcement Decree of the Act on the Promotion of Saving and Recycling of Resources).

The Basic Plan has set "Low-carbon, Zero-Waste Society" as its vision, with a goal of resource circulation rate of 20.3%, and a reduction of landfill by 26% by the year 2015, compared to 2009. To realize these goals, various implementation measures have been proposed under five strategies, as outlined in Table 10. The government expects that if the Basic Plan is fulfilled, about 5.3 million tCO_2 will be reduced by using landfill gas, and about 37.7 million tCO_2 will be avoided through the production of new and renewable energy (energization of waste resources). Furthermore, the economic value from the reduction of waste materials, increase in recycled goods, and production of new and renewable energy will amount to approximately 9.4 trillion KRW, with an effect of creating 11,528 jobs related to waste recycling.

Table 10: Strategies, tasks, and action plans for realizing a zero-waste society

Strategies	Tasks	Representative Action Plans
1. Switching to a material recycling social structure	Establishment of foundation for resource circulation	• Development of a national indicator set for setting of targets and monitoring performance of material cycles • Improvement of regulations for the promotion of resource circulation
	Strengthening of material cycle performance of development projects	• Development of a material cycle guideline to be used throughout the entire cycle of development projects (i.e., project preparation, design, construction, operation)
	Expansion of resource circulation for all processes of products	• Strengthening of regulations on packaging materials and methods • Arrangement of specific methods and standards for recycling discarded products; stronger penalty when not implemented
	Facilitation of green production and consumption trends	• Preparation of stakeholder participatory program to reduce waste materials and facilitate sharing of second-hand products • Creation of low-carbon, energy self-sufficient green villages
2. Realizing waste upcycling	Minimization of disposal of useful resources	• Reduction of direct landfilling of municipal waste to zero by 2020 • Strengthening of regulatory requirements for landfilling of industrial waste to increase material cycle
	Establishment of a national waste cycle network	• Establishment of a national resource circulation information network to control the waste cycle • Creation of regional resource circulation cooperation network that supports industrial resource circulation (e.g., information sharing, consulting)
	Promotion of reuse of resources	• Provision of second-hand furniture and home appliances to low-income families
	Strengthening of Extended Producer Responsibility (EPR)	• Expansion of products for which enterprises must collect discarded products to recycle • Strengthening of the regulations on the use of recycled aggregates in construction activities • Reinforcement of quality standards for recycled products
	Expansion of use of waste resources as energy source	• Expansion of refuse-derived fuel (RDF) production facilities, livestock excretions energization facilities, and biogas facilities
3. Creation of unified waste processing infrastructure	Optimization of waste processing	• Optimization plan for collection transport, and processing of waste materials (e.g., allowing treatment of waste across administrative borders to improve efficiency) • Promotion of public-private investment and operation of waste treatment facilities
	Reinforcement of toxic substance management	• Reinforcement of management of toxic waste from daily life (e.g., discarded medicine and fluorescent lighting) and agricultural waste (e.g., discarded vinyl and agricultural chemical containers) • Strengthening of the management of imported and exported toxic substances
4. Promotion of resource circulation industry and technological development	Development of high value-added resource circulation technology	• Expansion of R&D for high value-added recycling technology such as collecting rare metals • Conduct of periodic technical forums on waste energy recovery to help knowledge dissemination and promote related investments
	Strategic promotion of resource circulation industry and foundation of overseas expansion	• Government support for enhancing the position of the recycling industry • Awarding of government grants to private firms to conduct feasibility studies for overseas projects on waste reuse and recovery

2.4 Establishment of Green Industrial Complex and Clusters

The ROK's industrial complex has served a pivotal role in the nation's economic growth. According to the Industrial Complex Corporation (KICOX), each period saw different outcomes throughout the 50-year history of the nation's industrial complex, which is a result of the changing government policy in line with the national industrial structure (Park, 2014a). The shift in policy paradigm can be summarized as follows:

- **1960s:** Creation of light industry export industrial complex in regions where cheap labor is abundant
- **1970s:** Building of large scale coastal industrial complex to back up the government policy of shifting from labor-intensive light industry to heavy chemical industry
- **1980s:** Creation of local industrial complex and agricultural industrial complex in line with the government policy of balanced regional development
- **1990s:** Pursuit of multiple complex with various services like R&D, distribution, and welfare, given the growing importance of technological innovation in industrial growth
- **2000s:** Creation of venture complex, software, and information technology industrial complex, scientific research complex, and high-tech medical complex to execute the industrial policy of fostering high-tech industries and establishing innovation cluster (Porter, 1998)

With the successful execution of such government policies, the ROK's industrial complex has provided the strong physical foundation for the growth of manufacturing industries and to the economy at large. It is worth noting that the cost of creating industrial complexes was mainly borne by the government, which thus spared the enterprises from the huge investment burden. A good example is the Guro Industrial Complex – the nation's first export industrial district – which sparked the nation's industrialization in the late 1960s.

The government arranged industrial complex infrastructure like industrial water supply and road system in Guro in Seoul, which had large areas of state-owned land and with good accessibility for transport of raw materials and shipping export freights. As a result, the Guro Industrial Complex grew to shoulder approximately 10% of the nation's total export during the late 1960s to 1970s.

Note how the weight of industrial complex in the entire manufacturing industry of ROK is still significantly high. As of 2012, it accounts for 69% of the entire manufacturing production, 81% of the exports, and 47% of employment, and these indices have seen a steady increase since the year 2000. The establishment of industrial complexes has played a key role in facilitating regional economic growth and convergence in the ROK. Small and medium cities have developed around regions with industrial complex, with a high GRDP per capita (Park, 2014a).

The ROK's industrial complex cannot be spared from economic and environmental issues. While it is indeed a major contributor to national economic growth, it is also a main source of fossil fuel consumption. The Five-Year Plan has set the greening of industrial complex as an important task. The government has planned to go beyond the concept of environmentally friendly industrial complex that reduces energy consumption and promotes resource circulation, and further aim for creating industrial clusters that foster relevant industries with a focus on green technology. While minimizing environmental problems, this goal aligns with the low-carbon green growth vision by nurturing new industries for the industrial complex development plan to achieve economic growth. This is modeled after the experiences of Spain's strong industrial cluster in the wind power sector in the Basque region, which was able to overcome the challenges in the steel and shipbuilding industries, and the French Solar Valley, which was an attempt to revive the local economy of the Rhône-Alpes after the withdrawal of the air force base. In relation to this, the government has proposed a plan to support the creation of the following clusters:

- **Regional Green Industrial Clusters:** Industrial clusters refer to a network of enterprises, universities, and research centers in close proximity that promote innovation through frequent interactions and information flows.

The ROK's model of green industrial clusters emphasize fostering of green industries. Evolving around manufacturing platforms that produce green goods, green industrial clusters involve the participation of innovation actors (research centers, universities), technology intermediaries (technology support and commercialization centers), and corporate support providers (financing agencies and strategic consultants).

- **Eco-Industrial Parks (EIP):** The ROK has been promoting the creation of EIPs from the mid-2000s. EIP is a resource-circulating industrial complex in which the by-products, wastewater, and sludge from the production process are used as resource or energy source for other businesses through a network of enterprises. The government plans to increase the number of EIPs from five in 2009 to seven in 2010, and further expand annually. To maximize the effect of EIP, the regulations on recycling waste has been enhanced, and the residual heat from EIP is supplied to nearby regions for residential heating.

- **Low-Carbon Industrial Complex:** The government noted that industrial complexes, where small and medium businesses are concentrated, are the main source of carbon emissions. Thus, it has planned the creation of Low-Carbon Industrial Complex that actively promotes GHG reduction programs (i.e., CDP projects) for SMEs. The implementation measures include the installation of renewable energy facilities in idle sites inside the industrial complex, execution of energy efficiency retrofit activities, installation of refuse-derived fuel power production facilities, and shifting to the use of LED lights as street lamps for the industrial complexes.

- **Ubiquitous Industrial Complex:** The government has planned the creation of Ubiquitous Industrial Complex that enhances productivity and environmental quality of the industry through IT infrastructure. Diverse methods were sought to promote recycling of waste, such as monitoring the wastewater by blocks of the industrial complex through water quality sensors, and operating a real-time information sharing system on the waste generation of each company through GPS.

2.5 Target Setting

As described in this section, the government strategies and plans under the green industry agenda of the Five-Year Plan were structured around the two key goals of greening of the existing industries and fostering of new green industries as the nation's new growth engine.

Amidst the challenges of global recession and slowdown of domestic economic growth, green industrial transformation was sought as the solution to increase the number of jobs and improve corporate competitiveness, in addition to overcoming the risks of climate change, global resource scarcity, and environmental degradation. Such redirecting of industrial growth – which has built on resource-intensive patterns – was to drive new norms in industrial processes that exploit opportunities for renewed and sustainable growth.

Table 11: Main targets set under the "Green Industry" agenda

Target Indicators	2009	2013	2020
Rate of material cycle	15.0%	17.0%	17.6%
Share of green products in exports from key industries	10%	15%	22%
Number of large businesses and SMEs participating in green partnership	685	1,500	2,900
Number of green industrial complexes	5	10	20

Source: PCGG, 2009b

3. Policy Actions and Programs

3.1 Green Certification and Financial Instruments

Stimulating public private investment in the green growth sector – which involves greening of technologies, industries, and corporate management – is critical in realizing transformation toward a low-carbon economic structure. Free market principles is the most effective way to allocate funds, and the sectors relevant to green growth are no exception. However, the underlying challenge for greening of the industrial sector lies in how relevant investments run the risk of high uncertainties and long payback periods, in addition to private returns falling short of social returns. Due to the lack of financier's confidence in green investments – an area that is still relatively new and for a select few – it is natural that investments continue to place preference on conventional forms of investments such as simple manufacturing and construction that match their needs and risk profile. The ROK government emphasized that the existing financial mechanisms based on market dynamics in the ROK is insufficient to channel investments to the green sector due to the following (Joint Work of Relevant Ministries, 2009):

The number of green projects that meet the existing market requirements is limited, while the definitions of "green projects" and "green businesses" in the financial market are unclear, making it difficult for investors to deploy capital on projects that maximize positive environmental and/or climate benefits.

- The domestic financial market is not mature enough, with gaps in the diversity of financial instruments and investors that are willing to deploy capital into long-term projects, and expertise required in assessing the profitability of green technologies.

- Uncertainties in government policies (i.e., commitment, sustainability) on green growth and climate change as perceived by the private sector are too high to motivate the investors that are reluctant to shoulder risks.

Against this backdrop, the ROK government planned to take on a "catalytic role" of supplementing gaps in investments that cannot be filled by existing market function, and attempted to develop a wide range of financial instruments that can diversify the risks involved in green projects. Typical examples of such efforts are the "green certification scheme" and "low-interest government loans on green projects"; these schemes played an important role in channeling public and private funds to foster the nation's green industries based on the principles of selection and concentration.

3.1.1 Green Certification Scheme

The idea of green is often painted with a very broad brush, encompassing multiple benefits (whether in the form of energy efficiency or environmental quality) with different magnitudes of impacts. Recognizing how there are different shades of green and relative greenness, investors are often puzzled in differentiating green investments from conventional alternatives, and understanding why it is a good investment. The ROK government introduced the Green Certification Scheme in 2010 to provide a clear guideline on "what is green and what isn't" in terms of green technologies, green products, green projects, and green enterprises. Not only was the scheme aimed at alleviating the uncertainties in green investments by providing government assurance through certifications, it was to shed light on the diversity of green investment opportunities and portfolio options available. The scheme anchors on the Framework Act on Low-Carbon Green Growth, which specifies the government authority that is to certify the appropriateness of green technologies and industries.

Implementation

Green certifications are issued in four areas, based on scores from different sets of evaluation items; those that have scores of 70 and above (out of 100 points) are issued with green certificates.

- Green technologies refer to those that help cut down GHG emissions and pollution through efficient consumption of energy and resources, and improving material cycles in all economic and social activities of the society. Specifically, it targets 1,870 technologies classified in 10 areas:

  (1) new and renewable energy,
  (2) CO_2 reduction;
  (3) water quality and consumption;
  (4) green IT systems;

(5) green automobiles and vessels;
(6) green buildings and cities;
(7) innovative materials;
(8) green production;
(9) environmentally-friendly agricultural products; and
(10) environmental protection and preservation.

The certification of technologies is based on evaluations on the superiority (60 points) and greenness of technologies. Note that technological superiority refers to the potentials for commercialization and the scale of its anticipated impacts.

- Green products refer to goods on sale in the market that have benefited (e.g., during the manufacturing process) or directly derives from commercialization of green technologies described above. Certification criteria includes the level of quality management, success in production (i.e., whether production is sustainable, and whether the business owns the production facilities), and product performance. Note that certification is only issued for applications made by the applicant that either directly owns or is given the rights to practice the green technology that has been certified under the scheme.

- Green projects indicate those that help minimize GHG emissions and pollution by means of energy and resource savings. Main examples include installation of new and renewable energy systems, retrofits to cut GHG emissions in production activities, and introducing wastewater reuse facilities. A total of 95 types of projects are subject to certifications, categorized into areas identical to that of green technologies (nine areas, excluding the area titled "innovative materials"). Rigorous evaluations are made to validate the project's level of technology utilization (30 points), anticipated benefits from positive environmental impacts (50 points), and consistency with government's policy goals (20 points) prior to the issuance of certifications.

- Finally, green corporations or business entities refer to those that own one or more certified green technologies. Certification requires the applicant entity to have been in business for at least one year after foundation, and a minimum of 20% of the latest fiscal year's revenue derived from green technologies.

The main government organ overseeing the green certification scheme is the MOTIE and the administrative organization is its subsidiary, the Korea Institute for Advancement of Technology (KIAT). Nonetheless, the participation of other ministries and their affiliate institutions with expertise across the wide range of sectors relevant to the green certification is critical. Certification is issued on a voluntary basis, by applying to KIAT's online system. KIAT is given the role of designating appropriate evaluation entities (i.e., a total of 11 public research institutes, technology evaluation centers) and commissioning evaluations upon receipt of applications. For example, applications on technologies in the marine and energy industries are reviewed by the Korea Institute of Marine Science and Technology Promotion, and the Korea Institute of Energy Technology Evaluation and Planning, respectively. The certification review committee housed under KIAT is responsible for making the final decision for certifications based on the evaluation reports. Certifications are valid for a period of two years from the date of issuance and is renewable upon request.

Technologies, products, projects and business entities that have acquired green certifications are offed a wide range of benefits from the government, most of which take the form of "preferential treatments" relating to the use of financial services. Note that most of these financial services such as government's policy loans and grants refer to those that have long been operating in the market; green certifications have sought to take advantage of existing financial instruments, to avoid efforts and risks inherent in developing benefit programs of its own. For example, the government's "Policy Loan Program for SMEs," which aims to increase the competitiveness of domestic SMEs through low-interest loans offers priority access and loosening of loan limits to corporations with green certification.

Table 12: Benefits from green certifications

Category	Examples of Benefits
Financial support	• Priority access to loans, loosening of loan limits, increased insurance coverage
Marketing support	• Additional points awarded in government procurement • Financial support for holding of exhibitions and roadshows for showcasing green products
Foundations for green technology commercialization	• Certified green corporations exempt from costs in green technology certifications • Government support for employment of distinguished overseas professionals
Green technology commercialization	• Preference in the award of public R&D grants and patent applications
Others	• Business start-up funds for certified green corporations • Operation of free training programs for certified green corporations

Outcomes and Takeaways

After the launch of the scheme in April 2010, a total of 1,960 green technologies, 437 green products, 38 green projects, and 233 green businesses have been certified up to February 2015. The total number of applications during this period was 4,770, 56% of which were successful in certification issuance. KIAT reported that the number of annual applications has been on a steady increase, with growing interest especially among SMEs. During the first two years of implementation, SMEs accounted for more than 75% of the green corporate certifications issued. Technologies under the "new and renewable energy," "environmental protection and preservation," and "green IT" categories covered more than 50% of the certifications issued for green technologies.

It is difficult to quantitatively justify the outcomes of the green certification scheme as its benefits do not take monetized forms, and especially because green certifications may have played important role in attracting finance, but it is not the sole factor of success. However, it is without doubt that the scheme has sparked the domestic banking sector in developing financial products that are exclusive for businesses and projects with green features; corporate loan products from private entities entitled "New Green Corporate Loan (Shinhan Bank)," "Green Business Loan (Kyongnam Bank)," and "Green Growth Loan (Kookmin Bank)" are some of the leading examples. Green certification has helped these domestic banks to do away with the hassle of validating the appropriateness of green investments.

From the government's perspective, the scheme is an effective means of fostering green technologies, expanding the green product market, and creating new jobs, as demonstrated by two certification issuances that have received MOTIE's special recognition in 2014. Kumho E&G, a business that produces power management devices that help boost energy efficiency, reported an increase in revenues by 2.9 billion KRW and creation of 10 new jobs through the sales of its certified green products. Also, Booster Co., LTD. reported that it was able to secure 3.9 billion KRW of private sector and government investment, and achieve 350 billion KRW worth of revenue from the sales of its green certified product. On the other hand, green certification is a relatively simple, cost-effective, and rapid means of having access to a wide of benefits, from the perspective of industry and innovation actors. Under growing interest, the government has taken timely actions to expand the scope of certification; for example, certifications on green products was only included in December 2012, approximately two years after the launch of the scheme. Nonetheless, as the number of green certifications increase and the scope is enlarged, possible overlap with existing certification programs is becoming an issue of concern. Duplication creates confusion and hampers effectiveness of certifications, in addition to placing unnecessary burden for businesses.

3.1.2 Financial Instruments in Support of Green Industries

It was only after the government announced low-carbon green growth as the new national vision in 2008 when the term "Green Finance" started to gain public recognition in the ROK. Government strategies placed strong emphasis on how green finance not only brings about economic growth opportunities and positive environmental impacts, but it was to serve as a new area of business to financial sectors. Consequently, the government actively reached out to various institutional and private capital entities including national and commercial banks to stimulate the development of financial programs that meet the demand for capital needed to push forward its agenda on green industries. Fundamentally, green finance in the ROK is divided into those that:

(1) support green business activities such as enhancement of energy efficiency and environmental protection;

(2) channel funds necessary in fostering green corporations; and

(3) provide export credits for certified green corporations. Representative financial instruments that can fulfill these roles are loans, guarantees, investment funds, and insurances.

- **Green Commercial and Policy Loans:** Various public institutions including the national and regional banks utilized the government's special account to prepare policy loan programs that support investments in business activities consistent with the goals under the low-carbon green growth vision. These loans provide funds to green businesses under conditions of credit lines and discount rates that are highly favorable as compared to those of the commercial banks. The government urged the commercial banks to also arrange similar loans, which led to a total of 36 new programs being established and operated during 2009-2014.

- **Green Policy Guarantees:** A multiple number of financial institutions including the Korea Credit Guarantee Fund, Korea Technology Guarantee Fund, and the Export-Import Bank of Korea have been providing guarantees ensuring that the liabilities concerning green technology, green products, and green businesses will be met. In other words, these guarantees cover any loss that may arise in transactions against green businesses (i.e., green product manufacturers) to the insured (i.e., green product purchasers). Obviously, these green policy guarantees offer favorable conditions compared to conventional guarantees, such as ease in the maximum guarantee amount reduced guarantee fees. Policy guarantees are extensively used by SMEs that possess the technological assets but lacks financial solvency.

- **Green Policy Fund:** Green policy funds are fixed income financial instruments that are used to raise funds dedicated exclusively to green growth from both the public and private sectors. This provides investors an attractive investment proposition as well as an opportunity to meet capital needs from green businesses and projects. Considering how investments in green industries are often characterized by long pay-back periods, and high risk and high return profiles, blending of government funds with that of the private sector helps render longer term access to finance affordable.

- **Green Policy Insurance:** A number of public financial institutions operate insurance programs exclusively for green corporations to prevent loss that may arise in business activities. Insurances that compensate for loss from export contracts (i.e., implementation of trade receivables) or transaction of emissions permits under the Emissions Trading scheme are some of the representative examples. Green policy insurances are special in that they offer coverage on losses specific to green business areas (which are not often covered by conventional insurance products) at favorable conditions.

Implementation

A large portion of financial products that support government's commitment to make enough funds available to the green industry sector (excluding green policy funds which were largely new to the market) are actually products that have long existed and operated by a wide range of financial entities. The essence of what makes them "green" is the additional benefits or preferences placed

Table 13: Types and conditions for Green Industry Loans

Product	Supervising Ministry	Source of Fund	Loan Provider
New and Renewable Energy Loan	Ministry of Trade, Industry and Energy	Electric Power Industry Basis Fund	Korea Energy Management Corporation
Energy Saving Facility Loan	Ministry of Trade, Industry and Energy	Energy Utilization and Rationalization Fund	Korea Energy Management Corporation
Agriculture Synthetic Fund Loan	Ministry of Agriculture Forestry, and Fisheries	Comprehensive Agricultural Fund	National Agricultural Cooperative Federation
Tourism Fund Facility Loan	Ministry of Culture, Sports and Tourism	Tourism Promotion and Development Fund	Korea Development Bank
Environmental Industry Loan	Ministry of Environment	Environment Industry Promotion Fund and Environment Improvement Fund	Korea Environmental Industry and Technology Institute

exclusively for green businesses and projects. Accordingly, the implementing entity, source of funds, and beneficiaries of these green financial products vary according to their originally intended purposes (i.e., fostering of SMEs, increasing export capacities). This section seeks to shed light on some of the government's green policy loans, a category of financial products that have been most well correlated to the "green certification scheme."

The government's policy loan products can be largely categorized into:

(1) new and renewable energy loans;

(2) energy saving facility loans;

(3) agriculture synthetic fund loans;

(4) tourism fund facility loans; and

(5) environmental industry loans.

- **New and Renewable Energy (NRE) Loan:** NRE loans make available capital for installation of NRE facilities, as well as investments by manufacturers that produce NRE goods. In other words, these low-interest loans are divided into facility loans, manufacturing loans, and working capital loans. Note that working capital loans seek to help secure liquidity of small-scale NRE manufacturers (SMEs). The source of these loans is the government's Electric Power Industry Basis Fund, which is a collection of tax imposed on retail electricity users. The total annual volume of loans have fluctuated to meet the changes in demand; in 2015, a total of 115 billion KRW has been budgeted, 97% of which are to be directed to facility and manufacturing loans.

- **Energy Saving Facility Loan:** Low-interest loans are given to cover investments on installation of new facilities with high energy saving performance or retrofits for improving the energy efficiency of existing facilities. A list of pre-determined energy saving facilities is made available to guide loan applicants. The source of loans is the government's Energy Utilization and Rationalization Fund – a collection of special consumption tax on petroleum products – which was created to vitalize the domestic economy and promote investments on energy saving facilities. Annual budget for the year of 2014 was 500 billion KRW, with ceilings placed on single loan transactions (15 billion KRW). Loans typically have a three-year grace period followed by a five-year payback period, and are to only cover a portion of the total investment.

- **Agriculture Synthetic Fund Loan:** As the most widely recognized agricultural policy loan of the nation, the Agriculture Synthetic Fund Loans provide capital for various needs such as infrastructure related to agricultural production-storage-distribution, R&D on agricultural technology, and agricultural machinery manufacturing industries. In order to help the greening of the industrial sector, the loan program started to provide additional points for loan applications by certified green technologies, projects, and business entities. Investments on facilities for expanding environmentally friendly agricultural practices, process of livestock excretions, and replacement of old livestock sheds are some of the example items of the loan beneficiaries. The proceeds of the loans come from the government's Comprehensive Agricultural Fund and is operated by the National Agricultural Cooperative Federation, which is a federation of agricultural cooperatives that provides supply, processing, marketing, and banking services to the nation's agricultural sector.

- **Tourism Fund Facility Loan:** Additional points have been given to loan applications by certified green cooperation, to allow preference on investments in green tourism in operating the Tourism Fund Facility Loan. This financial product utilizes the government's Tourism Promotion and Development Fund to shoulder investments on facility infrastructure and business operation (i.e., working capital for travel agencies and hotel management). The total annual budget reached 480 billion KRW in 2014, with more than 80% allocated to facility expansion and modernization.

- **Environmental Industry Loan:** Operated by the MoE, the Environmental Industry Loan targets SMEs of the environmental industry that often face greatest problems in accessing finance. Under the ultimate goal of fostering the nation's environmental industry, interest subsidies are granted to accelerate investments in installation of pollution prevention facilities, implementation of environmental remediation projects, and the conduct of R&D activities. Interest subsidies refer to the difference the interest rates of commercial and public policy loan programs. Preferences have been given to applications by SMEs with green certifications.

Outcomes and Takeaways

Analogous to the outcomes of the green certification scheme, tracking the exact amount of capital mobilized to green industrial activities is difficult, as the evaluation on the "greenness" of investment is only one of the many factors in the due diligence of loans administered by a long list of financial institutions. However, it is clear that government endeavor has had positive impacts, both in terms of the diversity of financial products in support of green industries made available and their level of alignment to the government's agenda on low-carbon green growth.

In year 2009 alone – the year after government's announcement on low-carbon green growth vision – more than 40 financial products exclusive to green investments were created. A total of 80 different green policy funds have been launched, thanks to the active interaction and collective efforts between the heads of banks and asset management groups under the Green Finance Council, which was created and led by the president of Korea Federation of Banks. Unfortunately, such positive trend is at risk of collapsing after the entrance of new government in 2013. Policy-financing channels is bound to

Table 14: Amount of capital mobilized for green finance

Unit: hundred million KRW

Product	2009	2010	2011 (1~3Q)	Total
Lending	47,790	83,128	80,910	211,828
Guarantee	46,931	59,674	65,980	172,584
Insurance	7,426	41,386	37,973	86,785
Policy Fund	40	2,280	2,968	5,288
Venture Capital	4,579	5,530	4,817	14,926
Total	106,766	191,997	192,648	491,411

Source: PCGG, 2011

evolve with the changes in government policies, and low-carbon green growth has now become "the favorite agenda of the predecessor." Despite the positive achievements in engaging commercial banks to finance green industrial inspirations, the government's support for green finance has lost its momentum. Many of commercial banks' green financial products have already vanished from the market, and the "Green Finance Council" has reached *de facto* truant status.

3.2 Regional Green Industrial Clusters

Cluster-based industrial parks were first introduced during the 1990s in the ROK as an effective tool for developing competitive industries and generating employment. Following the success in establishing industrial complexes which started in the 1960s, the government strongly promoted industrial cluster policies in relation to achieving a balanced regional development. With the advent of intensifying technology innovation and reconfiguration of global manufacturing set-up (i.e., rise of China as a major manufacturer), industrial clusters were established at the vicinity of existing industrial complexes to strengthen their competitiveness, primarily by reinforcing innovation capabilities.

The green industrial clusters of the ROK refer to a geographical concentration of green industries, service providers, research centers, universities, and government institutions. The term "green" in this context obviously refers to achievement of "low-carbon green growth" through the production of green goods and services, such as enhancing the efficiency of energy and resource consumption. Compared to conventional industrial complexes that primarily exploit the cost benefits arising from shared infrastructure and services, the concept of industrial clusters take another step forward, toward reaping of benefits that arise from stimulating networking and collaboration between industries and innovation entities. Green industrial cluster adopts such concept of industrial clusters, but with additional goals of establishing a strong foundation for vitalizing regional industrial development in a low-carbon and environmentally sustainable manner.

Interregional Industry Promotion Program

Launched in 2009 under the objectives of fostering new industrial growth engines to propel regional development, the "Interregional Industry Promotion Program" was the government's most systematic approach to support establishment of regional green industrial clusters. Basically, the program offers grants to proposals from groups of enterprises, universities, and research institutes that seek to work towards developing innovative products which lead to increase in corporate revenues and creation of new job opportunities. Note that the program was also designed to help rally regional development and balance regional disparity which manifested during the nation's period of rapid economic growth. Grants with a maximum of three-year duration are categorized into two groups:

(1) R&D projects that focus on technology commercialization and product development; and

(2) Non-R&D projects that support knowledge sharing, business development, and fostering of talents.

The central government provided a list of priority areas of region's industrial growth, which served the basis for the selection of grant awards. Assessments were conducted to comprehensively evaluate the level of R&D capacity, potentials for technology commercialization, competitiveness of relevant industries, and potentials for regional market growth across the nation's 14 main cities and provinces

Table 15: Comparison of concepts of industrial complexes and clusters

Industrial Complex	Industrial Cluster	Green Cluster
• No common goal • Low correlation • Low cost of land use • Common use of infrastructure	• Common goal • High correlation • All kinds of industries • Common use of network and human resources	• Common goal for Low carbon, Green Growth, and improving environmental quality • Green industries • Use of renewable energy • Promoting energy efficiency • Developing green technology

(excluding the nation's capital Seoul and its host province Gyeonggi-do), which eventually translated into a list of priority industries most suitable for the selected regions. Obviously, no single city or province owns the highest level of capacities in all four areas of the assessment; green clusters were to establish inter-regional networks to complement and integrate the core capacities relevant to the entire value chain of industries. Below are some conclusions drawn from the assessment:

- The prerequisite conditions for fostering of solar PV industries come in the order of potentials for technology commercialization, level of R&D capacity, and geographical potentials for solar power generation. Daegu-Gyungsang (City-Province pairs) region with high capabilities for technology was best suited for establishing silica based solar cell industrial clusters, while the Daejon-Chungcheong region with nation's top R&D capacity was found ideal for establishing non-silica based solar cell industrial clusters.

- The competitiveness of relevant industries and the level of R&D capacity were identified as critical conditions for development of green car (e.g., electric vehicles, fuel-cell vehicles) industries. The Ulsan-Gyungsang region, which hosts the nation's leading car manufacturers, was identified most suitable for the creation of green car industrial clusters.

As opposed to the first phase of the program (2009-2012), which simply placed an emphasis on "innovative product commercialization," the second phase of the program (2012-2014) stressed the importance of "stimulating job creation"; grant applications were to specifically identify the number of new employment opportunities that arise both during and after project implementation. Under such guidelines provided by the central government (i.e., MOTIE as the supervisory organization supported by Korea Institute for the Advancement of Technology), the program's seven regional offices were given the role of project selection, management, and post-evaluation.

The outcome from the first phase (2009-2012) of the program has shown promising results. During the first two and a half years of the three-year period, a total of 11,681 new employments, 5.5 trillion KRW worth of revenues, and US$ 3 billion worth of exports were reported to have derived from the regional industrial clusters supported by the program. Approximately 1,100 entities (64% of which were enterprises) benefited from the grants provided in the form of matching funds, which totaled approximately 1 trillion KRW; each project averaged in 0.5 billion KRW.

Table 16: Priority areas by region under the Interregional Industry Promotion Program

Regions (Province)	Phase 1 (2009-2012)		Phase 2 (2012-2014)			
			Areas of Future Industrial Growth		Primary Industry Areas	
Chungcheong	Bio pharmaceuticals	IT	Bio and pharmaceuticals	Renewable energy (solar) and secondary cells	IT	Machinery
Jeolla	Renewable energy (solar and wind)	LED and Hybrid cars	Renewable energy (solar and wind)	Life-care products	LED and lighting	Green cars and vessels
(North) Gyeongsang	New and renewable energy (solar, fuel cells)	IT	New and renewable energy (solar, fuel cells)	IT	Smart mobile products	Innovative materials
(South) Gyeongsang	Green cars and vessels	Innovative materials	New and renewable energy (wind and nuclear)	Chemicals	Green cars and aircrafts	Green vessels and offshore plants
Gangwon	Bio pharmaceuticals	Medical tourism	Innovative materials		Bio pharmaceuticals	Health care
Jeju	Water industry	Meetings, Incentives, Conferences, and Exhibitions (MICE)	Renewable energy (wind)		Health and food	MICE

Although it is incorrect to assert that the grants from the program is the sole basis of the outcomes, the program has clearly contributed in stimulating the formulation of industrial clusters, especially for the green industry sector. The success of the program has also helped its beneficiaries to attract 450 billion KRW worth of investments. For example, Gumi City of the North Gyeongsang region hosted a solar cell plant from investments by Japan's Sanko Metal Industries, Inc. The government spending under the program has been widely accredited for having laid the foundations for balanced regional economic development.

Green Cluster Initiatives by Local Governments

The Five-Year Action Plan for Green Growth (2009-2013) specifically articulated targets for establishment of regional green industrial clusters; a total of eight new green clusters were to be developed by 2013. Supported by the strategic interests and strong momentum of the PCGG, local governments rushed many plans for developing their regional green industrial clusters starting in 2009. Based on the assessment of various factors – such as the region's concentration of employment, industry presence (i.e., manufacturers, assemblers, and component suppliers), technological specialization, patterns in relationships among industrial entities, geographical advantages, and market demand – local governments came up with rather ambitious plans that were packaged to reflect their uniqueness. Unlike how the "Interregional Industry Promotion Program" sought to support R&D activities, stimulate information flows, and enable product development, many of the local government plans took a step further. One example is the construction of special industrial districts or testbed facilities, pursued in the way that the ROK government supported the establishment of the nation's major industrial complexes.

Many of the local government plans sought to replicate the success of developing countries; for example, wind power clusters of Ringkøbing, Denmark, the Basque Country in Spain and the state of Texas in the U.S., and the solar energy clusters of the state of Thringen in Germany, the Rhne-Alpes in France and the Silicon Valley in the U.S. These examples set "good" representations of how green technologies can be foundations of new regional growth. The Basque Country's wind power cluster has helped overcome the fall of its steel and shipbuilding industries. The increase in jobs related to green technology in California tripled that of the total jobs in the state during 1995-2008, among which jobs related to solar power occupy the greatest proportion (Lee, 2010).

At the national level, STEPI's strategic report entitled "Green Cluster Strategy to Vitalize Regional Economy" provided strategic guidance toward the formulation of green cluster plans by local autonomies. The report identified Korea's industrial areas of highest potentials to develop green clusters by technologies, based on an analysis of the conditions for market formation, R&D capacity, industrialization capacity, and potentials for making use of existing related industries. For example, the South-Eastern regions of the nation (Gyeongsang region) was found to have the highest potentials in the field of hydrogen and fuel cells, with a well-balanced possession of all four core conditions. The existence of a strong automobile industry, and plans of nation's major steel maker – POSCO – to construct a stack (i.e., a core component of fuel cells) manufacturing factory in the region were identified as a significant advantage for the region's establishment of a fuel cell cluster.

4. Assessment

4.1 Quantitative Assessment

The ROK's pursuit of green industrialization has been showing positive results both quantitatively and qualitatively thanks to forceful government policies and active greening efforts of enterprises The government has sought to provide systematic and financial support to promote green industrial development while reinforcing various environmental and energy regulations and standards. Meanwhile, many domestic firms including conglomerates have begun to acknowledge the importance of greening their business operations as a key factor to survive in today's fierce competition, domestically and globally.

As explained previously, the ROK put forward four main strategies in developing its green industry – namely, pursuing the green transformation of the industrial sector, promoting resource circulation in the economic and industrial structure, strengthening green SMEs, and establishing green industrial complex clusters. Tangible results have been achieved regarding these strategies, although in varying degrees depending on the unique circumstances in the implementation process for each strategy.

Green Transformation of the Industrial Sector

Environmental friendliness is rapidly becoming an important factor for companies to be competitive in the global market, along with price and quality. As a result, businesses have been pressured to comply with certain practices related to the green transformation of industries such as the development of green production technology and products, reduction of air and water pollutants, cutting down on energy and resource usage, and the like. The ROK recognized the necessity of these efforts given its considerable progress in greening its major industries such as steel, chemical, automobile, and electronics, which consume much energy and emit large amounts of GHG. However, most of the outcomes of the ROK's green transformation are still quantitatively limited due to the long-term period required to reap the full benefits of such efforts.

- The accumulated number of firms that gained certification from ISO 14001 – an international standard on environmentally friendly management – shows a sustained increase in the ROK, although the annual number of newly approved firms has decreased since 2005. The outcomes from such expansion of green management practices by enterprises are most evident in the reduction of pollutants. In the ROK, the total quantity of pollutants emitted by the manufacturing industries[4] might have increased due to the growth in production activities, but the index divided by the added value, or the intensity of emitted pollutants, in other words, is making positive progress.

- The level of efforts exerted by businesses on green management practices can also be examined in terms of the amount of investments made in improving and protecting the environment. Although the growth in

Table 17: Total number of ISO 14001 certified firms

Year	1996	2000	2005	2010	2014
Newly certified	48	180	2,899	1,668	1,394
Maintaining certification	48	405	5,016	6,626	8,018

Source: Korea Accreditation Board, 2014

Table 18: Fluctuation and intensity of emissions in the manufacturing industry

	Total emission of pollutants (ton)		Discharge (1,000 m³/day)	Added value (billion)	Intensity of emission (ton/billion)		Intensity of discharge (1,000 m³/day/billion)
	SOx	NOx	Industrial wastewater		SOx	NOx	Industrial wastewater
2006	159,903	157,774	2,687	242,292	0.309	0.651	0.011
2009	180,882	200,920	3,324	300,036	0.324	0.670	0.011
2011	219,220	234,296	3,118	379,521	0.290	0.617	0.008

Source: MOE, 2014 Bank of Korea 2014

4 | Emissions generated from combustion and manufacturing process

annual spending on pollution prevention related activities stagnated in 2009, there was a rebound in 2012, indicating that the ROK's manufacturing businesses were responsive to government strategies to expand responsibilities for sustainability on all levels, and practice "leaner" production. It should be noted that such investments in the prevention of environmental pollution usually lead to an increase in sales by related industries; sales of equipment, resources, facilities, and services that reduce emissions can help gauge the extent of green transformation. The share of turnover of the nation's green industry, which was 0.63% in 2005, has steadily increased to 1.44% in 2013.

- In the case of GHG reduction, the outcome was found to vary by industries. Key industries such as steel, petrochemical, oil refining, semiconductor, and display have actively pursued methods to cut down on GHG emissions on a company-wide level – such as enhancing energy efficiency and production processes, and expanding the use of waste resources like waste energy. For instance, POSCO, one of the ROK's main steel producers, set a target of reducing the CO_2 emissions per one ton of crude steel produced in the steel mills by 9%, from the average 2.18 CO_2 ton in 2007-2009 to 1.98 CO_2 ton in 2020, with a scheme to invest approximately 1.5 trillion KRW by 2018 to achieve this target. POSCO is also planning to invest 5.5 trillion KRW in green growth projects such as developing high-tension steel plates that enhance automobile fuel efficiency and high-quality electrical steel that enhance energy efficiency in motors and transformers. On the other hand, LG Chemicals, a major petrochemical company, has planned to reduce emissions by 23% compared to BAU by 2020 and is managing its energy use and GHG emissions through the IT system, with a scheme to further expand its green management system.

- These efforts by industries have covered the entire process of production – from product design to production process and waste disposal – and have been revealing diverse results on energy efficiency and GHG reduction. However, the basic units of GHG emissions based on

Table 19: Share of environmental industry in total industry turnover (%)

2005	2007	2009	2010	2011	2012	2013
0.63	0.81	0.96	1.05	0.93	1.43*	1.44*

Note: Numbers with asterisk are projections

Source: MoE, 2013; Bank of Korea, 2013

Table 20: Basic units of CO_2 emissions in the ROK's steel and petrochemical industries

		2005	2010	2012
Steel	Added value (billion)	19,878	25,362	22,189
	CO_2 emissions (million CO_2 ton)	64.8	108.0	121.4
	Basic units of CO_2 emissions (1,000/CO_2 ton)	306.8	234.8	182.8
		2007	**2010**	**2013**
Petrochemical	Added value (billion)	7,382	11,036	21,040
	CO_2 emissions (million CO_2 ton)	41,594	46,409	48,942
	Basic units of CO_2 emissions (1,000/CO_2 ton)	177.5	237.8	429.9

Source: KOSTAT, 2014; KOSA, 2014; KPIA, 2014 "added value" differ greatly from one industry to another. In the case of the steel industry, which is responsible for almost 30% of the GHG emissions of the manufacturing industries, the basic unit of GHG emissions (added value/CO_2 emissions, 1,000 won/CO_2 ton) in the Five-Year Plan was 312 in 2009 and was expected to hit 352 by 2013, which is a 12.8% increase. However, in reality, it steadily fell to 234.8 in 2010, and declined further to 182.8 in 2012. Although such results stem from the fact that the energy efficiency of the ROK's steel industry is already one of the highest in the world (making further improvements largely difficult), the low performance of added value in steel products (from the worldwide oversupply of steel) played a large part. Meanwhile, in the case of the petrochemicals industry, which is the second-largest emitter of GHG after the steel industry, the added value is rapidly increasing relative to CO_2 emissions, thus showing swift progress toward green transformation.

Development of Green Venture SMEs

The ROK government announced a comprehensive plan to increase the contribution of green SMEs to green growth in 2010, setting out specific targets on fostering a growing number of SMEs that utilize green technologies, developing the required human resources, expanding access to finance, and building capacities to implement environmentally sustainable business management practices. The following milestones represent the major progress made under this initiative:

- Creation of Green SMEs: A growing number of green SMEs in the ROK – which is defined as companies whose certified green technologies account for over 20% of the total annual sales turnover under the "Green Certification Scheme" – are not monitored by government statistics, thus making it difficult to evaluate the level of progress made. An imperfect proxy indicator may be the number of SMEs engaged in "Sewage, Wastewater, Waste Treatment, Material Reuse, and Environmental Recovery Services Industries," which is one of the 11 service-industry groups categorized under the annual Korea SME Statistics Report. During the period of 2009-2013, the number of SMEs and employees engaged in this industry saw a 41.4% and 23.6% growth, respectively, which significantly exceeds the average figures for all sectors over the same period (11.4% and 14.2%). The number of new company formations in this industry also showed a steep increase – from 352 in the year 2009 (equivalent to 7.8% of the total number of companies) to 619 in the year 2013 (equivalent to 9.7% of the total number of companies). These positive outcomes were attributed to the significant extent of concentrated government support for new start-ups; for example, leading universities of the nation were designated to provide free office space, mentoring, training, and extensive networking opportunities to green start-up founders.

- Access to Finance: The government's policy fund for enterprises in the green industrial sector increased more than three-fold, from 173 billion KRW in 2009 to 561.5 billion KRW in 2011. A large portion of this fund was channeled in the form of low-interest loans for financing projects utilizing green technologies; the total volume of these loans increased steadily from 156 billion KRW in 2010 to 258 billion KRW in 2011. The total amount of green R&D expenditures by the government granted to SMEs also showed a significant increase, from 363 million KRW in 2009 to 510 million KRW in 2012.

- Capacity Building: The government's flagship initiative to enhance the capacity of SMEs came in the form of a program promoting the partnership between large companies and SMEs. Launched in 2001, the "Green Partnership Program" aims to transfer knowledge on green management practices and cleaner production by facilitating a two-year contract between large enterprises and SMEs; these SMEs are often companies within the value chain of large enterprises (i.e., manufacturing) in need of support to comply with global environmental standards such as REACH (Registration, Evaluation, Authorization and Restriction of Chemicals) of the EU. When low-carbon green growth was proclaimed as the new national vision in 2008, the program was revised drastically to place emphasis on supporting the carbon reduction efforts of SMEs. Through the signing of "Carbon Partnerships," large companies are to share their experiences with SMEs in establishing GHG-emissions inventory, calculating the carbon footprint of products, and improving the carbon efficiency of manufacturing processes. Partnerships during the period of 2009-2011 involving 166 projects have been reported to have cut down approximately 27.5 trillion KRW in SMEs' spending on reduction of CO2 emissions and energy consumption.

- Green Industrial Certifications: Introduced in 2010, the "Green Certification" scheme launched by the government played a critical role in engaging the SMEs in green growth. The certification covers green technologies, green products and services, green projects, and green businesses, and extends eligibility for receiving various forms benefits. It is important to note that a large portion of these benefits have been designed specifically to support SMEs, such as preferential treatment for small-scale loan applications, and operation of special export credit insurance programs for SMEs.

Resource Circulating Economy and Industrial Structure

The ROK enacted the "Act on the Promotion of the Conversion to Environmentally Friendly Industrial Structure" in 1995 to enhance the productivity of natural resource use and promote industrial activities that reduce environmental pollution. Following the efforts made in support of this legislation, the Five-Year Plan pursued diverse policies, the outcomes of which were fundamentally reflected in the domestic material consumption per GDP and the recycling rate. Positive results demonstrate the progress made by the nation's industry in reducing costs through resource-use efficiency and enhancing product's added value.

- The ROK's material consumption per unit GDP has continued to decrease over the years – by 22.9% from 0.811 kg/1,000 KRW to 0.625 kg/1,000 KRW during the period of 2002-2011. Domestic material consumption intensity is a measurement of the total amount of material directly used per unit GDP, reflecting the nation's overall efficiency in terms of resource consumption.

Table 21: Domestic material consumption per GDP

Unit: Kg/1,000 KRW

2003	2005	2007	2009	2011
0.814	0.697	0.660	0.628	0.625

Source: KOSIS, 2014

Table 22: Industrial waste generation and recycling rates

Unit: Kg/1,000 KRW

Category		2005	2008	2010	2013
Waste Generation		112,419	130,777	137,875	149,815
Waste Treatment	Landfill	16,604	24,285	23,309	24,629
	Incineration	7,326	6,937	7,983	9,339
	Ocean Disposal	11,532	6,940	6,956	2,609
	Recycling	76,957	92,615	99,627	113,238
Recycling Rate (%)		68.5	70.8	72.3	75.6

Source: KECO, 2014

- The industrial waste recycling rate has greatly increased from 68.5% in 2005 to 75.6% in 2013. Out of the main industrial waste, the waste synthetic resin, waste metal, and wastewater saw a steep rise in recycling rate; in particular, waste metal was recycled almost entirely as of 2013. The industrial waste recycling rate reflects the industrial sector's willingness to protect and preserve the local environment, as well as to divert waste to more economical use.

Green Industrial Clusters

Among the government's various efforts to promote the green transformation of industrial complexes, the most fruitful to date has been the establishment of the Eco-Industrial Parks (EIP). The ROK's EIP program is being carried out in three stages, from 2005 to 2019. Over the decades, the concept of eco-friendly industrial parks has become increasingly flexible to embrace different types of networks that strive for high environmental and economic benefits. In the ROK, EIP mainly aims to form an industrial community that achieves both economic and environmental goals by minimizing the discharge of waste and by-products, based on cooperation between enterprises on the one hand and the regions around the park on the other.

Following the completion of the first phase (2005-2009), which focused on pilot testing the EIP model in five selected industrial complexes, the second phase (2010-2014) of the program sought to expand the number of EIPs across the nation and adopt the Hub-Spoke network. Unlike the EIPs established during the first phase of the program – which bring together businesses within a single complex to collaborate towards achieving collective benefits – the Hub-and-Spoke network promotes cooperation between businesses housed within a regional industrial complex (i.e., Hub), on the one hand, and a multiple number of its outskirts complexes (i.e., Spoke), on the other. There were three new constructions of EIPs in 2010 and one additional construction in 2013; a total of nine EIPs are currently in operation. The government provides financial grants (as matching funds) for projects proposed by businesses in these parks; related projects include investments for the development of technologies and networks for efficient waste re-use and reduction, energy recovery, and wastewater treatment.

A group of researchers led by Park (Park, 2014b) assessed the economic and environmental benefits of the EIP program. The assessments of a total number of 244 projects completed during the 2005-2013 period indicated that 118 projects have led to successful technology commercialization or actual operation of business networks to improve material cycles. Such success have led to 828,113 tons/year reduction in generation of waste and by-products; 215,517 ton/year reduction water usage and generation of wastewater; 250,475 TOE/year savings in energy use; and approximately 1.1 million tCO_2/year of avoided emissions. Such outcomes translate into a significant rate of environmental return (i.e., 5,408 tons of waste and by-products; 1,407 tons of water usage and waste water generation; 1,635 TOE of energy; 7,231 tCO_2 of emissions) per unit government spending (approximately US$ 100,000) through the provision of project grants. Some actual examples of project-level outcomes are as follows:

- Steam supplied from waste-incineration facilities of Hyundai Heavy Industries to the production lines of Hyundai Motors and Hyundai Hysco in the Ulsan EIP has been reduced by approximately three billion KRW of annual energy spending, in addition to 12,736 tons of avoided CO_2 emissions each year.

- Hankuk paper Mfg. Co., Ltd. located in the Onsan industrial complex is being supplied with dense CO_2 and steam from a refinery of Korea Zinc Company Inc., which leads to approximately 64,000 tons of avoided CO_2 emissions each year.

- Cheil Industries, which produces imitation marble in Yeosu EIP, has been able to avoid approximately 300 million KRW of spending each year from waste disposal by allowing resource recovery businesses to utilize their waste free of charge. The wastes recovered are being repurchased as materials for production of imitation marble, generating approximately 190 million KRW of annual profits for waste recovery businesses.

4.2 Qualitative Assessment

As the quantitative assessment illustrates, some of the government's efforts in greening the industries are evident but despite the positive results, several gaps remain. For example, the basic benchmarks for CO_2 emissions and energy efficiency were not met to the extent that was planned. Despite the increase, the number of SMEs engaged in green industries has not fulfilled the target set under the Five-Year Plan. Most importantly, the ROK's share in the world's green market is still insignificant, despite the government's strong support for green R&D and market expansion. A confluence of complex factors influenced this performance such as the ambitious nature of original targets and the evolving unfavorable conditions of the domestic and international economic environments. In addition, the government's economic policy serves as a limitation to fostering green industries – by still concentrating on expanding the supply when it should rather be focusing on circulation instead of consumption, and regional distribution, instead of central concentration.

As part of the low-carbon green growth policy, the green transformation agenda for the industries has contributed significantly to advancing environmental friendliness and improvement of businesses. Just ten years ago, there were very few enterprises – usually the large enterprises – that considered green management as their core business value. Nonetheless, as the government expanded R&D investment in green technology and promoted various green growth policies, the industries' perspective has eventually changed, given the corporations' increasing recognition of the value of developing green products, reducing pollution emission, enhancing resources and energy-consumption efficiency, reducing waste discharge, and increasing the recycling rate as part of their core management strategy as revealed in their active efforts to advance into the global market using green technology development as an entry point.

However, the ROK's green transformation success is concentrated mainly on large enterprises, as demonstrated by how "green partnerships" between large enterprises and SMEs are primarily initiated and led by large enterprises. Many SMEs are still looking at green transformation from a passive stance; apparently, there is an imbalance between large enterprises and SMEs in achieving green transformation. To resolve this, there is a need to change the focus of the greening strategy to focus rather on incentivizing and developing the capacity of SMEs to be actively engaged in green transformation.

The policies and systems that ROK is using to encourage the recycling of industrial waste has contributed greatly to reforming the enterprises' perspectives on material cycles and promoting technological development. Nevertheless, a large proportion of small-scale industrial sites continue to show insignificant recycling rates as compared to those of developed countries from the lack of technology access and capacities. In addition, government policies that have centered on increasing recycling rates have created negative side effects, such as insufficient *ex post facto* management of toxic substances and even production of inaccurate recycling statistics. As for resource circulation outcomes of the EIP projects, the current results are largely based on government support, raising concerns that the current policy may raise overdependence of the enterprises on government.

The strengthening of energy efficiency standards, setting of national mid- and long-term targets for GHG reduction, and implementing the TMS and ETS have played a significant role in actively seeking ways to reduce GHG emissions. The ETS, launched in January 2015, greatly contributed to leading the active reduction efforts in the industrial sector. As firms need to keep their emissions within their allocated Certified Emission Reduction (CER) or purchase CERs in order to emit additionally, the reduction of GHG emissions is directly reflected in the enterprise's revenue under the ETS. Yet, whether the ROK may successfully induce GHG reduction through the ETS will be evaluated in due course.

The ROK has settled into a high energy-consumption structure, and the energy efficiency of domestic top energy consumers is already at its highest level, which makes it very difficult to reduce GHG emissions yet further by increasing energy efficiency. As the main rivals of the ROK, like China and Japan, are not pursuing strong reduction policies of GHG emissions, if the ROK's green transformation is really going to succeed in strengthening the national competitiveness while reducing GHG, it must gain consistent support from the industrial sector.

5. Takeaways and Recommendations

The intensification of environmental problems and the increasing level of complexities to resolve them is a common challenge that comes with rapid economic growth. Environmental pollution, especially during the early phase of the ROK's economic takeoff, was perceived naturally as a symbol of development rather than an alarming social concern. For example, it is inscribed in the monument built in 1967 wishing for the development of Ulsan, the hub of the nation's earliest industrial complexes, "The moment the black smoke from industrial production reaches far into the atmosphere, it will be a sign that the hopes and progress of the people of the nation have arrived at our doorstep."

However, the developing countries have started to understand and consequences of accepting environmental deterioration for the sake of swift economic growth. Put aside the warnings over "the earth is finite" and continued resource extraction will eventually cause our systems to collapse, there are already visible signs in newly industrialized countries such as China and India that public health impacts attributed to environmental pollution are a significant obstacle to sustained economic growth. With the growing awareness that high growth alone does not necessarily assure better social outcomes, "quality of growth" is being picked up as an important agenda in developing countries.

Green industry brings economic, social, and environmental benefits (UNIDO, 2011). From an economic viewpoint, green industry promotes the development of green industrial technology and environmentally friendly products. For example, developing technologies that collect reU.S.ble materials from wastes creates ripple effects such as a reduction in production costs and new investments aiming to increase resource production, a reduction in waste and pollutants, creation of new jobs, and rise in incomes. Since the inefficient use of resources inflicts serious environmental pollution, the ecological effects of improving resource efficiency will be especially significant.

Despite the array of benefits of fostering green industries, there are numerous obstacles that must be overcome in developing countries. Green industry fundamentally favors conservation over supply and material circulation over simple consumption, but the economic growth strategies of developing countries often prioritize continued supply to meet the growing demand. Within this context, developing countries have inadequate market structure to pursue efficiency and resource circulation measures as both the public and private sector pursue short-term payoffs at the expense of long-term gains, thereby making green industries less attractive.

Based on the ROK's experience, developing countries must recognize how much more difficult the greening of industrial practices can become if it is trapped in an economic strategy mostly driven by increased material supply. Restructuring industrial consumption is an enormous task; the inertia of investments in the fixed assets of manufacturing industries makes changes in their consumption patterns much more difficult to achieve. Once industries lock-in to resource-intensive consumption patterns, their momentum inevitably restricts the government's ability to enforce strong regulatory controls that support market transformation – this is arguably one of the primary constraints to the limited success of the green industry agenda in the ROK. Striking the right balance between growth and conservation is complex, but developing countries that are in the early stages of industrialization must recognize that they have the opportunity to minimize the potential for later regrets and begin to make the most out of interventions that can offer short-term benefits.

One factor behind the immediate successful outcomes of the ROK's green industry policy is the nation's adequate technological capability to support the process. Not only did the nation accumulate technologies during its period of rapid economic growth, but it became a global leader in multiple areas of innovation such as information and communications technologies. Technology convergence (i.e., IT-based energy management systems) served as the launch pad for green industries and the government ensured that R&D activities continue to fuel innovation-led transformation. It is indisputable that government patronage for sustained public and private investment in technology R&D served as the foundation for realizing a green industrial transformation. Considering such strong evidence, an uppermost priority in developing countries is in the accumulation and application of technological assets. Although strengthening of technological cooperation with developed countries serves as a good starting point, success can only build upon strong motivation of the government to master innovative technologies.

The ROK's strategies highlighted how the greening of existing industries and creation of new green industries must be pursued simultaneously. Such strategic direction is based on the notion that the fostering of green industries can only be successful when there is sufficient demand for its outputs, which can be naturally driven by the process of the greening of existing industries. In other words, the greening of existing industries alone that is likely to rely heavily on imported goods would fail to capture the essence of green growth, which is to magnify the synergies between environmental sustainability and economic growth. The common engine driving these two parallel processes is the government policies on emission cuts and resource efficiency. Unlike strategies for industries strictly founded on market principles, government interventions that allocate appropriate incentives and regulations are critical in the early stages of advancing the green industry agenda.

The ROK's performance in end-of-pipe treatment has kept pace with the growing level of economic development. In the mid-1990s, the Ministry of Environment led the reinforcement of various regulatory environmental standards and successfully induced private investments on pollution prevention. As such, the green industry agenda presented in the Five-Year Plan was intended to tackle issues beyond the scope of traditional environmental protection, such as optimizing energy use and promoting resource circulation. In contrast, developing countries that have not yet established standards to improve pollution management practices must seek to expand the green industry agenda to foster traditional environmental industries engaged in waste recycling and pollution control. The related plans in developing countries may involve improving end-of-pipe treatment in the agricultural, fishery and forestry sectors, which are often the main sources of income. It should not be overlooked that the ROK embarked on technological innovation to foster its traditional environmental industry as early as the 1990s, which was well before the idea of low-carbon green growth was conceptualized.

References

Bank of Korea. 2009. "Study on Manufacturing Industry of Japan and its Competitiveness for Future Policy Implications." Bank of Korea, Seoul.

Bank of Korea. 2013. *Industrial Statistics 2013*. Seoul: Bank of Korea.

Bank of Korea. 2014. "Economic Statistics System 2014." Statistics Database, Bank of Korea, Seoul. Accessed December 12, 2014. https://ecos.bok.or.kr/.

Energy Use Rationalization Act. 2014. Republic of Korea Statutes Act No. 12298.

Enforcement Decree for the Framework Act on Low-Carbon Green Growth. 2010. Republic of Korea Statutes Presidential Decree No. 25456.

Framework Act on Low-Carbon Green Growth. 2010. Republic of Korea Statutes Act No. 11965.

IEA/OECD (International Energy Agency/Organization for Economic Cooperation and Development). 2014. *World Energy Outlook 2014*. Paris: IEA.

Joint Work of Relevant Ministries. 2009. "Measures to Foster Capital Inflow to Promote Green Investment." Joint Work of Relevant Ministries, Seoul, July.

Joint Work of Relevant Ministries. 2012. *The Second Five-Year Plan for Green Growth (2014-2018)*. Accessed April 17, 2015. http://www.greengrowth.go.kr/?page_id=2452.

KCCI (Korea Chamber of Commerce and Industry). 2007. "Study on Sectoral Contribution to National Economy of Korea and Future Implications." KCCI, Seoul, February.

KECO (Korea Environment Corporation). 2014. "Environmental Statistics Database." Statistics Database,

Korea Accreditation Board. 2014. "Database – ISO Certification Information Network." Statistics Database, Korea Accreditation Board, Seoul. Accessed September 28, 2015. http://www.icin.or.kr.

KOSA (Korea Iron and Steel Association). 2015. "Steel Data." Statistics Database, KOSA, Seoul. Accessed September 26, 2015. http://steeldata.kosa.or.kr/.

KOSIS (Korean Statistical Information Service). 2014. "Korean Statistical Information Service." Statistics Database, KOSIS, Seoul. Accessed September 25, 2015. http://kosis.kr/.

KOSTAT (Statistics Korea). 2014. "Korean Statistical Information Service." Statistics Database, KOSTAT, Seoul. Accessed September 25, 2015. http://kostat.go.kr/.

KPIA (Korea Petrochemical Industry Association). 2014. *Korea Petrochemical Statistics 2014. Seoul:* KPIA.

Lee, Yoon-Joon, Jung-Hyup Lee, Ji-Young Seo, and Hye-Young Byun. 2010. "Green Cluster Strategy to Vitalize Regional Economy." Science and Technology Policy Institute (STEPI), Seoul.

New Growth Power Vision and Development Strategy. 2009. *New Growth Power Vision and Development Strategy.* Accessed September 30, 2015. http://www.korea.kr/archive/expDocView.do?docId=10136.

MKE (Ministry of Knowledge Economy). 2008. Green Industrial Development Strategy of Korea.

MoE (Ministry of Environment). 2013. "Report on the Environment Industry Survey 2013." Ministry of Environment and Korea Energy Economics Institute, Seoul.

MoE (Ministry of Environment). 2014. *Yearbook of Environment Statistics* 27. Seoul: Ministry of Environment.

OECD. 2013. "Nanotechnology for Green Innovation", *OECD Science, Technology and Industry Policy Papers*, No. 5, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/5k450q9j8p8q-en.

Park, Jong-Bae, In-Joong Kim, Sang-Jin Han, and Bun-Wook Kim. 2014a. "50 years of Industrial Location, its Achievement and Limitations." *KICOX Report 2014 Summer* 54, Korea Industrial Complex Corporation, Seoul.

Park, Jun-Mo, Hyeong-Woo Kim, and Hung-Suck Park. 2014b. "Assessment of Strategy and Achievements of Eco Industrial Park (EIP) Initiative in Korea." *J. Kor. Soc. Environ. Eng* 36(12): 803~812.

PCGG (Presidential Committee on Green Growth). 2009a. *National Strategy for Green Growth (2009-2050).* Accessed April 17, 2015. http://www.greengrowth.go.kr/?page_id=2450.

PCGG (Presidential Committee on Green Growth). 2009b. *The Five-Year Action Plan for Green Growth (2009-2013).* Accessed April 17, 2015. http://www.greengrowth.go.kr/?page_id=2452.

PCGG (Presidential Committee for Green Growth). 2011. "Performance Evaluation of Green Finance Promotion and Recommendation for Future Improvements." Presidential Committee for Green Growth, Seoul.

Porter, Michael E. 1998. "Clusters are Geographic Concentrations of Interconnected Companies and Institutions in a Particular Field." Clusters and the New Economies of Competition, *Harvard Business Review*, Boston.

Prime Minister's Office, Ministry of Strategy and Finance, Ministry of Education, Science and Technology, Ministry of Foreign Affairs, Ministry of Knowledge Economy, Ministry of Environment, Ministry of Land, Infrastructure, and Transport. 2008. *The First National Energy Basic Plan (2008-2030).* Accessed April 17, 2015. http://energyjustice.kr/zbxe/48310.

UNIDO (United Nations Industrial Development Organization). 2011. "Green Industry: A key pillar of a Green Economy." Policy Brief prepared for the Ministerial Meeting on Energy and Green Industry Vienna, June 21-22.

UNSTATS (United Nations Statistics Division). 2014. "National Accounts Main Aggregates Database." Statistics Database, UNSTATS, New York. Accessed September 28, 2015. https://unstats.un.org/unsd/snaama/dnlList.asp.

Global Green Growth Institute

Korea’s Green Growth Experience: Process, Outcomes and Lessons Learned

Chapter 7: Green Homeland and Transportation

CHAPTER 7

GREEN HOMELAND AND TRANSPORTATION

Summary

Since the 1960s, urbanization has been fueling the ROK's economic growth but at the same time, has contributed significantly to GHG emissions, energy consumption, and other multifaceted challenges. To transform the energy-intensive industrial structure of the cities, the Five-Year Plan for Green Growth has focused on three major entry points: urban planning, buildings, and transportation. In line with the country's low-carbon green growth vision and through the strong political buy-in from the local authorities, the ROK has achieved great strides in pilot testing green model cities along with carrying out proactive urban regeneration activities in various city sprawls. Furthermore, the efficiency of the ROK's public transportation system has improved significantly through the years and now serves as a good benchmark for other countries given its state-of-the-art and innovative transport infrastructure. The building sector also showed progress in terms of curbing emissions by strengthening green-design construction standards and energy efficiency rating certifications based on rigid and transparent procedures. The ROK's experience in the area of green homeland and transportation underscores the importance of addressing complex urban problems – not as stand-alone issues but as a part of the larger integrated system encompassing physical, economic, social, and behavioral factors.

1. Introduction

1.1 Overview

Cities are the epicenter of human activities. In most countries, cities have been the key drivers of national growth, job creation, and innovation. The OECD (2011) reported that just 2% of the OECD regions, the largest OECD urban areas, generate about one-third of all growth in the OECD. Driven by rapid industrialization, however, cities have also been the primary sources of environmental problems and resource-use inefficiencies. The International Energy Agency (2010) noted that cities and urban areas across the globe, where close to 50% of the world population reside, accounted for 67% of the global energy use and 71% of energy-related CO_2 emissions in 2007.

Since the 1960s, cities and urban areas have been fueling the ROK's economic growth. Its rapid pace of urbanization has made urban areas the center for concentrated and intensified business and industrial activities. The OECD (2012) reported that the ROK's real GDP increased sixteen-fold from 1970 to 2009, while its share of urban population, following the UN definition, doubled over the same period from 40.7% to 81.9%. In 2009, seven metropolitan cities[1] along with Gyeonggi Province, comprising only 16% of the nation's territory but 69.2% of the total population, produced 66.3% of the gross regional domestic product (GRDP) (Statistics Korea, 2015).

Aside from the industrial sector, the transport and building sectors have contributed significantly to GHG emissions and energy consumption in the ROK's cities. In 2009, the transport sector consumed 19.7% of energy, of which 80.8% was from road transport; it accounted for 14.8% of total GHG emissions, of which 94.6% was from road transport (KOTI and KEMCO, 2014).

1 |These include Seoul, Busan, Daegu, Incheon, Daejeon, Gwangju, and Ulsan in the order of population size.

On the other hand, the building sector contributed 25.4% of the total energy consumption and emitted 22% of the total national GHG emissions in 2009 (KEMCO, 2014). It should be noted that 40% of national energy use and emissions in 2009 were from the building and transport sectors. Thus, the cities, specifically the buildings and transportation system, are crucial entry points for the ROK to substantially reduce energy consumption and GHG emissions.

Given the continuous focus on economic growth while striving to mitigate GHG emissions in the urban sector, policymakers have proposed measures to pursue green growth in the ROK's cities. In light of this, the Five-Year Plan for Green Growth selected "green homeland and green transport" as one of ten policy directions, along with transforming the energy-intensive industrial structure. The plan focuses on three major areas:

(1) green urban planning;
(2) green buildings; and
(3) green transportation.

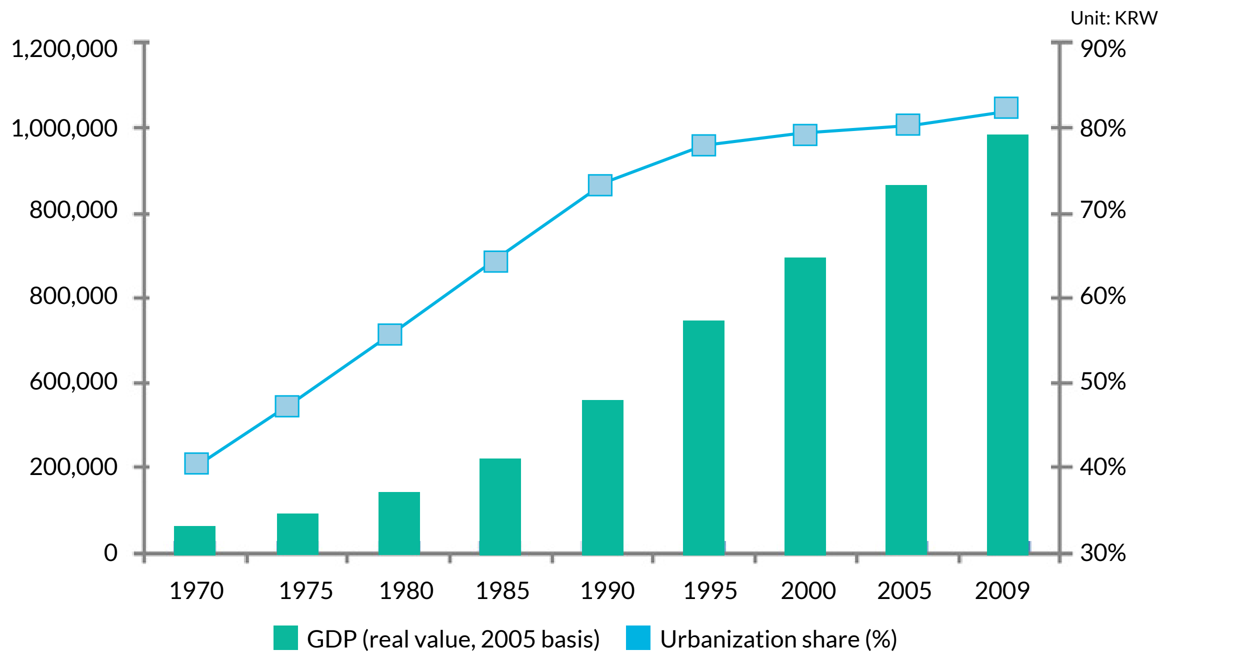
1.2 Baseline Assessment

In furthering economic growth and industrialization, national policies have been anchored in enabling and facilitating business and industrial activities to maximize output. However, this entails huge environmental and social costs, especially in cities and urban areas, where most of the country's activities, industries, and infrastructures are concentrated.

Root Causes of Challenges

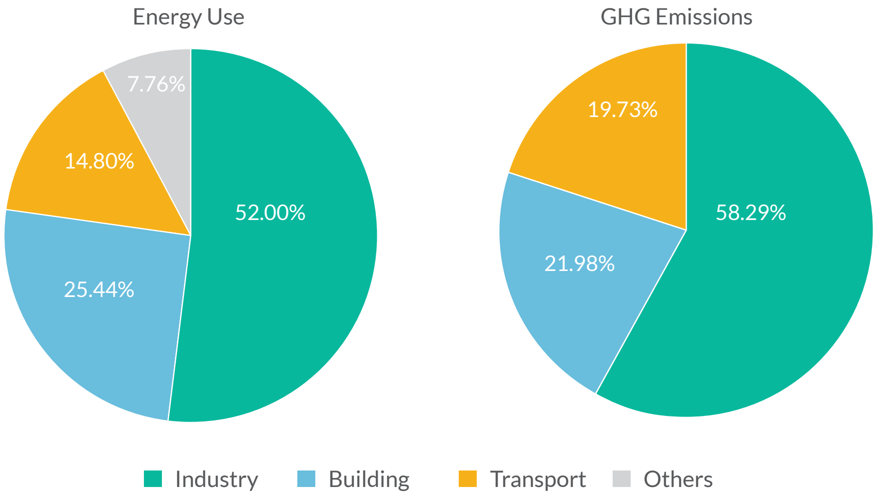
Since the early 1990s, sustainability and climate change issues have been the subject of serious discussions in Korean cities due to the worsening air pollution, rising temperatures, increasing precipitation, and frequent heatwaves. In pursuing low-carbon green growth, the urban challenges that policymakers should resolve are therefore multi-faceted – covering environmental, demographic, socioeconomic, as well as climate change and sustainability issues.

Figure 1: GDP and the urbanization process in the ROK (1970-2009)



Source: OECD, 2011

Figure 2: Percentage of national energy use and GHG emissions by sector in 2009



Consistent with other developed countries, the ROK's economic growth and urbanization moved in tandem. The share of urban population increased substantially, as did the Korean economy, reaching a share of over 90% of the national population in 2009. Virtually all urbanization activities took place between 1970 and 1990 but the trend has gradually declined since then. In particular, Seoul, covering only 0.2% of the nation's entire area, was home to 21.1% of the national population and contributed 23.7% to the total GDP in 2009. Also in the same year, the Seoul Metropolitan Area (SMA), including Incheon and Gyeonggi Province, accounted for 49.3% of population and 52.2% of total GDP (KOSTAT, 2015).

The UN estimated that close to 50% of the world population resides in urban areas in 2010. In the case of the ROK, it is one of the most urbanized countries, where nine of its metropolitan areas belong to the top 50 cities (among 268 urban areas in OECD) with the highest population density. The Seoul metropolitan area, including Incheon, ranked eighth with more than 15,000 persons/km^2 and Pohang ranked 51st with over 5,000 persons/km^2.

The ROK's rapid economic growth has resulted in increased disposable income and affordability of urban amenities, leading to a consumption-oriented lifestyle that entails greater utilization of resources and higher GHG emissions. The use of electric

Figure 3: Trends in temperature and precipitation on the Korean Peninsula (1912-2005)

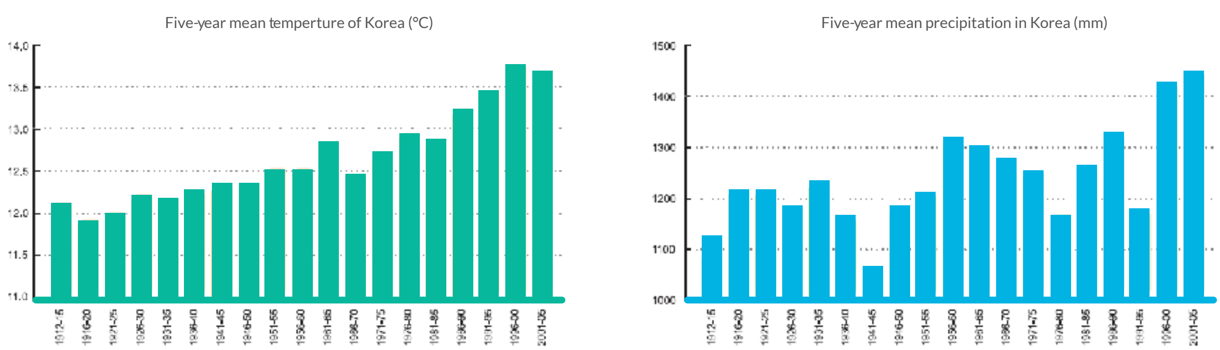


Table 1: ROK's urbanization rate and GDP growth (1970-2009)

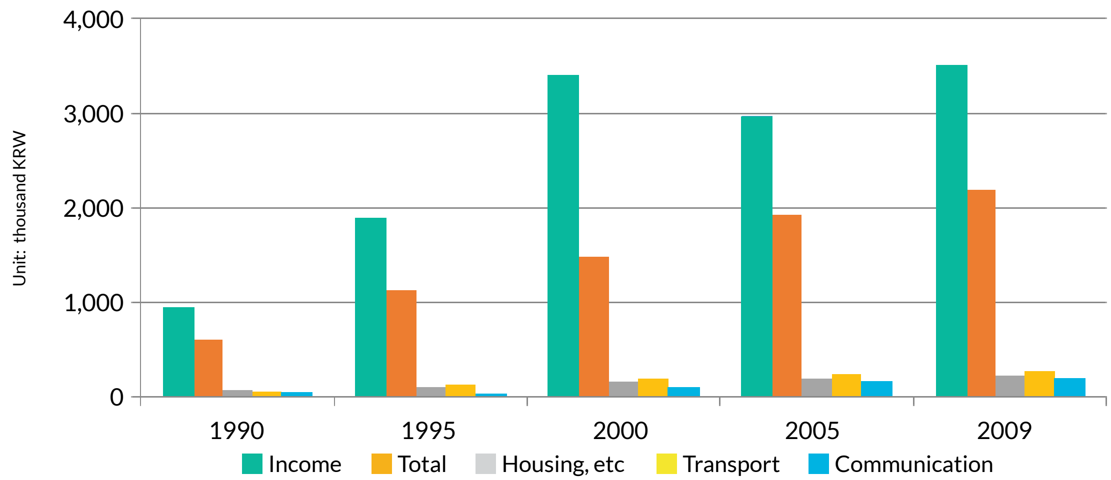
Index	1970	1980	1990	2000	2009	Annual Average Growth (%)			
						70-80	80-90	90-00	00-09
Population ('000)	32,241	38,123	42,869	47,008	48,182	1.69	1.18	0.93	0.41
Urbanization (%)	50.1	68.7	81.9	87.7	90.8	3.21	1.77	0.69	0.36

Source: Korean Statistical Information Service

devices for household activities has increased significantly, along with better quality of housing and transportation. Between 1990 and 2009, the average urban household income and expenditure per month increased by 391.2% (from 938,000 KRW to 3,670,000 KRW) and 276.6% (from 603,000 KRW to 2,180,000 KRW), respectively. On the other hand, the corresponding average household expenditures for transport and housing, including water, electricity, gas, communication and other fuel, increased by 586.8%, from 121,000 KRW to 710,000 KRW over the same period as seen in Figure 4.

The worsening traffic caused by the rapid pace of motorization remains a daunting challenge for urban policymakers. Due to the continuous rise in income and living standards, nationwide vehicle ownership soared more than 136-fold from 126,000 in 1970 to 17.3 million in 2009 (KOSTAT, 2014). The mainstream Korean transport policy until the 2000s was anchored in building and expanding infrastructure to facilitate the development of transport networks and at the same time, accommodate the increasing travel demand through capacity expansion. Despite the substantial investments to ease bottlenecks in the transport

Figure 4: Average monthly income and expenditure of urban households (1990-2009)



Source: Korean Statistical Information Service

Table 2: The pace of motorization and urban railway expansion in the ROK (1970 - 2009)

Index	1970	1980	1990	2000	2009	Annual Average Growth (%)			
						70-80	80-90	90-00	00-09
Vehicles registered ('000)	126	527	3,394	12,509	17,325	15.38	20.47	13.52	3.85
Intercity railway lengths (km)	3,193.2	3,134.6	3,091.3	3,123	3,373				

Source: National Transport Statistics of Korea, Korea Transport Database Center, 2013

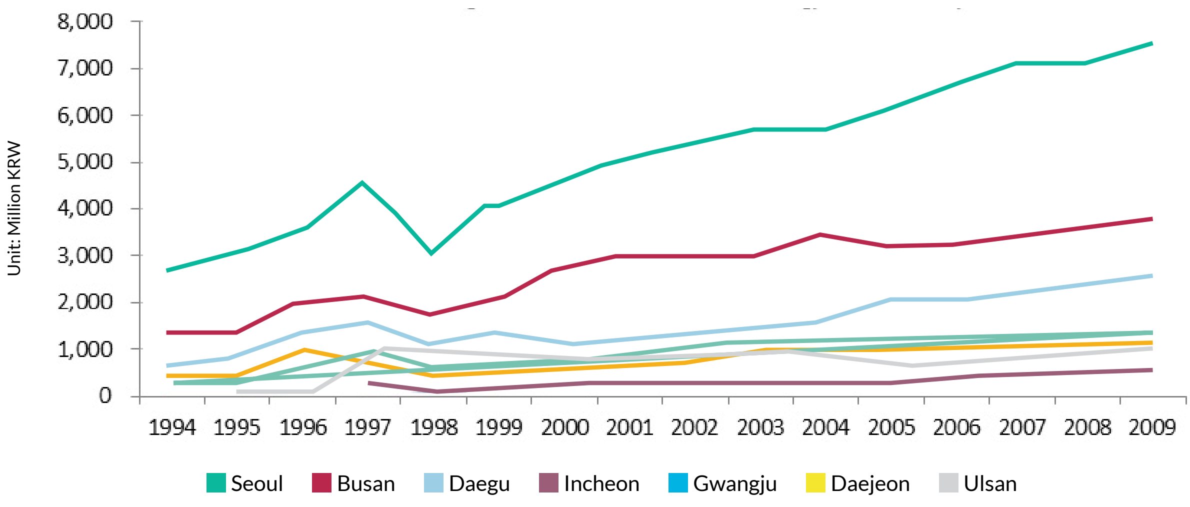
systems such as roads, railways, ports, aviation and metro, most resources were invested in road transport facilities while overlooking public transit systems and other modes. Yet vehicular demand continued to grow, outstripping the enhanced capacity of the road transport system, thereby promoting dependency on automobiles.

Expanding road capacity remains a great challenge especially in urban areas considering the chronic congestion on urban roads every day, causing poor transit service and negative environmental externalities. Since the 2000s, transport policy has started to focus on service improvements rather than expansion to respond to the public expectation of improving service quality. However, the problem of congestion still worsened, inflicting higher costs as shown in Figure 5. Although the trend has slowed down since 2000s, the number of registered vehicles still increased by an annual average of 3.86% between 2000 and 2009, and this trend continues.

Relevant Problems

From the 1960s until the 1980s, the Korean urban policy focused on developing large cities that would

Figure 5: Congestion costs in seven metropolitan cities (1994-2009)



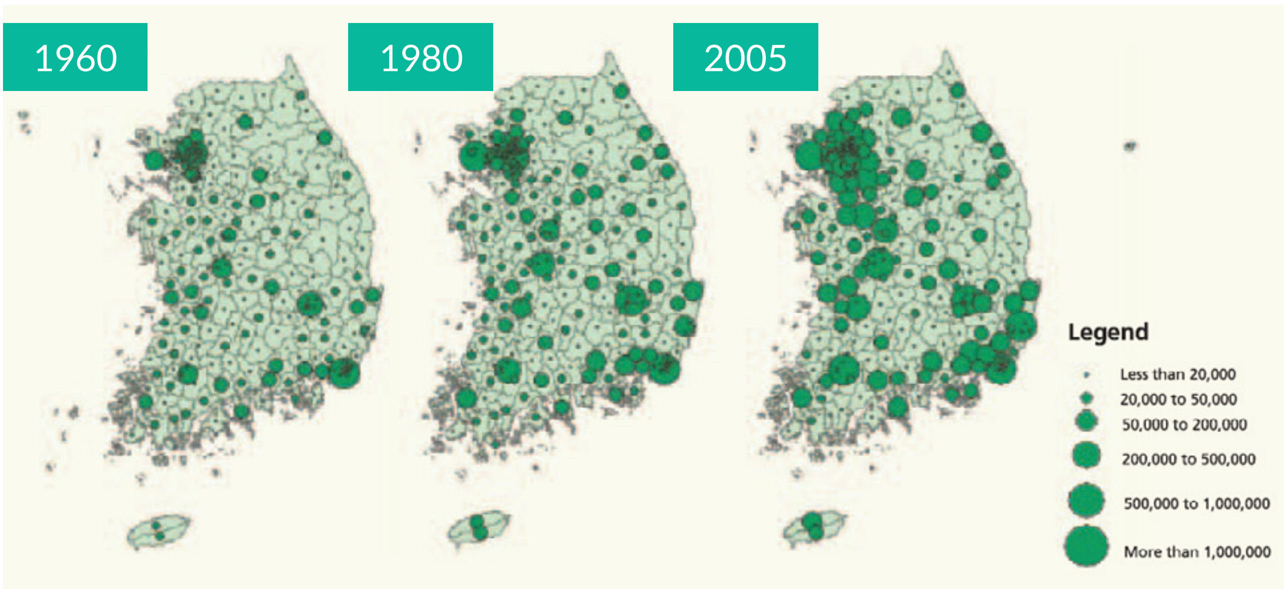
Source: National Transport Statistics of Korea, 2013; Korea Transport Database Center, 2013 accommodate rapid economic growth. Over this period, metropolitan cities (e.g., Seoul and Busan) and heavily industrialized cities (e.g., Ulsan, Gumi, Pohang, and Changwon) were developed as major economic and industrial centers, and designated respectively as a "National Industrial Complex." Numerous new town development projects involving large-scale commercial and housing plans were initiated in and around the large cities. Along with the speedy and massive scale of urbanization, cities rapidly evolved as modern hubs and covered more spaces for new developments, even gradually occupying more lands that are once designated as protected inner areas while sprawling to surrounding outer areas at the same time. Meanwhile, a number of new cities in the outer areas have emerged, with increasing concentration of activities and industries. Small-sized cities became large or medium-sized cities, forming metropolises with adjacent cities and urban areas (See Figure 6).

Despite the decentralization policy initiated in the 1980s that promoted balanced territorial development by restraining the concentration of population and industry in the Seoul metropolitan region, the problem still persists. Existing urban areas expanded constantly, adding more environmental and ecological burdens on urban residents, while old towns further deteriorated.

The number of high-rise buildings has steadily increased, particularly due to the government's strong support for housing and new town projects. From 1984 to 2009, the total number of buildings in the ROK increased from 5.88 to 6.62 million, yet residential buildings decreased from 4.96 to 4.50 million. In the same period, 10-story (and above) buildings substantially increased from 1,739 to 78,874; this means that most newly constructed residential buildings are high-rise structures. It should be noted that between 1990 and 2010, 58.43% of the total new houses were high-rise apartments. In 2005, the share of high-rise apartments in Seoul was 54.3%, which is higher than in Sydney (20%) and Toronto (40%). Between 1975 and 2005, each housing unit became bigger and the space occupied by a person increased from 8.2 m^2 to 22.8 m^2.

The widespread ownership of private cars created greater decision-making opportunities for people regarding housing, work, business, recreation, and

Figure 6: Growth of cities in the ROK by population size



Source: KRISH Gazette, 2011

Table 3: Housing conditions in the urban areas (1980-2005)

	1975	1980	1985	1990	1995	2000	2005	% Change (1975-2005)
Space per housing (m^2)	68.1	68.4	72.6	80.8	80.7	81.7	83.7	122.9
Space per person (m^2)	8.2	10.1	11.3	13.8	17.2	20.2	22.8	278.0
Persons per room	2.3	2.1	1.9	1.5	1.1	0.9	1.3	56.5

Source: Korea Statistics Office

other activities. However, excessive automobile dependency has exhausted the transport carrying capacity of cities and urban areas. Until today, road transport remains dominant while the share of railway and other transit modes declined for both passengers and freight (Figure 7). Road transport accounts for 94.9% of the total carbon emissions, of which private vehicles accounted for 60.6% of CO_2 emissions, followed by freight trucks at 24.4% in 2009. These patterns are consistent with most developed countries (IEA, 2008) and reflect the trend of increasing dependence on private vehicle use (KEEI, 2007). Furthermore, as congestion increased, nationwide average travel time for commuters increased from 29 minutes in 1995 to 32.9 minutes in 2010, while that of Seoul alone increased from 35.9 minutes to 41.2 minutes in the same period.

Policy Options

To cope with the multi-faceted urban challenges, urban policy should reduce externalities and resource use as well as minimize negative impacts on the environment and urban residents. Against this backdrop, green cities have emerged as a policy option. The concept of the green city has evolved from various related models such as sustainable city, eco-city, and low-carbon city and it encompasses all the components of such models.[2]

Since the concept includes all components of the urban sector, a green city strives to create clean and efficient energy, transportation, and building infrastructure. In doing so, some of the measures include linking city, countryside, and forest resources while implementing regional resource-recycling schemes; improving institutional measures on low-carbon urban planning; promoting low-carbon urban regeneration projects; and developing, designating, and supporting new cities for testing low-carbon energy-saving measures.

The concept also encompasses fostering green buildings by applying a variety of regulatory and incentive measures that can alter energy demand and improve energy efficiency. Since buildings account for nearly one-third of all global GHG emissions, simple efficiency and design improvements can make a drastic difference in emissions reductions. Stringent design standard, certification, and rating systems are possible regulatory options while financial support, tax cuts, and credits for landlord or tenants are possible incentives. Furthermore, the dissemination of green building construction techniques with strengthened

2 | A green city is defined as a unit of space that reduces energy consumption and emissions by expanding the green area with land use reformation; including preservation of the natural ecology, improvement of transport systems, adaption of green IT technology, new and renewable energy sources and through expansion of the bio-ecological area. It means a new way of enhancing the sustainability of urbanized areas with ecosystem services at the core of the concept. (New Growth Engine, 2015)

guidelines for design, construction, and maintenance, and the use of renewable energy are also good instruments.

To reduce emissions in the transportation sector, being one of the fastest growing sources of GHG in the ROK, the fundamental approach should be a package of push and pull policies to drive significant modal shift to a green transport system.
The "push" policies include financial instruments such as congestion pricing, toll, parking charge as well as technical and regulatory instruments such as auto restricted zone (ARZ) and parking removal. Such approach focuses on influencing the individual's travel decisions by bearing its real costs. The "pull" policies, on the other hand, intend to discourage the use of inefficient modes - autos and trucks - by making alternative modes more attractive such as public transport and improving the walkability and ease of biking in and around the city. Greening the transportation also implies encouraging the public to use low-carbon green transport such as bus and rail by providing and supplying more integrated transit links and promoting public transportation, integrated transit center, and bus rapid transit (BRT). It also entails developing and commercializing green transport technologies such as hybrid or electric vehicles, Intelligent Transport System (ITS), and developing and applying eco-friendly logistics facilities and equipment.

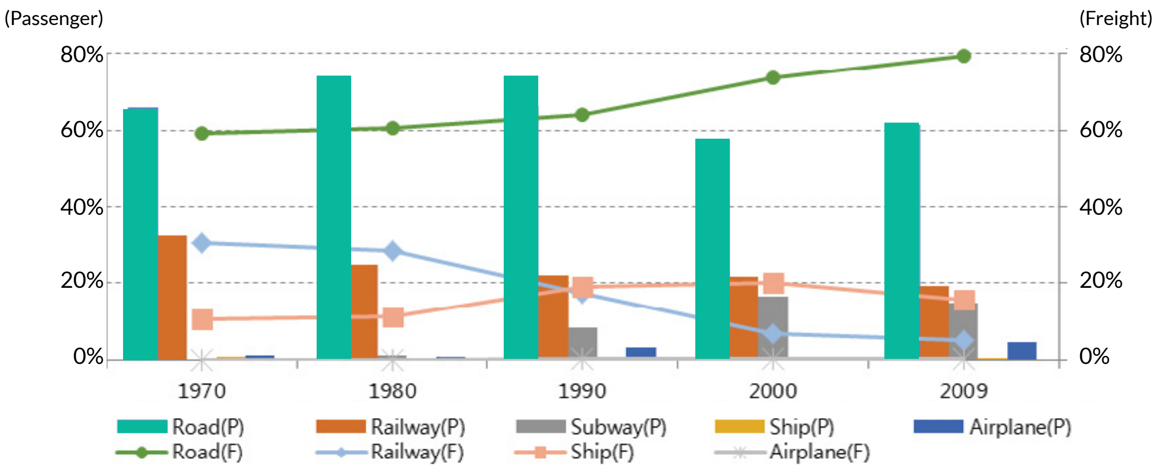
The efforts concerning the greening of city, buildings, and transportation are interrelated. Integrated planning between land use and transportation is thus critical for the ROK to pursue green growth. Since most of the nations' green efforts must be implemented at the local level, the central government should design a set of policies coherent with the local level to effectively facilitate and support the greening efforts on both national and subnational levels.

1.3 Challenges and Opportunities for Green Homeland and Green Transport

Having eco-friendly cities with green transportation requires political commitment and government actions involving various ministries and governing entities. It also necessitates serious involvement from related industries and technologies. The Five-Year Plan carved out the creation of green homeland and green transport as one of ten policy agendas, under the national strategy of "Improving the Quality of Life and National Prestige."

The strategic directions for achieving the green homeland and green transport agenda were then analyzed through SWOT analysis. The results of the SWOT analysis clearly indicate that there was great room for improvement in this respect despite the anticipated difficulties. The plan also prioritized

Figure 7: Share of different transport systems in passenger and freight (1970-2009)



Source: KRISH Gazette, 2011

five strategic directions under this agenda as well as specified the policy actions to be taken:

(1) greening the homeland and cities;

(2) expanding ecological space;

(3) promoting construction of green buildings;

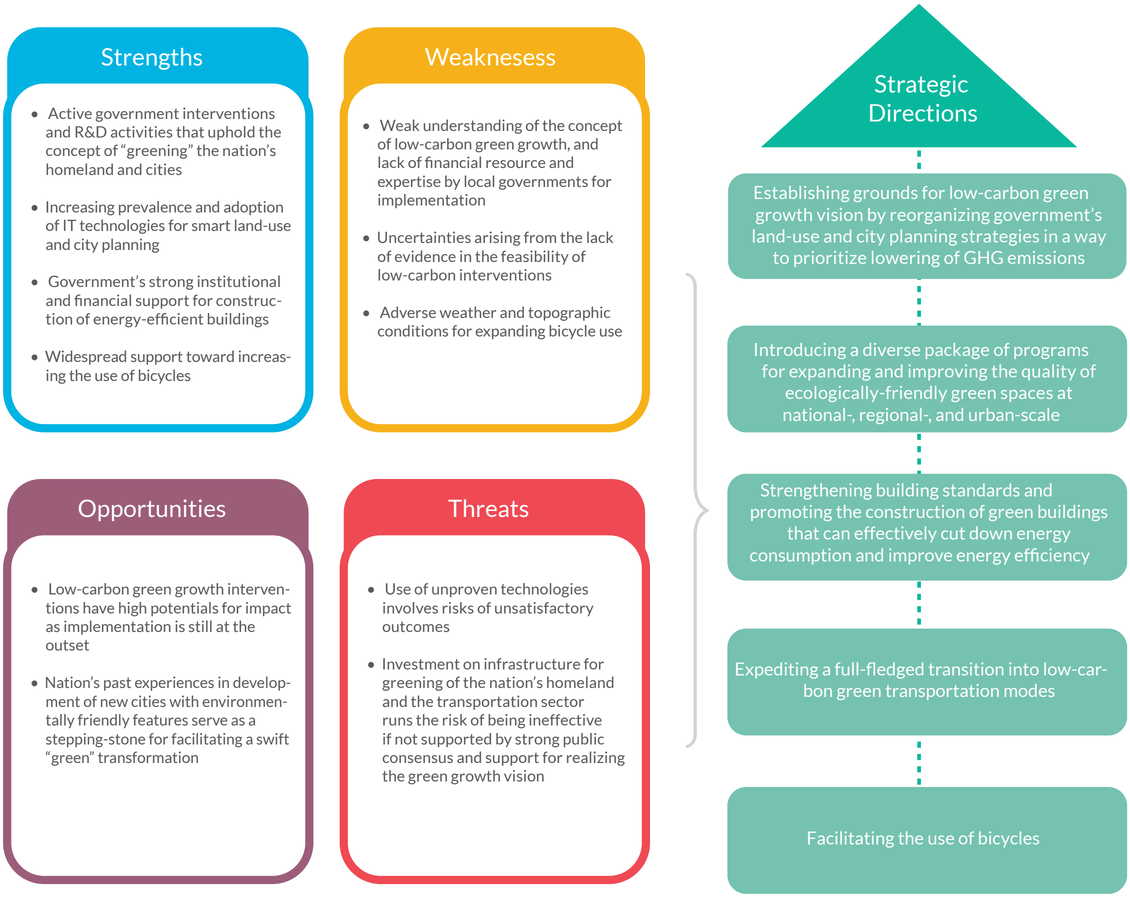
(4) establishing a green transport system; and

(5) facilitating bicycle use.

Figure 8: Conceptual development of green city

Source: GGGI, 2011

Figure 9: SWOT analysis and directions for the green homeland and transport agenda



Source: PCGG, 2009

Table 4: Specific tasks and actions under the green homeland and green transport agenda

Tasks	Actions
1. Greening of homeland and cities	a. Establish a green homeland that champions low-carbon green growth b. Transform the city and region into LCGG-oriented structure c. Strengthen green homeland by securing safety and carbon sink as well as providing baseline database
2. Expansion of ecological space	a. Foster image of green Korea via systematic management of nature reserves b. Enhance the quality and efficiency of eco-space c. Expand symbiotic eco-space and strengthen their connections d. Provide institutional framework for expansion of eco-space
3. Expansion of green buildings	a. Amend institutional infrastructure and framework to establish the groundwork for green buildings b. Obtain social consensus and conditions for expanding green buildings c. Devise action plans for expanding green building by types of buildings
4. Establishment of green transport system	a. Expand green transport network b. Shift to green logistics c. Amplify the growth potential of green transport and logistics
4. Promotion of bicycle usage	a. Enhance the role of the bicycle as a means of green transport and regional development b. Create a bike-friendly environment c. Promote a bicycle culture

Source: PCGG, 2009

2. National Strategies and Target Setting

2.1 GHG Reduction Targets under the Green Homeland and Green Transport Agenda

As promised at the G7 summit in 2008, the ROK officially finalized the mid-term national GHG reduction target at 30% lower than 2020 BAU level in 2009 based on rigorous scientific assessment. Note that this goal is the highest reduction rate recommended by the IPCC (MoE, 2014). The setting of the national GHG reduction target was followed by the preparation of sectoral mid-term reduction targets by 2020, which was announced in 2011. As touched upon extensively in Chapter 2 of this report, the process of setting the national and sectoral reduction targets involved numerous quantitative analysis and discussions with relevant ministries and experts, along with public consultations as a means to build a strong social consensus and support.

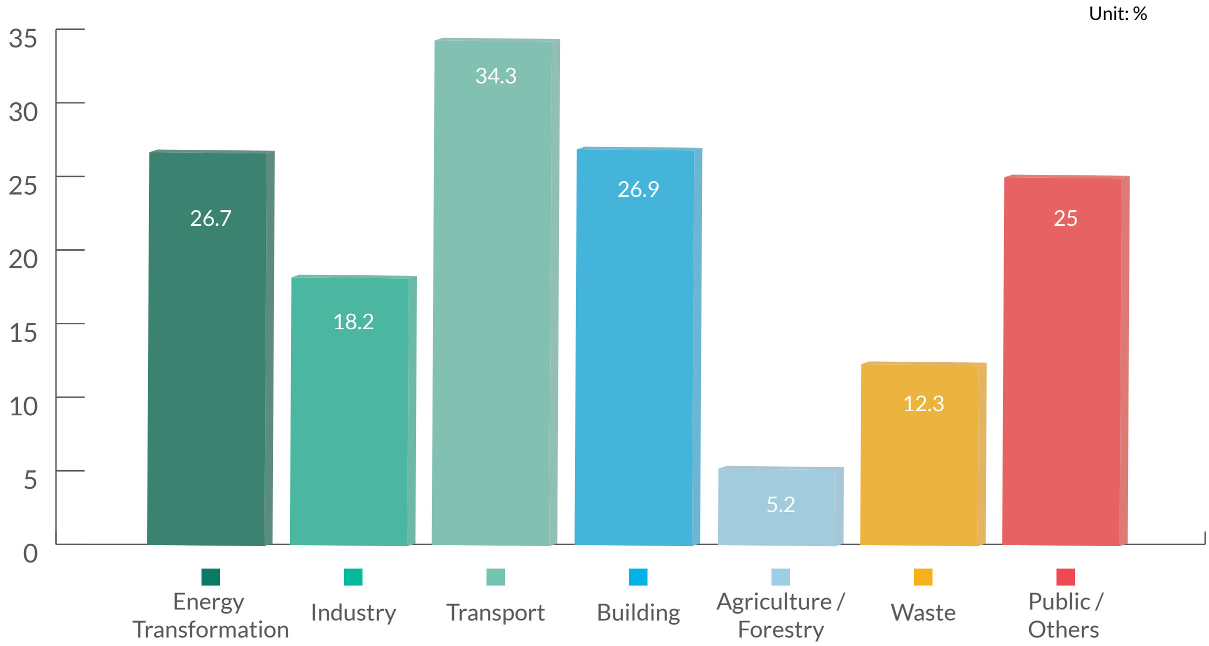
As shown in Figure 10, the sectors with the highest reduction target was transportation (34.3%) and building (26.9%), thus demonstrating how these sectors were identified as key areas to achieving the nation's GHG reduction target. As of 2008, the combined GHG emissions from these two sectors account for over 40% of the total national emissions.

2.2 Strategies: Green Cities and Green Buildings

Green City

The Five-Year Plan aimed to transform the ROK' major cities to uphold its vision of low-carbon green growth. In the process of strategy formulation, benchmarking studies were conducted to understand the wide range of relevant concepts made available and implemented by the developed countries, such as "compact cities," "new urbanism," and "urban villages." The Ministry of Land, Transportation and Maritime Affairs (MLTM) played a key role in developing the green city strategies with coordinated efforts of other relevant ministries

Figure 10: Percentage of GHG reduction by sector in 2020 BAU level



Source: MoE, 2014l

and public agencies; they worked together to ensure that the Five-Year Plan provides clear directions supported by a list of exemplary project-level interventions – such as rehabilitation of dilapidated urban areas, construction of energy-independent homes – to be carried out by ministries and local government authorities.

To help guide the implementation of the Five-Year Plan's green city agenda at the subnational level, the MLTM developed the Guidelines for Low-Carbon Green City Planning in July 2009. This document aimed to demonstrate how to systematically incorporate climate change issues in urban planning, through the elaboration of standards, predictions, evaluation, and countermeasures. For example, local government's city planners were to analyze the sources of urban GHG emissions, make future emissions projections, propose spatial plans that help minimize energy consumption, and recognize the role of urban greenery on carbon balance.

In November 2009, the MLTM, along with four other ministries and the Forest Service Agency, proposed an action plan called "Strategies for Green City and Green Building Initiatives," which served as the blueprint for the project-level interventions on green cities. Elaborating the directions set forward in the Five-Year Plan, the document prioritized the following actions:

- **Energy-Saving Urban Planning:** The urban consumption of energy was to be minimized through the promotion of spatial plans for compact cities, realizing intermodalism (i.e., provision of connections between different transportation modes through construction of transfer centers), proactive application of information technology to improve material productivity and resource management, introduction of low-carbon transportation infrastructure (i.e., bus rapid transit and exclusive bus lanes), and construction of green homes (i.e., energy-independent homes).

- **Strengthening Foundations for Resource-Circulating Cities:** As a means of enhancing the resource productivity of urban activities, local governments were to expand waste recycling practices by introducing automated waste collection centers, energy management systems, and rainwater harvest facilities.

- **Creation of Urban Ecological Spaces:** Areas surrounding reservoirs and waterways of cities were to be developed into ecological spaces offering opportunities for recreation, and the city's high-density areas were to accommodate green spaces (e.g., parks, carbon grove) which help mitigate urban heat island effects.

In order to localize these national-level action plans, pilot projects to promote green cities were to be undertaken by local governments in partnership with the responsible ministries. Pilot projects were either "green the new city plans" or "green existing cities," incorporating several district features of green cities – such as adoption of energy saving building codes (green homes), establishment of new and renewable energy systems (zero energy towns), and improvement of urban parks and greenery (low-carbon cities) – that best meet the local circumstances. In other words, a range of different pilot city proposals was suggested by the Strategies for Green City and Green Building Initiative, stimulating local governments to develop their own green city concepts that embrace the existing local development agenda. The central government provided strong signals on the need for relevant ministries to be strongly involved in the local initiatives, especially in terms of ensuring that the necessary budgetary and financial resources are made available.

Green Buildings

Recognized as one of the most energy-intensive sectors of the nation, the government pledged to take nationwide measures in transforming the building stock. Unlike the locally-centered initiatives under the green city agenda, interventions for greening of buildings were to bring about nationwide transformations on how buildings are designed, constructed, and utilized. Under an ambitious target of achieving a 31% reduction in GHG emissions from the building sector by 2020 (against the emission levels of 2005), the Strategies for Green City and Green Building Initiatives emphasized that relevant actions must evolve around:

(1) strengthening of energy standards for new buildings;

(2) energy efficiency improvements for existing buildings;

(3) inducing voluntary energy-reduction efforts from building residents; and

(4) supporting development of innovative technologies and establishment of infrastructure.

In order to provide a legislative basis for the government's efforts toward green buildings, the Act on the Creation and Support of Green Buildings prepared by MLTM came into force in 2010. In addition to providing the guiding principles on green buildings, the Act prescribes incentive measures to support green building investments.

Of the nation's many major cities that actively promoted the government's concept of green buildings, Seoul played a leading role. The city had adopted the Seoul Initiative on Green Growth in 2005, which led to a comprehensive plan that sought to reduce urban energy use in two phases; the first phase targeted public building retrofits and the second phase aimed for the expansion to the private sector. In 2007, the city created the Green Architecture Standards – which is similar to the Leadership in Energy and Environmental Design (LEED) scheme developed by the U.S. Green Building Council – specifically to be applied for buildings in Seoul. The newly constructed public buildings in Seoul are mandated to meet this requirement, while incentives are made available to private sector partners in the form of tax cuts on building acquisition and registration.

2.3 Strategies: Green Transport

To efficiently implement green growth strategies in the transport sector, the MLTM quickly devised a legal framework by enacting the Sustainable Transportation Logistics Development Act in June 2009, which came into force in December 2009. The Act aims to present rudimentary policy directions for the transport sector to promote the development of a sustainable transport logistics system based on the six basic principles:

Table 5: Action plan for green buildings

Plans	Project-level interventions
1. Strengthening of energy standards for new buildings	a. Strengthen the building design codes b. Introduce standards that regulate a building's total annual energy consumption c. Subsidize the construction of "one million green homes" (energy independent homes) by 2018 d. Mandate the application of environmentally friendly and renewable energy technologies in public buildings
2. Energy efficiency improvements for existing buildings	a. Expand voluntary participation in building certification schemes b. Provide subsidies and non-monetized benefits for energy efficiency investments c. Carry out government-led programs for energy efficiency improvements in public office and school buildings
3. Promotion of voluntary energy-reduction efforts from building residents	a. Expand the carbon-points system (refer to Chapter 5) b. Mandate the assignment of energy management expert in buildings with annual energy consumption greater than 2,000 TOE c. Expand the green start campaign (refer to Chapter 5)
4. Support for development of innovative technologies and establishment of infrastructure	a. Provide public grants for R&D projects on green building technologies b. Offer specialized training for green building experts c. Establish a nationwide building energy consumption database

Source: Strategies for Green City and Green Building Initiatives, 2009

(1) promoting a low-carbon transportation logistics system by reducing emissions;

(2) advancing environmentally friendly transportation systems;

(3) promoting a transportation system that saves energy and resources;

(4) improving the mobility, accessibility, and safety in transportation;

(5) promoting a balance among different modes of transportation; and

(6) effectively integrating urban land use and transportation planning.

In line with this Act, local governments were mandated to formulate the Master Plan for Sustainable Transport and Logistics Development with a planning horizon of 10 years, which should devise specific policies and measures along with their required financial needs. The Sustainable Transportation Logistics Development Act was indeed innovative in the sense that it suggested a wide variety of comprehensive and integrated measures to promote green transportation across different modes of transport.

The government's Green Transportation Strategy prepared in November 2009 by the MLTM and MKE served as the blueprint to realizing the essential provisions of the Act. The document declared making an ambitious paradigm shift in transport policies: from energy-consuming and automobile-oriented

Table 6: Summary of project-level interventions proposed by the Green Transportation Strategy

Plans	Project-level interventions
1. Strengthening of the Travel Demand Management (TDM)	**Strengthen the TDM:** congestion pricing scheme, car-sharing programs, eco-driving habit, telecommuting, etc.
	Build low-carbon Smart Transport System for best utilization of existing facilities: Intelligent Transport System (ITS), Smart Highway Project, Electronic Toll Collection System (ETCS) on freeways (high-pass system), and multi-modal integrated travel information center
	Introduce Green Transport Zone (GTZ): green traffic priority zone, vehicle volume restriction by district, Transit-Oriented Development (TOD)
2. Promotion of bike use and pedestrian	**Integrate public transit and bike:** bicycle racks on buses and rail vehicles and at rail stations and bus stops, improved amenities in large buildings and facilities for bike users
	Build safety-enhanced bicycle infrastructure: lifestyle adapted network (transit station connection, rapid bikeway, stricter legal standards on the sidewalks for combined use for bike and pedestrian)
	Improve human-oriented pedestrian environment: pilot pedestrian mall and transit mall projects, and pedestrian day (Nov. 11)
3. Use of convenient and faster public transit systems than private automobiles	**Enhance competitiveness of bus services:** new regional services, transfer center at freeway rest stations, bus rapid transit (BRT), elimination of blind transit service catchment areas
	Expand urban and regional rail services: new rail systems in metropolitan area, initiation of express services
	Expand national high-speed rail network: early completion of the Phase 2 Korea Train eXpress (KTX) project, "Design Standards for Accelerated Railway Service" to reduce costs
4. Establishment of rail and coastal water-based green transport systems	**Implement two-layer loading DST operation:** new connection between Busan port and Gwangyang port
	Expand rail-based intermodal transport system: enhance rail infrastructure to enhance rail model share
	Expedite modal shift to green transport modes: subsidy for trucking industry
	Promote coastal water transport system: port charge reduction and tax exemption
	Build the Geyoungin Aragil inland waterway: opening of China route, financial support ship design and building
	Establish carbon reduction logistics: national network of logistics complex, reduced dead-head travel distances, certification of green logistics, green port development, create short-distance air routes

Source: MLTM and MKE, 2009

system toward a human-oriented green transport system, and from supply-oriented to demand-oriented approach through the establishment of coordinated and strengthened networks among different modes of transport with strong emphasis on operationally efficient intermodalism. Ultimately, the strategy was to help ensure a 33%-37% reduction in GHG emissions from the transportation sector against BAU levels by 2020, equivalent to 20%-24% reduction in annual emissions as compared to the level recorded for 2005.

Through a combination of "push" and "pull" measures,[3] the Green Transportation Strategy focused primarily on inducing modal shift from road transport to more energy-efficient and environmentally friendly modes, such as railway, walking, and bicycles. The push measures included strategies such as congestion charges and Green Transport Zone (GTZ) in large cities to control the heavy demand for private cars. On the other hand, the promotion of public transit, rail and water, and non-motorized modes with expanded networks and enhanced services were suggested as pull measures, along with the urban densification policies, such as Compact City and Transit-Oriented Development. In order to minimize the construction of road infrastructure, improved efficiency in the use of existing road facilities through the adoption of Intelligent Transport Systems was also proposed.

In July 2008, the Ministry of Public Administration and Security announced the promotion of bicycle as one of its long-term national strategic agenda backed up by an implementation plan (Comprehensive Plan on Bicycle Promotion; MOPAS, 2008). Consultation meetings with all relevant ministerial and local government agencies were held to support the implementation of the plan, which specifically targeted the construction of 3,114 km of additional bicycle lanes nationwide between 2009 and 2018, and 1,700 km of bicycle lanes along the waterfront pavements in four major rivers. Such investments were expected to boost the nation's share of bicycles use in transport (i.e., modal split) from 1.5% in 2009 to 5% in 2013. In June 2010, the Comprehensive Plan on Bicycle Promotion was updated into the Master Plan for National Bicycle Road, which is essentially a 10-year construction plan for the nationwide network of bicycle roads.

Table 7: MLTM's targets for the green transport agenda (2009-2013)

Actions	Targets				
	2009	2010	2011	2012	2013
Urban rail modal share (%)	19	20	21	22	23
KTX network length (km)	240.4	240.4	364.6	364.6	364.6
Openings of light rail transit line	-	1	2	-	1
Bus Rapid Transit (BRT) routes	-	2	2	2	2
% of High-Pass usage	40	50	60	65	70
Multi-modal transfer centers	-	4	4	4	3
Subsidy for green logistics (million KRW)	-	1,500	5,000	5,000	65,000
Newly designated logistics complexes	2	8	10	5	-
Expansion of radio frequency identification (RFID) system and infrastructure	13	20	51	68	-
Shift to liquefied natural gas (LNG) trucks	45	50	1,500	1,750	2,000
Attendees for Eco-Drive training program	-	1,280	1,280	1,280	1,280
Pedestrian Malls	-	5	5	5	5
Intelligent Transport Systems (ITS) infrastructure on national highway network (%)	17.5	18.0	20.8	23.6	26.3

Source: MLTM, 2010

3 | Push measures are those imposed on individual travelers' behavior and decision, while pull measures are designed to encourage less use of road transport modes, typically privately owned cars and trucks (Vuchic, 2005).

Apart from those introduced above, the MLTM ensured that the strategies and plans already existing under the nation's transportation framework were refined to fully uphold the concept of low-carbon green growth. The representative examples include the Second National Railway Master Plan (2011-2020) and the Second Public Transportation Master Plan (2012-2016). Table 7 summarizes the targets set forth by all national-level transportation plans and strategies for the period subject to the Five-Year Plan for Green Growth (2009-2013).

2.4 Target Setting

The creation of green homeland and transport is one of the ten policy directions under the Five-Year Plan for Green Growth. Placed under the objective of "improving the lives of people and enhancing the national prestige," the agenda item placed forward a total of five key programs:

(1) construction of carbon-neutral new green cities and rehabilitation of the dilapidated areas of existing cities;

(2) expansion of nature reserves (ecological space) through the restoration of city streams and forestation within the city areas;

(3) expansion of green buildings through the introduction of energy efficiency ratings and incentives;

(4) expansion of green transportation and public transit system; and

(5) promotion of using bicycles (PCGG, 2009).

Table 8: Quantitative targets in the Five-Year Plan for Green Growth (2009-2013)

Programs	Target Indicators	2009	2010	2011	2012	2013
1. Green Homeland and City	Build carbon-neutral cities	0	1	3	5	8
	Low-carbon green regeneration of cities (%)	5	10	20	30	40
2. Nature Reserves	Eco rivers and streams (%)	60	61	62	65	70
	Nature reserves (ha)	1,800	1,900	2,000	2,300	2,500
	Multi-purpose street (%)	5	10	18	25	30
3. Green Buildings	Green homes ('000)	55	70	95	105	675
	Energy rating and green certification (%)	40	50	60	90	100
	Green design standard and criteria (%)	20	40	60	80	70
	Green homes (%)	10	30	40	50	60
	Reform of existing buildings (%)	10	30	40	50	60
4. Green Transport	Public transit share (%)	50	51	52	53	55
	Rail mode share (%)	19	21	23	25	30
	Auto share for short-distance trip (%)	43	40	37	34	30
5. Bicycle Usage	Modal share	1.5	3	4	5	5
	Bike city	1	3	5	10	20
	National cycling lane (km)	100	300	500	1,000	1,400
	City bikeway (km)	50	100	300	600	1,000
	Use rate (%)	10	15	20	25	30
Fiscal expenditures (trillion KRW)		4.7	9.5		11.0	

Source: PCGG, 2009

3. Policy Actions and Programs

3.1 Green Transportation

Exhaust gases from automobiles account for more than 60% of air pollution, underscoring the need for stringent environmental policies to be reconciled and pursued in the transportation sector. As part of the Five-Year Plan, the government devised various action plans for promoting green transportation. Some of its low-carbon policies that have shown progress include the formulation of a comprehensive transportation demand management plan; distribution of green cars; provision of incentives to stimulate a modal shift to public transportation; improvement in fuel efficiency standards; and imposition of regulations on CO_2 emissions. In the ROK, the green transportation trend began to emerge largely from the cities that possess strong basic infrastructure. Accordingly, this section introduces the main policies and actions of the transportation sector in the ROK, focusing on the nation's capital, Seoul, where the greening of transportation services is best carried out.

3.1.1 Transportation Reform in Seoul and the Metropolitan Area

An enabling legal and institutional environment is critical to the establishment of green transportation systems, in addition to the infrastructural measures that bring about physical changes. On this note, the Seoul Metropolitan Government (SMG) pushed for an extensive reform of the public transportation system in 2004, and after the introduction of the Five-Year Plan, it introduced electric vehicles and compressed natural gas (CNG) buses to lessen the carbon footprint of the transportation sector. The SMG's public transformation reform in 2004 especially focused on transforming public bus travels, specifically through the following actions:

(1) enhancing the efficiency of bus operation systems;

(2) improving the charging system;

(3) providing exclusive median bus lanes; and

(4) introducing a quasi-public bus operation system.

Moreover, it created the T-Money system that uses contactless smart cards to pay for all transportation expenses covering bus, metro, or taxi. Today, the use of transportation cards is not just a tool for payment; it represents significant progress in Seoul's public transportation policies, facilitating the transparent operation of transport income and reduction of operation costs of transport facilities.

Efficiency of the Bus Transportation System

Traffic conditions in Seoul worsened as the number of automobiles rapidly increased from one million in the early 1990s to two million in the 2000s. Despite the changing circumstances, improvements in the city's bus operating system were not explored for decades, and citizens thus began to turn away from the deteriorating quality of bus transport service. As such, the SMG began to restructure the bus operating system to induce citizens to give up driving cars and choose public transportation instead. Replacing the original operating system – that was merely divided into city, express, and circular buses – the new system is composed of:

(1) the Blue bus that crosses the main points of the city directly;
(2) the Green bus that circles the neighborhood and is linked to the subway station;

(3) the Red bus that links Seoul and the metropolitan area; and

(4) the Yellow bus that covers the downtown areas.

Based on this system, the bus routes were completely reformed as well. The winding routes were straightened and the intervals between buses were shortened to increase efficiency. The colors signify the type of bus, which can be easily seen by the commuters at a glance.

Integrated Fare System

The public transportation charging system in Seoul was not integrated in the past, which means that commuters paid an additional fare for every change of mode of transport. This was an irrational system in which the commuter was often overcharged for changing buses, mainly because there was no direct (single mode) route to the destination. To overcome this problem, the SMG instituted a comprehensive charging system for public transportation. This system allows passengers to make bus-to-bus or bus-to-subway transfers for the price of one ticket, using a single card. Under the new system, 1,050 KRW was charged if the total distance is less than 10 km, regardless of the means of transport or number of transfers, and an additional 100 KRW for every 5 km (note that these prices are as of 2004 when the system was first introduced). The number of transits may not exceed a maximum of five times (otherwise, additional charges apply), and the comprehensive transit discount is applied only when the transfer interval of transit is within 30 minutes. This charging system enhanced the convenience of passengers, and at the same time, made public transportation more accessible and affordable.

Introduced for the first time by SMG in the ROK, the comprehensive public transportation system was expanded to its host province – Gyeonggi Province – in 2007 as well, providing benefits not only to Seoul citizens but to all residents of the metropolitan area. Obviously, as the expansion of such benefits leads to less profits for buses and metro, the comprehensive public transportation system faced opposition from transport facilities. In the case of the metro, there was less opposition as it is operated by the public organizations (Metropolitan Rapid Transit and Metropolitan Subway Corporation) under the SMG. Nevertheless, raising the minimum charge was unavoidable, and the SMG had to partly cover the incurred losses.

On the other hand, there was considerable debate on who should cover the losses among bus passengers of Seoul and Gyeonggi Province. The Gyeonggi Provincial Office proposed that SMG should cover a larger share but from the SMG's perspective, it was impossible to subsidize the buses that Gyeonggi residents use with the taxes collected from Seoul citizens. This problem was left unresolved for a prolonged period; during this time, Gyeonggi Province passengers were compelled to pay multiple minimum charges – once when hopping on a bus from Gyeonggi Province to Seoul, and for a second time when transiting to a Seoul bus. Under the circumstances, residents of Gyeonggi Province began to selectively ride Seoul buses that pass through parts of Gyeonggi Province to avoid multiple charges, leading to a loss of passengers for Gyeonggi Province buses. To address the situation, Gyeonggi Province eventually conducted active negotiations with SMG, and they were able to reach an agreement to implement an integrated charging system.

Table 9: Yearly amount of discount from public transportation transits per person

Year		2007	2008	2009	2010	2011	2012
Amount of fares discounted from transits (in 10 million KRW)	Total	5,392	5,944	6,164	6,184	6,264	7,192
	Subway	1,679	1,967	2,137	2,152	2,219	2,581
	Bus	3,713	3,977	4,027	4,032	4,045	4,611
Average daily number of persons who availed themselves of the discount (in thousands persons)		1,054	1,105	1,157	1,162	1,180	1,175
Average amount of discounts per person (in 1,000 KRW)		512	537	533	532	530	612

Source: Seoul Policy Archive, 2015

Table 10: Operational characteristics of public buses in Seoul

Type of Bus	Example
Blue Bus: Blue buses shorten the distance and time needed for transport by crossing the entire Seoul City from East to West, and North to South. Blue buses ensure speed and punctuality.	
Green Bus: Green buses form a dense network for districts that Blue buses do not cover. Green buses cover transportation needs within a confined local district and provide accessibility.	
Red Bus: Red buses directly connect metropolitan areas to downtown areas. Red buses are intended to absorb commuters that cross the city boundaries using privately owned vehicles.	
Yellow Bus: Yellow buses run short distances in regions with much daytime traffic. Yellow buses cover business and shopping needs within the region.	

Source: SMG, 2015

Exclusive Median Bus Lanes

The exclusive median bus lanes facilitate the use of public transportation and ease traffic in the downtown areas by separating buses from other transportation modes. The SMG implemented exclusive median bus lanes in three sections in Seoul in 2004, and has expanded to the lanes by about 15 km each year; mainly for roads with multiple bus routes and serious traffic jams. As of late 2012, 115 km of exclusive median bus lanes were constructed on 12 main roads, which increased the average speed of buses by around 30%, from 15.8 km/h to 19.9 km/h. In particular, some main streets with intense traffic benefited the most from this action, given the increase in travel speed of up to 80%. In addition, exclusive median bus lanes contributed greatly to the timeliness of buses, thereby boosting public confidence in buses – as well as the revenues of bus companies.

During the initial period of establishing exclusive median bus lanes, the pedestrians and passengers who were not yet accustomed to the system would jaywalk or the buses would surpass speed limits, resulting in higher cases of accidents. However, the continuous promotion of the system led to improved citizen awareness and an orderly culture of following traffic rules, thereby reducing the number of accidents every year. In implementing the exclusive median bus lanes, the SMG exerts significant efforts to minimize the inconveniences to passengers, pedestrians, and drivers.

Quasi-public Bus Operation System

The private bus companies' selective operation of buses based on the routes of highest profitability was a concern for SMG. This operation is not only against the public interest on wide geographical coverage of bus services but also impedes the overall quality of bus services. To address this problem, the SMG introduced the quasi-public bus operation system in 2004. Basically, the new operation system allows SMG to exercise authority in determining bus routes, intervals between buses, and number of buses in operation. Also, one Bus Operation Consulting Body was to manage the revenue of all private bus companies. The SMG provides subsidies if there is a deficit, and collects the revenue (from the Bus Operation Consulting Body), if it is above a certain level, to reinvest in infrastructure for enhancing bus services.

This quasi-public bus operation system combines the benefits of both private and public systems in which local governments or public enterprises manage their operations. In addition to transferring the right to route decisions to citizens (which is reflected by SMG), this improves the bus service by guaranteeing stable profits for bus companies and monthly income for bus drivers. Also, it resolves excessive competition among bus companies, delivering positive outcomes such as reducing bus accidents, enhancing hospitality, and eradicating illegal operations.

However, as the revenue from transport remained sluggish, while the operation costs for transport companies have continuously increased, SMG has faced a growing financial burden. For instance, during the period 2007 to 2012 when bus fares remained flat, the annual financial burden shouldered by SMG increased by over 60%, from 163.6 billion KRW to 265.4 billion KRW. Moreover, with the quasi-public bus operation system guaranteeing a certain level of profit to transport companies, events have demonstrated how bus companies have lost the motivation to cut down on their operation costs. In order to reform this monopolistic operation system with no competition, the entry barrier needs to be lowered so that new bus operators can enter the market, and operators that do not succeed in making profits can be liquidated.

Integrated Transit Fare Card System (T-Money Cards)

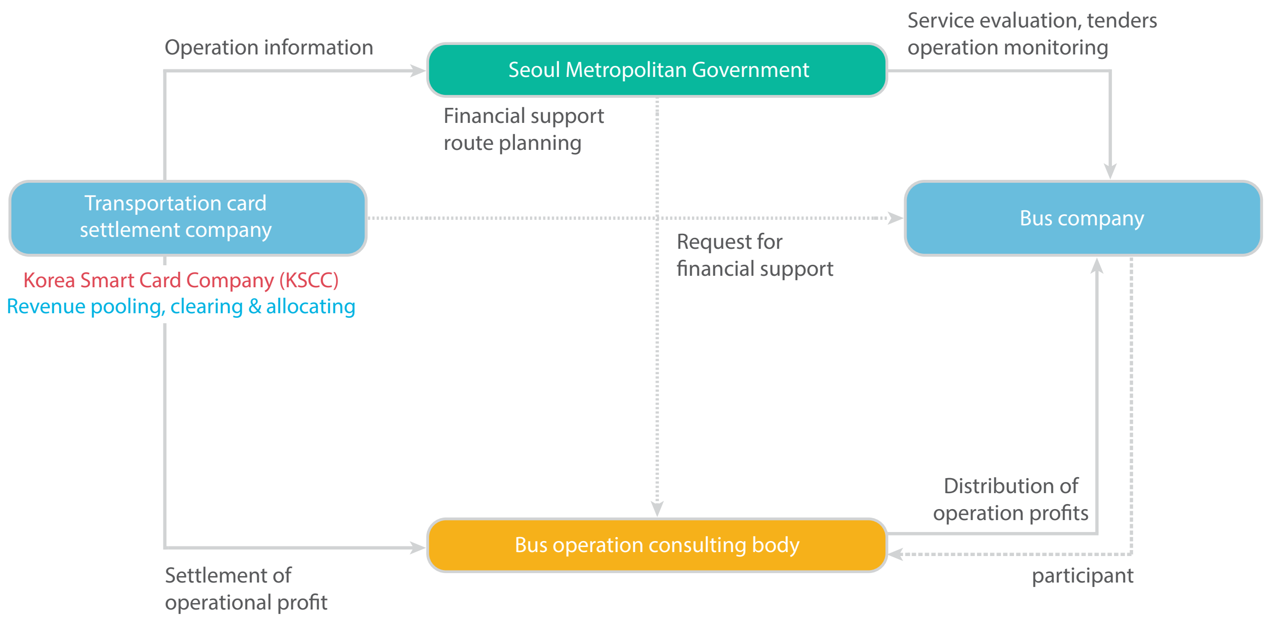
The T-money system utilizes smart cards with chips and GPS installed in buses and metro stations to record the date and time of commute and calculate the fare, providing a rational charge based on the traveled distance. The introduction of T-money cards – rechargeable transportation cards – thus completed Seoul's objective of an integrated fare system. In other words, through the introduction of T-money cards, citizens do not have to use separate cards for buses and metro, and can use public transportation at a lower cost through the distance-proportionate charging system and the transit discount system. It is a contact-less payment system that saves passengers from the inconvenience of the process of paying cash to bus drivers, enabling a faster and more convenient commuting experience.

The development of an integrated transportation card system was called for from two different aspects. From the operational aspect, the original charging system which opened doors to introduce various forms of transportation cards (i.e., transportation cards that offer certain membership benefits) was at the risk of being monopolized by a single operator in the market, making it difficult for the local government to apply its transportation policies, hampering the transparency of revenues and profits of transport companies, and discouraging the needs for making improvements in service. From the systematic aspect, a new system was called to address the problems arising from the aging of payment infrastructure, such as poor security and disorder in service provision. The new T-money card system resolved these existing flaws, and at the same time led to more convenience in using public transport. For example, citizens enjoyed the benefit of expanding the recharging of transportation cards to new means such as the Internet and mobile phones, and the use of a single card for multiple purposes such as credit card with transport card functions.

Outcomes and Takeaways

The SMG's transportation reforms that began in 2004 have been achieving positive results. Above all, the utilization rate of bus services, which had been falling steadily ever since the subway began expanding routes in the early 1980s, underwent a turning point in 2004. Also, with passengers exploiting the free-of-charge transfers between

Figure 11: Joint management of revenue pool under the Quasi-public Bus Operation System



Source: SMG, 2015

Figure 12: T-money cards being used in subways, buses, and taxis in Seoul

Source: SMG, 2014

subway and buses as well as the distance-proportionate charging system, Seoul's public transportation service has shown continued annual increases in total passenger carriage.
The usage rate of T-Money Cards by bus passengers, amounting to almost 100%, represents the importance of effective charging systems and payment methods. Reforms in the fee collection method sparked a change in commuting patterns, from using a single route or single mode of transport to reach a certain destination, to making linked trips, thereby making the transit system more efficient.

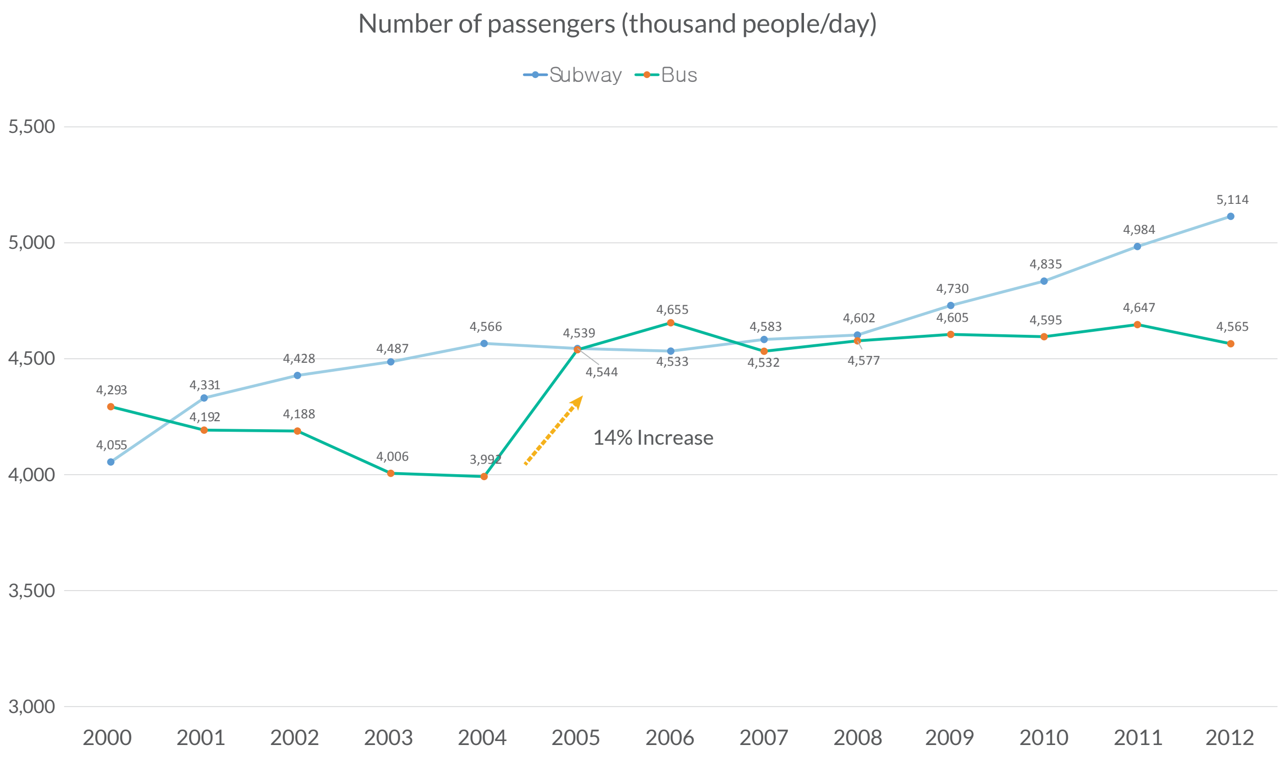
As the revenue of transport companies increased, the quality of services has improved as well, resulting in enhanced public confidence in the transportation system in Seoul. The reform has cut the operation costs of the transport companies while reducing boarding and stoppage time, thus leading to higher profit. Based on a survey in Seoul in 2012, the public satisfaction of using buses and subways has drastically improved, as of 2004.

The T-Money transportation card system is gaining global attention for benchmarking in countries such as New Zealand, Malaysia, and Colombia. For instance, in the case of Malaysia, the Korea Smart Card Corporation (the company that provides T-Money Card services in Korea) and LG-CNS (a subsidiary of LG Corporation) have helped establish a new transportation card system in Kuala Lumpur, which is now operating successfully. The number of bus passengers in Kuala Lumpur, which used to be around 250,000 per day, has increased by 20,000 within just a single month after the adoption of the new transportation card system. The bus companies' revenue has also increased by 20%, primarily from the avoided loss in cash fares that were being lost in the pockets of bus drivers.

3.1.2 Improvement of Vehicle-Emission and Fuel-Economy Standards

Despite the continued improvement in accessibility, value-for-money, and quality of service offered by public transportation, many people in the ROK still

Figure 13: Trends in public transport usage in Seoul



* Subway ridership excludes free-pass holders.

Source: SMG, 2014

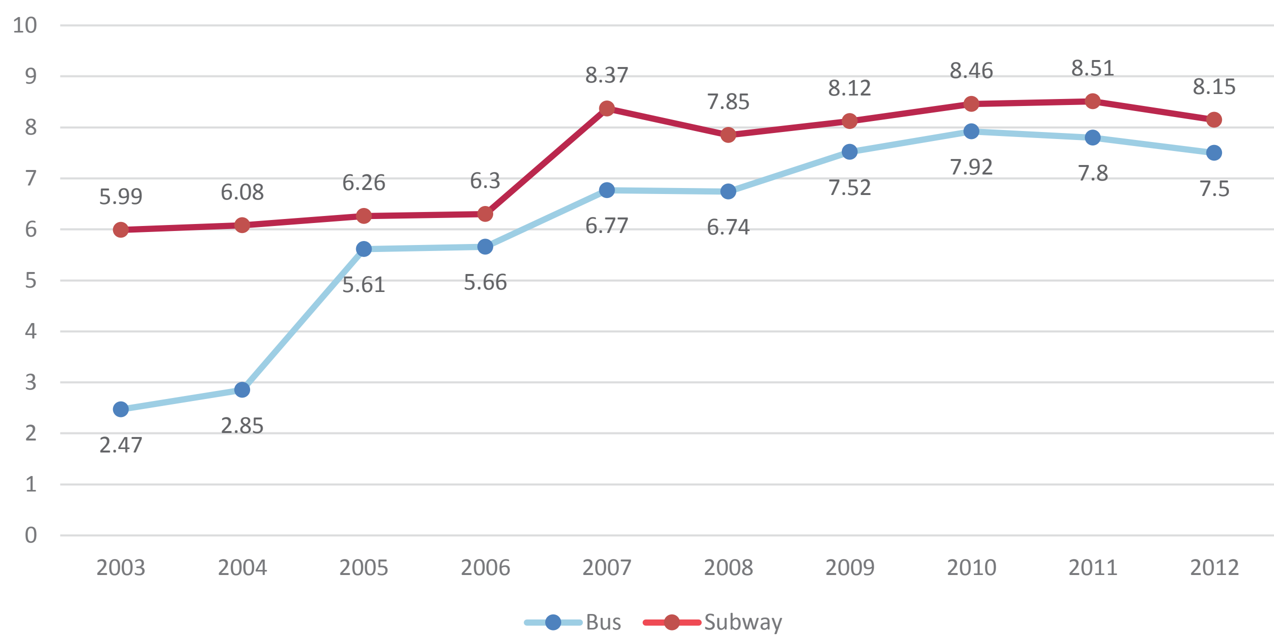
rely on privately owned vehicles, as it is usually far more comfortable and convenient. Thus, the government has continuously sought to regulate the level of emissions and improve fuel efficiencies of private vehicles, in addition to stimulating a modal shift to public transport. It is important to recognize that the government anticipated that such measures would not only help cut emissions from the transportation sector but also create ripple effects in the domestic automobile industry, and specifically in improving the competitiveness of local automobiles in the global market.

A special characteristic of the ROK's regulation on privately owned vehicles is the "optional regulatory scheme," which provides the choice of either following the regulation on average fuel economy or GHG emissions. In other words, the scheme requires automobile manufacturers to ensure that their cars achieve a certain level of fuel economy, or GHG emissions performance, whichever the manufacturer finds to be more advantageous. Prior to the adoption of the optional regulatory scheme in 2012, the government followed a regulation that was based solely on the average fuel economy; vehicles with large (above 1,600 cc) or small (1,600 cc and below) engine displacements should meet different minimum fuel economy standards.

Implementation

The MKE set the standards for average fuel economy while the MoE performs the same function for GHG emissions. Automobile manufacturers are to select one of the two criteria and report to MoE no later than March every year. The MoE compiles the decisions made by automobile manufacturers and shares it with MKE for collective management purposes. Consequently, the automobile manufacturers are to request designated test agencies to evaluate either the average fuel economy or GHG emissions performance of their vehicles prior to sales. It should be noted that numerous test agencies in the public sector – such as the Korea Environment Corporation and Korea Institute of Energy Research – have been certified and designated to support the implementation of this policy. The automobile manufacturers are required to submit their performance results by models and sales accounts, which serve as the basis for compliance, to MoE by no later than March of the following year. Subject to a justifiable reason, automobile manufacturers are allowed to switch from one regulatory criterion to the other in the following year.

Figure 14: Degree of satisfaction for the bus and subway service in Seoul



Note: Rating based on a scale of 0 to 10

Source: SMG, 2014

Automobiles subject to the "optional regulatory scheme" launched in 2012 are passenger vehicles (that are either domestically manufactured, or imported) with 10 seats or below, and with gross weight of less than 3.5 tons. The targeted average fuel economy and GHG emissions are 17 km/L and 140 g/km, respectively. It should be noted that the average fuel economy or GHG emission is evaluated for a single car manufacturer (not for each car model) considering its product mix in sales; for example, the average fuel economy of a car manufacturer is equivalent to the sum of fuel efficiencies of different car models multiplied by their share (%) of sales. In order to allow flexibility for automobile manufacturers against the new standards, the policy was planned to be phased in; standards are to apply to 30%, 60%, 80% and 100% of the total automobile sales by each manufacturers by 2012, 2013, 2014, and 2015, respectively. However, small-scale automobile manufacturers with domestic sales of less than 4,500 vehicles are to be relieved with reduced requirements.

Outcomes and Takeaways

The government's target for 2015 (100% of vehicles to meet one of the criteria set under the optional regulatory scheme) was achieved in 2013, which was actually earlier than planned. Such outcome is a result of not only the government's strong commitment, but stringent efforts made by the ROK's domestic automobile manufacturers that export approximately 70% of its total production to the global market. Recognizing that the standards set by the countries having the world's biggest automobile markets are significantly high, the ROK's domestic automobile industry has made timely and constant engagements in R&D to push forward the technological progress required in improving the environmental performance of their vehicles. For example, the average GHG emission targets (following the ROK's method of calculation) set by the EU, Japan, China, and the U.S. are 91 g/km (by 2021), 100 g/km (by 2020), 110 g/km (by 2020), and 133 g/km (by 2020), respectively, which are significantly lower than the ROK's 2015 target. The government remains compelled to ensure that the fuel economy and emissions standards in the domestic market would help the nation's car manufacturers to keep pace with the changing circumstances of the global market. In 2014, it was announced that a new target of 24.3 km/L (average fuel economy) or 97 g/km (GHG emission) needs to be met under the optional regulatory scheme by 2020.

Regulating vehicle emissions by setting of fuel economy (or GHG emission) standards is a complex process that needs to take into account a multiple number of variables, such as vehicle mix by size and fuel, trends in vehicle sales, and average distance travelled. For example, the increase in household income during the 1980s-2000s has led to a steep rise in the share of mid- or large-sized cars with high emission levels in the ROK. The adoption of the optional regulatory scheme helped stimulate changes in this trend as automobile manufacturers are encouraged to develop and sell cleaner and more efficient models. In an effort to transform consumer preferences, the government changed its basis for taxation on car ownership from "engine displacement" (i.e., more tax imposed to cars of higher engine displacements) to "fuel economy and GHG emission" performances in 2010. The strengthening of vehicle fuel economy and GHG emission standards served as a good starting point in increasing public consciousness on climate change issues.

3.1.3 Old Car Replacement Subsidy Program

The old car replacement subsidy program (also referred to as the car-scrapping scheme) provide subsidies to vehicle owners that trade-in their old vehicles for new and more fuel-efficient vehicles. The underlying rationale to the program is clear and simple – to help decrease emissions from the transportation sector by removing energy-inefficient vehicles from the roads and revitalizing the domestic automobile industry that employs more than one million people in the ROK. The program provided public subsidies for a limited period to individuals who purchased cars before the year 2000, a year marked by strengthened requirements for vehicle-emission levels.

Implementation

The program was effective for a period of eight months, starting from May 2009, the earliest period of the nation's recovery from the global financial crisis. Subsidies came in the form of tax cuts in the purchase and registration of new vehicles. Specifically, the sales tax and registration tax collected by the local government authorities, and the special consumption tax imposed by the national tax agency were to be reduced by 70%. However, ceilings were placed on the maximum amount of tax deductions, which increased according to the size of the newly purchased automobile; for example, a ceiling of 2.5 million KRW (approximately US$ 2,300) was placed upon purchase of a large-sized car. Tax deductions applied once for each old car replaced, regardless of the number of old cars to be replaced by a single individual. Beneficiaries were required to register their aged vehicles on an online system by submitting applications to car dealers, which would provide them with a certification of replacement upon purchase of a new car – the basis for tax deductions made by tax authorities.

Outcomes and Takeaways

Contrary to the concerns that the old car replacement subsidies would hamper the government's tax revenues, the program actually resulted in an increase in tax revenue, thanks to a considerable rise in the number of new car purchases. Specifically, the total number of new car sales during the first seven months of the program reached 885,000, which was a 35.4% increase over the same period in the previous year; approximately 35.4% of these sales were subject to replacement subsidies. While the government initially projected that 270,000 old car replacements were to benefit from the program (i.e., equivalent to 5% of the 5.5 million old cars on the road eligible for subsidies), a total of 380,000 old scrapped cars were found to have been provided with subsidies at the end of the eight-month period. The volume of new car sales in the ROK was revitalized to the levels prior to the global financial crisis in 2009. The Bank of Korea announced that approximately 35% of the nation's increase in GDP for the second quarter of 2009 (as compared to second quarter of 2008) was attributable to the increase in automobile sales.

While the program was successful in stimulating demand to support the automobile manufacturing industry, its contributions in reducing the nation's GHG emissions from the transportation sector remains questionable. Most importantly, the majority of subsidies supported the purchase of large-sized sedans and sports utility vehicles, which are not the best-in-class environmental performers. Without doubt, the average GHG emission levels of new cars that were subsidized were greater than those of old cars traded in, but the new cars were not hybrids or electric cars; the program failed to impose additional conditions based on either the fuel efficiency or emission performances. Moreover, the program did not help steer people toward small and more fuel-efficient vehicles. Understanding how a significant share of emissions from a vehicle's cycle are caused during production, the program in the ROK was closer to being a stimulus package for the automobile industry. The experience of the ROK once again demonstrates why the old car replacement subsidy program is supported by the biggest car-producing countries around the world. A more effective policy alternative may be one of linking the program to the electric vehicle rebates, which have been gaining momentum globally.

3.2 Green Cities

In the ROK, GHG emissions in urban areas account for approximately 43% of the total national emissions. Identifying a wide range of low hanging fruits in addressing climate change and GHG reductions in the urban context, the government decided to implement the "greening of cities" across the nation based on the legal mandate of the Framework Act on Low Carbon Green Growth[4], by mainstreaming green growth into the existing Comprehensive National Land Plan and the Basic Urban Plans. In an attempt to accelerate this process, the Ministry of Land, Infrastructure and Transport (MOLIT) officially released the Urban Planning Guideline for the Low-Carbon and Green City, which assists decision-makers of city and district level planners in local government offices to incorporate various mitigation options. This section aims to delve into some of the progress made by the major cities across the nation under the Five-Year National Plan for Green Growth.

4 | Article 3 (Basic Principles of Promotion of Low Carbon Green Growth) states that: "The Government shall rearrange infrastructure, including national land and cities, buildings and transportation, road, ports and harbors, and waterworks and sewerage systems, to make them suitable for low-carbon green growth while preserving the value of national resources and environment at the same time."

3.2.1 Greening of Cities in the ROK – Case Studies of Incheon and Seoul

Given how most Korean cities have reached near complete urbanization, the local governments' efforts to green its cities have focused not on creating new cities, but rather on renovating the existing cities and improving their systems for reducing GHG emissions and improving environmental sustainability. Each city should embody the low-carbon green growth model and formulate plans to implement a variety of actions, such as:

(1) spatial planning targeted on reducing GHG emissions;

(2) bridging the trends observed in commuting patterns with the city's transportation planning to help reduce energy intensity; and

(3) expanding the application of green infrastructure (e.g., renewable energy generation facilities, rainwater harvest, and recycle systems).

These local government plans also incorporated investments to be made by the central government's line ministries, and sought to align them with local development directions. Moreover, the city-level plans reflect the regional characteristics such as geographical, social, and cultural attributes. Seoul's "Green Car Smart City" and Gangneung city's "Low-Carbon Green City" provide examples of how the concept of green growth was mainstreamed in the urban planning process in the ROK.

Seoul Case Study (Green Car Smart City)

The ROK's capital city, Seoul, is known for its high population density and traffic volume. While the SMG focused on the supply of transportation infrastructure – new urban freeways and subway lines – until the early years of the 1990s, its transportation policies started to focus on demand-side management to resolve the congestion problems in 1993. Most importantly, a congestion pricing scheme was introduced as a means of controlling the use of private vehicles. Despite the sizeable reduction in traffic volume and increases in average travel speed, the growing concerns over air quality in the late 1990s and its health implications forced the SMG to take further steps to promote better environmental quality. In 2002, the SMG announced plans to replace all city buses running on diesel fuel with compressed natural gas (CNG) buses.

Against this backdrop, the SMG announced its ambition to become a global leader in the roll-out of green cars and transportation systems through the "Green Car, Smart Seoul" proposal in November 2010. "Green cars" refers to vehicles (e.g., electric, hybrid, and fuel-cell) that minimize air pollution and with high fuel efficiencies, as compared to conventional petroleum and diesel vehicles. Through this proposal, the SMG set an ambitious target of rolling out 120,000 electric cars by 2020. To accomplish this target, 50% of public buses and vehicles owned by state organizations, 10% of privately owned vehicles, and 1% of freight vehicles were to be replaced with electric equivalents. As a means of accelerating the deployment of green cars, 110,000 electric car recharge stations will be made available by 2020. Specific strategies of the proposal included:

- **Sustained Demand:** The SMG provides a reliable demand for green cars by placing a mandate on green car purchases by public institutions, and supports R&D initiatives related to the development of green car technologies.

- **Accelerating Market Growth:** Subsidies are offered for green car purchases and operation, and the SMG boosts investments to improve the city's infrastructure on vehicle charging.

- **Strengthening User-centered Support:** The SMG prepares and enacts various laws and policies specific to green car users to provide preferential tax exemptions and benefits, such as exemption from paying congestion fees and access to reserved parking spaces.

Deployment of CNG Buses (Seoul)

In 2002, the SMG embarked on replacing its diesel-run public buses – a major source of the city's air pollution – with CNG buses to help clear the city's air and cut down on energy spending. As of 2014, all intra-city buses (8,750 units) in Seoul have been replaced. Through its CNG bus deployment program, the SMG subsidized the purchase of CNG buses using budget allocated by the central and city governments (50:50 ratio), which significantly reduced the burden on city bus companies. In addition, the purchase of approximately 1,600 additional buses such as community buses and tourist buses has also been subsidized. The cumulative spending of the government under the program has reached 350 billion KRW. The SMG made additional investments to establish a total of 46 new CNG charging stations (as of 2010) across the city to enable a smooth transition.

The CNG buses not only avoid the emission of particulate matter, but also help cut down nitrogen oxide emissions and improve energy consumption. Although CNG buses neither run on renewable sources nor are completely harmless to the environment, they have contributed significantly to reducing the city's air pollution levels. The SMG reported that Seoul's air quality has continued to improve over the years, reaching an annual average of 48μgm^3 (particulate matter concentration) in 2010, which was the lowest in the past 15 years.

Deployment of Electric Buses (Seoul)

Encouraged by the success of the CNG bus deployment, the SMG in 2010 commenced the introduction of electric buses that produce even less pollutants. The first electric bus to operate in Seoul was introduced in Namsan, an area that has become the symbol of Seoul, especially to tourists. It is worth noting that these electric buses were developed by a domestic bus manufacturer that was financially supported by the SMG. It directly purchased a total of 15 buses to operate on three different routes. Not only has Namsan's electric bus drawn much popularity among the citizens, reaching an average of 2,000 users per day within the first 100 days of its operations; it has also contributed in attracting global interest in the ROK's environmentally friendly technology. Electric buses have become a tourism icon for visitors to Namsan and a symbol of Seoul's environmental awareness.

Despite the SMG's ambitions to introduce a total of 337 electric buses by 2014, the momentum eventually came to a halt primarily due to budget shortage and technical challenges. Understanding how purchasing electric buses requires hefty government investment, the public criticized the operation for its low economic efficiency. Electric buses revealed technical limitations in running distance such as requiring frequent recharging, and vulnerability to extremely hot and cold weather conditions, leading to frequent service cancellations. Although the SMG has failed to popularize electric buses, the initiative played a key role in increasing public interest in electric cars and other related green technologies.

Car-Sharing Program (Seoul)

Seoul launched a car-sharing program known as the "Nanum Car Service" in February 2013 to ease the city's traffic congestion and to resolve parking problems by reducing unnecessary car ownership as well as promoting a "sharing culture." The service aims to provide access to shared vehicles to individuals in need of a convenient alternative to renting a vehicle or using a cab or delivery service. The major difference between the Nanum

Table 11: Annual supply of CNG buses in Seoul

Category	Total	Years					
		Up to 2008	2009	2010	2011	2012	2013
Total	10,376	6,147	1,757	1,173	590	467	242
City Bus	8,750	5,414	1,396	1,044	396	332	168
Community Bus	1,049	487	214	85	100	100	63
Others	577	246	147	44	94	35	11
Government Spending (million KRW)	350,996	215,158	49,818	37,636	19,328	16,326	12,716

Source: Seoul Policy Archive, 2015

Car Service and regular car rentals is that the reservations can be made easily via the Internet, mobile phones, or ARS (Automatic Response System) service; the cost is also cheap as it is commensurate to the actual number of hours used. It should be noted that approximately 20% of the cars under the Nanum Car Service are electric and hybrid cars.

The service can be used by anyone over 21 years of age with at least one year of driving experience. The fee is automatically charged through the credit card registered during the service member application process made via the Internet. Obviously, the costs of fuel consumed are additionally charged depending on the actual distance traveled. Users can pick up the car in pre-selected locations at 30-minute intervals after making a reservation, and the service automatically ends when the user returns the car to the pickup location. An advantage of Nanum Car Service is that it operates on an unmanned system allowing 24-hour access and is free from the hassle of signing of contracts.

Although the Nanum Car Service is being provided by multiple numbers of private entities that have been selected through an open bidding process, the SMG is the implementating entity responsible for the service operations and maintenance. In other words, the SMG has the authority to select or replace the participating private entities, specify uniform service standards, and offer user benefits such as deduction of public parking fees for Nanum Cars. This efficient governance structure has helped improve the quality of service and accelerate the increase in service coverage. To ensure that a sufficient number of electric cars is available for the service, the central government and the SMG have been subsidizing the procurement of such cars by the participating private entities.

The SMG reported that a total of 1,922 Nanum Cars offered service in 912 locations across Seoul as of December 2014. These locations are primarily public parking lots, and parking lots of public government offices. A steady increase in the membership numbers (370,000) has led to an increase in usage, reaching a daily average of 3,026 roll-outs. The average rental time on a single roll-out was approximately four hours. Public satisfaction with the service was also reported to be high; in a survey conducted among 5,950 users, 78.4% were positive regarding the quality of service. Users have also reported that they have been able to reduce 36.6% and 36.7% of the number of roll-outs and distance travelled, respectively, by taking part in the car sharing program. In addition, 62.2% of the users replied that they were willing to dispose of their private vehicles or give up purchasing one if the Nanum service becomes more readily accessible. Due to the SMG's pioneering efforts, similar car-sharing programs are speading rapidly across other regions of the nation, including the Gyeonggi Province, Incheon City, and Jeju Island.

Figure 15: Electric bus in Namsan

Source : EBN News, 2015

After the offical launch of the program, the SMG faced several criticisms from the public regarding the management and operation of the service. For example, there was a discrepancy in the number of cars made available for sharing in different locations, which led to frequent failure in meeting the demand. In addition, there were strong complaints on the need for the Nanum car to be returned to the location where it was originally picked up. The fact that the usage fee can only be paid for by using a pre-registered credit card was also cited as an inconvenience. The SMG is continuously cooperating with the private service providers to close such gaps and increase the number and level of incentives offered to Nanum cars in service.

Gangneung Case Study (Low-Carbon Green City)

The city of Gangneung is a major transportation hub where highways, railroads, and sea routes meet. Located on the east coast of the nation, it has high potential in renewable energy generation as well as the tourism industry due to its beautiful natural environment. Thus, Gangneung has identified the potential of green transportation, energy, and tourism to boost its local economic growth. In 2009, the central government selected Gangneung as the nation's first pilot "Low-Carbon Green City," leading to the development of a new city development masterplan. Based on consultations with expert groups, private sector entities, and public research institutes, as well as the outcomes of the organized international conferences on urban development, the actions under the masterplan are based on the following six key ideas:

(1) environmentally friendly land-use planning;
(2) green transportation;
(3) preservation of natural ecology;
(4) energy use optimization;
(5) enabling water and resource cycles; and
(6) green tourism.

The action plan is expected to lead to a 49% reduction in GHG emissions (against BAU levels), a 35.9% reduction in energy use (against BAU levels), and a 16.5% expansion of green ecological space.

Based on the masterplan, a total of 29 projects are to be implemented in three phases during the period of 2011-2020.

- The first phase (2011-2012) has nine projects that can be readily implemented within a short timeframe; these include the creation of bicycle paths, establishment of renewable energy facilities in Gangneung waste water treatment plant, and retrofitting of school facilities with low energy variants.

- The second phase (2011-2016) focuses on building the foundations for a Green City, and covers 15 project-level interventions such as prevention of traffic congestion in the city centers and tourism

Figure 16: A Nanum car stationed in a designated parking space in a public car park in Seoul

Source: Transportation News, 2015

centers by reorganizing the transportation systems, creating an ecological park by restoring the Soonpogae Lake to its natural ecological form, and building recuperation areas that connect mountainous areas with the regional medical centers.

- The third phase (2011-2020) seeks to attract private investments in five large-scale projects based on a longer timeframe. Its activities include the construction of test-bed R&D complexes for demonstrating renewable energy technologies that suit regional specificities, installing biomass power plants capable of converting waste into energy, and the introducing smart grid and energy management systems.

It should be noted that most of the project's implementing entities are governmental organizations (provincial government and line ministries), while a limited number of projects with high commercial viabilities – such as the establishment of green business complex and zero-carbon residences – are undertaken by the private sector. Approximately 1 trillion KRW was projected to be spent on the three phases, indicating the need for a strong buy-in from the national and provincial governments to translate into actual investments. As of 2013, all nine projects of the first phase of implementation have been undertaken as planned; some of the key examples are provided below. However, after the instatement of the new government in 2013, there has been a slowdown in momentum to pilot-test Gangneung as the nation's first low-carbon green city, but its intended outcomes in the long term have put more pressure on the city government to actively advance the agenda.

Renewable Energy Powered Wastewater Treatment Plant (Gangneung)

In the Gangneung wastewater treatment plant, the government constructed an 890 kW capacity solar power plant and 3 kW capacity wind energy facilities during the period of 2010-2012 with a total investment worth 5.24 billion KRW, provided by the central (50%), provincial (9.2%), and municipal government (40.8%). The existing streetlamps of the wastewater treatment plant were replaced with renewable energy powered lamps in order to reduce energy consumption. As a result, a total of 1,140 MWh of energy is being provided annually from renewable energy sources, which accounts for approximately 15% of the total annual energy consumption. The quantity of GHG emissions that have been avoided is expected to reach 525 tons of CO_2 equivalent per year.

Water Re-use System in Gangneung General Sports Stadium (Gangneung)

In 2011, the Gangneung General Sports Stadium installed a water re-use system that can provide

Figure 17: Renewable energy facilities of the Gangneung Wastewater Treatment Plant

Source : Gangwon News, 2015

100 m^3 of water daily to be used in grass sprinkling and firefighting. The system collects wastewater discharged from a neighboring apartment complex and employs a membrane bioreactor (MBR) and advanced oxidization process (AOP) technologies for treatment. In addition, the stadium installed a rainwater harvesting system in its rooftop to provide 10 m^3 of water from simple filtration treatment process to be used for urinal flushing purposes. The central government and private investors equally shared the cost of this investment, which was worth 2.92 billion KRW in total.

Green Ecological Roads (Gangneung)

During the period 2010-2011, the city of Gangneung built green ecologial roads extending 11.5 km over the existing hiking trails near Gyeongpo Lake, a key tourism site. Green ecological roads are environmentally friendly trails that offer walking and cycling facilities. Investments totaling 2.2 billion KRW were channeled to the planting of roadside trees, rehabilitation of ecological forest cover, and establishment of bicycle-exclusive roads. The budget came from several sources, namely, the central (50%), provincial (12.3%), and municipal governments (37.7%). As a means of maximizing tourist opportunities, the project also built tourist recreational areas, an ecology observatory, and biotopes (i.e., artificial spaces set up to simulate a natural habitat) along with green ecological roads.

3.2.2 Urban Farming

Urban farming refers to the utilization of an urban plot of land to cultivate crops for various purposes including leisure and education. The practice can take place in various locations such as under-utilized pieces of land, rooftops, or balconies. In response to how urban farming has been successful in gaining public-wide interest, the government released the Five-Year Plan for Urban Agriculture (2013-2017) in 2013. The plan recognizes that urban farming has a role to play in improving the quality of life of urban residents, and has thus decided to expand the size of urban farms to 1,500 ha and the number of urban farmers to 2 million people by 2017. In order to accomplish this goal, local governments have been implementing a diverse number of related programs that offer technical, administrative, and financial support to stakeholders.

The promotion of urban farming in the ROK was made possible through the enactment of the Act on the Development and Support of Urban Agriculture in 2011. The law categorizes urban farming into five types according to their purpose or geographical context:

(1) residential farming within individual homes;

(2) near-residence farming in common areas of mass complexes;

(3) downtown farming in vacant areas of buildings;

(4) collective large-scale farming; and

(5) educational farming.

Government support for urban farming has naturally evolved around these categories to meet their customized needs. Local governments – in collaboration with the Ministry of Agriculture, Food, and Rural Affairs (MAFRA) – are to legislate local ordinances to help promote urban farming practices.

Implementation

The most representative type of support from the local governments comes in the form of establishing the required infrastructure for urban farming. Through public advertising, local governments receive grant proposals for the purchase of farming equipment and inputs like seeds and fertilizers. For example, the Seongbuk district of Seoul periodically receives applications from schools, daycare centers, silver halls, and residential community representatives that plan to transform their unused plots of land into cultivated areas. Upon request, the district office dispatches “urban farming supporters” on a monthly basis to provide the necessary training.

Securing the space to pursue urban farming is perhaps the single most important element toward promoting its widespread practice. Accordingly, local governments have been active in identifying and making available various types of under-utilized or unoccupied plots of land, and subsequently opening them to the public. The heads of local government offices have been establishing “shared urban farms” in vacant areas of public ownership, to be leased to a multiple number of urban farmers. On the other hand, private entities have also begun to acquire lands for establishing "commercial" urban farms to be leased to the public. The government offices have been supportive of such private sector engagement by providing free training programs and administrative assistance that can help ease the difficulties encountered during the process.

The MAFRA is responsible for preparing the nationwide strategies and setting of targets to promote urban farming, primarily through the establishment of Five-Year Plans for Urban Agriculture. The Urban Agriculture Committee – housed under MAFRA's ministerial office and consisting of members drawn from the central administrative body, academia and the private sector – provides the required expert advisory on national government policies. However, the local government offices assume the role of translating strategies into specific plans and actions on the ground through their own budget. Urban farmers can support this process by creating "urban farming communities" that help raise interest and motivate individuals through knowledge-sharing and collaboration.

Outcomes and Takeways

After the enactment of the Act on Development and Support of Urban Agriculture in 2011, the number of local government ordinances on the promotion of urban farming increased rapidly. In response to such support, there was a steep increase in the number of urban farming practices; the total area increased from 104 ha in 2010, to 558 ha in 2012, while the number of urban farmers increased from 153,000 to 769,000 over the same period. It should be noted that this number of urban farmers is equivalent to approximately 25% of the nation's total population working in the agricultural sector. In terms of the scale of the development by different cities, Seoul was found to be in the lead with approximately one million m^2, which accounts for 0.17% of the city's total area.

Urban farming is known to have a wide range of benefits, not just in the form of leisure or recreation, but by providing the opportunities for making food as local as possible, adding greenery to the urban centers, and offering recreational areas for urban residents. The PCGG also recognized how urban farming can also help create additional new jobs by fostering of experts. The key success factors to expanding urban farming practices are the provision of required land, establishment of infrastructure, and dissemination of knowledge.

Given the high population densities of cities and the potential confict in the use of land between stakeholders of varying interests, securing a sufficient supply of land is the biggest challenge in the promotion of urban farming. It is thus important for local governments to take a long-term perspective in acquiring land to be offered to the public; not only does this process require a consideration on future urban planning, but urban farms must be located in a way that can match

Table 12: Different forms of government support for urban farming practices

Category	Description
Operational Support	- Opening of training programs on urban farming - Provision of equipment and farm inputs - Financial grants for operational costs of urban farming communities
R&D	- Fostering of urban farming experts - Financial grants for R&D projects relevant to urban farming practices
Provision of Land	- Establishment of shared urban farms in vacant areas of public ownership - Administrative assistance toward the establishment of commercial urban farms
Awareness Raising	- Holding of exhibitions and public contests related to urban farming
Policy Intervention	- Preparation of standards and regulations for safe urban farming practices

the characteristics of the local development. Government incentives should be made available to open privately owned land, while regulatory measures may be needed to allow urban farming in environmentally protected areas or riverside areas. Utilizing rooftops and balconies of high-rise buildings is especially important, as urban farming can help alleviate the "heat island" effect. Collective farms established in areas that are distant from urban centers are likely to become "weekend farms" that receive less care or even become abandoned with the passage of time.

3.3 Green Buildings

The population density of the ROK's main cities is the highest among large cities in the advanced nations. For example, the country's capital, Seoul, has a population density that is two to ten times greater than the major cities of the OECD. This situation has raised the urgency of the need to redistribute the population to help achieve balanced regional development, but at the same time it also opens opportunities to maximize the advantage of high population density – specifically, the easing of investment burden for basic infrastructure and reduction of energy consumption in human activities such as commuting (e.g., by reducing daily travel distance) and room heating (e.g., by adopting grouped heating systems). Daily living in cities with sparse population in many advanced countries has led to inefficiencies and wastage in energy and material consumption. The ROK hopes to avoid this problem considering its limited energy sources and one solution is the improvement of energy-efficiency performance of its buildings.

In line with the nation's vision of low-carbon green growth, the government has supported various incentive programs – most notably tax cuts and subsidies for certifications – to promote efficient use of energy and adoption of environmentally friendly construction technologies. Although many of these programs were launched in the early 2000s, it was only after the announcement in 2008 of low-carbon green growth as national strategy that these programs became subjected to rigorous government oversight.

3.3.1 Building Design Criteria for Energy Saving

Although energy consumption from buildings in the ROK accounts for approximately 25% of the nation's total consumption – which is below the global average of 30% – energy consumption per unit area is significantly higher than those of developed countries such as Japan and those of the EU. Benchmarking the practices of the developed countries, the ROK issued its first building standard in 1977 (on insulation thickness), which was followed by various other standards relevant to energy consumption by building types. Most importantly, the government mandated the submission of Energy Saving Worksheets before the launch of construction

Figure 18: Example of an urban farm development in Seoul

Source: Kim, 2014

activities in 1985 to validate compliance with the minimum energy efficiency standards. In order to synthesize an increasing number of energy efficiency standards by building types, which were being placed forward among many other architectural standards, the government released the Building Design Criteria for Energy Saving (BDCES) as a stand-alone document in 2001. The BDCES was a result of an extensive amount of desktop study on the building energy codes of developed countries; it underwent numerous revisions to keep pace with the changing technological and environmental landscape.

Implementation

In issuing the legal permit for new buildings, the local government authorities are required to execute the building codes developed by MOLIT. The property owners are mandated to prepare the energy-saving worksheets – signed by the architect, mechanical engineer, and electrical engineer – to be submitted to government offices. Then, the local offices review and approve the worksheets through the support of KEMCO, based on blueprints and supplemental data provided by the property owner. The local authorities are allowed to audit the buildings after construction for design compliance, in which discrepancies may lead to the revoking of building permits. The submission of energy-saving worksheets applies to buildings with floor areas of 500 m^2 and above. However, buildings with no cooling and heating systems are exempted.

The BDCES contains four sections – construction design, machinery design, electric facility design, and renewable energy facility design – and each section is composed of mandatory and recommended items. For example, the installation of high-efficiency transformers is mandatory, while the adoption of energy-efficient lighting such as LED lights is recommended. The energy-saving worksheet is basically a checklist of such items adopted in design. The evaluation of the overall energy-saving performance is done through the Energy Performance Index – a measuring tool that evaluates the performance of buildings in terms of energy consumption and savings – which gives a score between 0-100 points. Only those awarded with EPI points above 65 are granted building permits. For public buildings such as government offices and community centers, the bar is raised to 74 points. Buildings exceeding the minimum standards of the code are provided with several benefits, such as alleviation of restrictions on building area over the site area.

Outcomes and Takeaways

Acknowledging the importance of strengthening the design codes to keep pace with the technological improvements, MOLIT made a total of 14 revisions during 1985-2013. The EPI points system was also revised during this process. MOLIT sought to ensure that the evaluation criteria is up-to-date in supporting measures with the highest energy-saving

Table 13: Historical development of the building design criteria for energy-saving in the ROK

Year	Development
1985	Placement of a mandate on submission of Energy Saving Worksheet
1986	Development of energy-saving criteria for mercantile buildings
1992	Development of energy-saving criteria for office buildings
1995	Adoption of Energy Performance Index (EPI) in evaluating energy saving performance
1996	Formulation of energy-saving criteria for buildings for cultural activities and assembly and education
1999	Formulation of energy-saving criteria for buildings of multi-unit residences
2001	Release of the Building Design Criteria for Energy Saving (BDCES)

potential and ease of implementation. In alignment with the government's low-carbon green growth vision, the revision that took place in 2013 was a big leap forward in terms of taking the BDCES a step closer to design standards of "passive buildings" – buildings that require minimal heating or cooling to sustain the weather. In addition, the coverage of the energy-saving worksheets was expanded and additional points were allocated to encourage the adoption of renewable energy.

Following the expanded scope of buildings mandated to submit the energy-saving worksheets, the number of review requests has increased over the years. The success of BDCES lies primarily in setting adequate criteria and fostering the technical capacities required for the preparation and review of energy-saving worksheets. The MOLIT ensured that the strengthening of standards takes a phased approach to minimize the burden of property owners and contractors. In addition, it designated two public organizations (expanded to four in 2013) to build the capacity of local governments in reviewing compliance with the given codes. The government has also developed detailed procedures and built testing facilities to gauge the energy-saving performances of building components, which is critical to making available options in meeting the design code.

Note that the evolving architectural design codes apply only to new buildings, which explains why the outcomes of the BDCES are limited. Approximately half of the nation's buildings have been constructed before 2001, which is the year when the insulation standard was strengthened significantly. Thus, the buildings before this year have been exempted from the energy-saving requirements. This calls for the need to revise the policy to also cover old buildings that waste energy. The calculation of energy efficiency based on a component basis is another limitation of the BDCES since this approach fails to provide comprehensive information on the overall energy-saving performance of buildings. As a response, the government introduced a policy that seeks to regulate the total energy use per unit area in 2013, in which the Energy Demand Worksheets ensure that the building's total energy demand per unit area does not exceed a pre-determined value, which reflects that of an average building. After pilot-testing of office buildings with floor sizes greater than 10,000 m^2 from 2001, the new policy now applies to all buildings with floor sizes greater than 3,000 m^2.

3.3.2 Energy-Efficiency Grade Certification Scheme

The voluntary certification scheme boosts the demand for buildings with high energy efficiencies and sound energy management by assessing the credentials of a building's energy performance through a third party. The standards set forth by the ten-grade rating system has been designed in such a way to engage all parties involved in a building's lifecycle – including the construction company, building owner, operations and maintenance

Table 14: Expansion of the scope of buildings mandated to submit energy-saving sheets

Prior to 2009	Revision in 2009	Revision in 2013
• Apartment and condominium buildings with over 50 households • Public bathhouses over 500 m^2 • Hospitals over 2,000 m^2 • Office buildings greater than 3,000 m^2 • Education and research buildings with centralized cooling and heating systems, and floor area greater than 10,000 m^2	• All apartments and condominiums • All education and research buildings with floor area greater than 10,000 m^2 [Minimum EPI score for building permit] • 60 points	• All buildings with floor area greater than 500 m^2 [Minimum EPI score for building permit] • 65 points

agencies, and building residents. Since the inception of the scheme in 2001, the rating standard has been constantly revised to expand the coverage of eligible buildings and strengthen the certification process. Related efforts have accelerated the adoption of evolving technological advancements in construction, materials, and design, such as adoption of underfloor air conditioning systems, graywater systems, and ambient light sensors.

Implementation

The certification process follows a two-step procedure – the preliminary and main certification – during the construction phase of a building. For preliminary certification, either the building client, building owner, project developer, or the construction company will submit an application to an accredited certifier, along with the required documents such as the final architectural drawing and load calculation documents. The review by the certifiers – which could be third party public agencies designated by the government – leads to a recommended provisional rating, which is reported to the entity in charge of certification issuance (KEMCO). In the second stage, an additional application is submitted to the certifier along with the as-built drawings. The certifiers then recommend the final performance rating to KEMCO based on desktop reviews and field visits. The validity period of issued certification is 10 years from the date of issuance, during which KEMCO is to ensure the consistency in meeting the certification requirements.

The evaluation of the energy-efficiency performance is made based on calculations of primary energy demand per unit area, which takes into account various needs such as room heating and cooling, hot water supply, lighting, and ventilation. In cases where there are two or more buildings on a single plot of land, separate certifications may be issued for each building. The certification grades are separate for residential buildings and non-residential buildings, but both are divided into ten levels, with 1+++ being the best and 7 being the worst in terms of efficiency performance. It should be noted that the coverage of the buildings eligible for certification expanded rapidly during the period of the Five-Year Plan for Green Growth (2009-2013). Although the policy initially covered only newly built communal residences (2001-2009), newly constructed commercial buildings were included in 2010, then it expanded to include all types – both newly built and existing buildings – in 2013, with minimum floor area (subject to cooling and heating systems) of 500 m^2. In addition, the rating system has been revised multiple times to keep pace with the increasingly stringent efficiency standards; for example, the standards for Grade 1 or lower in non-residential buildings was strengthened from below 300 kWh/m^2 to below 260 kWh/m^2 in 2013.

Efficiency grade certifications are provided based on voluntary applications, and the government has ensured that the certification offers sufficient incentives to stimulate participation. Most importantly, buildings are offered reductions in acquisition tax and registration tax of 5-15%, depending on the grade-level (above Grade 2). The benefit was enforced in 2010 to encourage developers and investors to prefer energy-efficient buildings. In addition, energy-efficient buildings are subject to 4-12% leniency in architectural design regulations, such as increase in floor area and building height. Companies that have participated as contractors of high energy-efficiency grade buildings are entitled to earning additional points in bidding for public sector contracts.

Table 15: Number of energy saving worksheets reviews by year

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total
Number of Reviews	819	1,544	1,818	2,828	3,406	2,087	1,951	2,742	4,242	4,882	26,319

Source: KEMCO, 2013

Outcomes and Takeaways

The scheme has helped promote the development of energy-efficient buildings across the nation. Most importantly, the total number of buildings that acquired Grade 1 certification increased 46-fold, from 1,119 in 2008 to 51,658 buildings in 2010. It should be noted that residences with Grade 1 certification are reported to consume approximately 40% less energy than conventional residences. Of course, such certification records are neither proportional to the actual energy saved, nor do they serve as a basis for estimating the improvements in energy efficiencies. Rather, the records help redirect codes and regulations on architectural design to shift the focus on exploiting cost-effective energy efficiency potentials.

Opening ways to maximize the use of the building energy-efficiency grades is thus the scheme's most important success factor. For instance, standards may be put in place to ensure that asset valuation of buildings can be made in connection with the issuance of certification or the level of energy-efficiency grade awarded. Informing the building tenants of the efficiency grades to be reflected into negotiations for lease contracts provides benefits for both the tenant and the building owner, while stimulating the property market to make energy-efficient choices. Recognizing that buildings have a lifespan that reach tens of years, the energy consulting industry engaged in energy diagnosis and retrofits is an important enabler of the scheme's success.

Table 16: Energy efficiency certification grades by building category

Grade (Lower the Better)	Residential Building	Non-residential Building
	Annual consumption of primary energy per unit area (kWh/m²)	Annual consumption of primary energy per unit area (kWh/m²)
1+++	Below 60	Below 80
1++	60 or above – below 90	80 or above – below 140
1+	90 or above – below 120	140 or above – below 200
1	120 or above – below 150	200 or above – below 260
2	150 or above – below 190	260 or above – below 320
3	190 or above – below 230	320 or above – below 380
4	230 or above – below 270	380 or above – below 450
5	270 or above – below 320	450 or above – below 520
6	320 or above – below 370	520 or above – below 610
7	370 or above – below 420	610 or above – below 700

Source: MOLIT, 2014

3.3.3 Green Standard for Energy and Environmental Design (G-SEED) Program

The G-SEED program aims to demonstrate the "greenness" of buildings based on a wide range of information including energy use, GHG emissions, and environmental performance. Unlike the energy-efficiency grade certification scheme, the G-SEED's rigorous third-party commissioning process evaluates the energy performance beyond energy savings that are closely related to the environmental sustainability throughout a building's lifecycle, such as the use of recycled materials in construction, friendliness of the design in accordance with the surrounding environment, and amount of water savings in building operations. The program is similar to the LEED (Leadership in Energy and Environmental Design) certification that is being globally recognized as the leading sustainability standard for buildings.

In the ROK, rising concerns on environmental impacts of building construction and operation led to the launch of the Green Building Certification (GBC) scheme in 2002. After the Green Building Development Support Act was promulgated in February 2012, the GBC scheme was rebranded as G-SEED, which integrates all government provisions related to the promotion of green buildings (the policies were originally dispersed under multiple laws including the Construction Act and the Housing Act).

Implementation

The G-SEED certification, which is awarded based on a similar procedure for energy-efficiency grade certification, is also divided into two stages:

(1) preliminary certification based on desktop review on the architectural design; and

(2) main certification based on review of as-built drawings and site inspection.

The MOLIT and MoE have alternately served as the administrative body of the program, supported by the Korea Institute of Civil Engineering and Building Technology (KICT) as the implementing entity that prepares the certification standards and procedures, designates third party certifiers, and inspects certification records. A total of 11 private and public institutions that meet the given requirements (i.e., human resources with expertise in design categories subject to evaluation) have been designated to provide certification services.

The certification audits cover all new buildings (i.e., less than three years from the issuance of building use permits) and existing buildings on a voluntary basis. However, certification is made enforceable to the construction of new buildings or expansion of buildings owned by the public sector, with floor areas greater than 3,000 m^2; this is a strengthened mandate from that under the GBC which only applied to public buildings with floor areas greater than 10,000 m^2. In addition, public buildings are mandated to acquire grades of two stars and above. Certification is valid for five years, with the possibility of a five-year extension.

The G-SEED certification corresponds to points earned in seven design categories. Items of evaluation and their standards vary according to the designed function of the building. Four certification grades are offered – 4 stars (Outstanding), 3 stars (Excellent), 2 stars (Good), 1 star (Average) – based on the total points accrued. Applicants are provided

Table 17: Outcomes of energy efficiency certification for communal residences (as of March 2013)

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Total
Number of households	1,107	695	382	4,039	16,094	22,226	45,337	63,728	68,828	11,417	233,853	143,050	57,719	596,656
Amount of energy reduced (TOE)	484	158	104	735	3,743	5,095	10,429	16,146	18,849	3,114	58,858	43,488	14,690	160,471
Amount of GHG emissions avoided (tCO_2)	1,131	370	244	1,719	8,749	11,911	24,381	37,749	44,064	7,276	137,595	101,669	34,341	375,117

Source: MOTIE, 2009

with a certification plate to be fitted into building entrances. Incentives for certified buildings with high G-SEED grades are identical to that under the energy-efficiency grade certification, which are 5-15% reductions in building acquisition and registration tax. The G-SEED certified buildings are also subject to 4-12% leniency in architectural design regulations. In addition, G-SEED certified buildings are offered a 10-15% reduction in property tax (for the first five years after certification issuance), and a maximum of 50% reduction in environmental improvement charges, which is a government tax collected from owners of buildings and motor vehicles that discharge vast amounts of environmental pollutants. To encourage participation in the G-SEED program, local governments have also been supporting applicants in the form of grants for covering their costs in certification.

Outcomes and Takeaways

The level of participation in the G-SEED (formerly the GBC) has shown high dependence on the scope of buildings covered by the program and the government incentives made available from certification. The first annual increase in the annual

Table 18: Design category for apartment buildings under the G-SEED certification

Category	Description
1. Land Use and Transportation	Ecological value, impacts on surrounding areas, quality of residence, reduction in transportation load
2. Energy and Environmental Pollution	Energy savings, sustainable (renewable) energy use, GHG emissions avoided
3. Materials and Resources	Resource savings, waste reduction, segregation and recycling of waste, sustainable resource use
4. Water Circulation and Management	Water circulation system, water savings
5. Operation and Maintenance	Site management quality, efficiency of building maintenance, efficiency of unit maintenance, ease of maintenance
6. Ecological Environment	Greenery, ecological function of building areas, biotope plan
7. Indoor Environment	Air quality, room-heating, noise, use of daylight

Source: MOLIT, 2014

Table 19: G-SEED certification grades by points earned

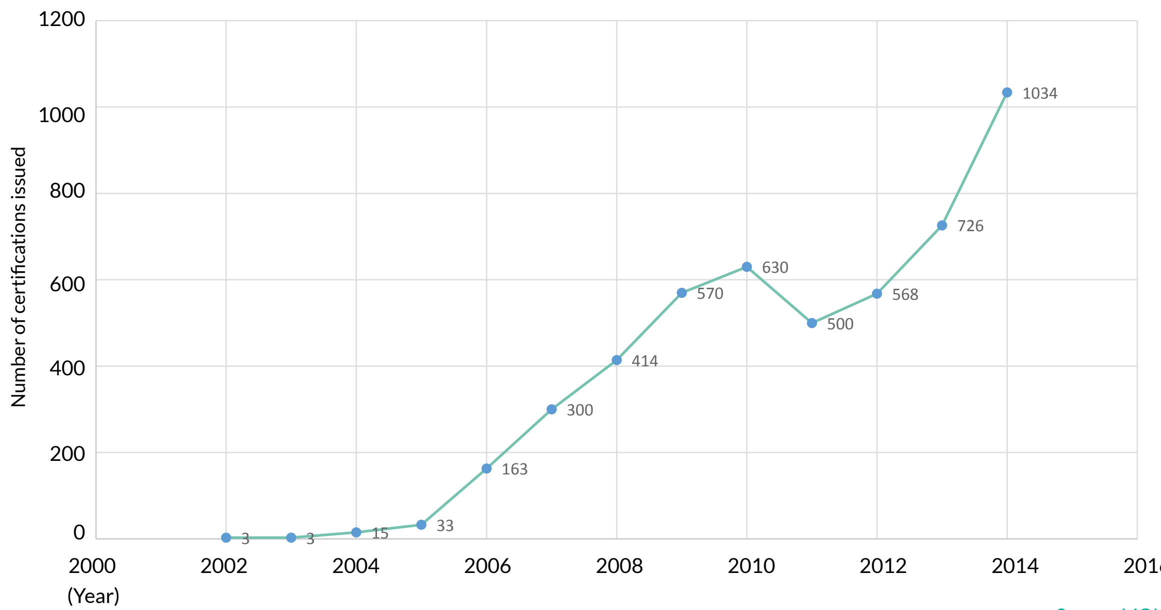
Grade	Multi-unit Housing		Others (educational buildings, mercantile buildings, lodging facilities)		Small Detached Housing
	New Construction	Existing Building	New Construction	Existing Building	
Outstanding (4 Stars)	74 points and above	69 points and above	80 points and above	75 points and above	74 points and above
Excellent (3 Stars)	66 points and above	61 points and above	70 points and above	65 points and above	66 points and above
Good (2 Stars)	58 points and above	53 points and above	60 points and above	55 points and above	58 points and above
Average (1 Star)	50 points and above	45 points and above	50 points and above	45 points and above	50 points and above

Source: MOLIT, 2014

number of certifications issued was in 2006, which marks the year when the government allowed property developers to add 3% to the selling prices of residences in G-SEED certified buildings. Participation further arose from 2008-2010, primarily from the expanded scope of G-SEED certifications to newly built educational buildings, and provision of tax cuts. With G-SEED certification made mandatory for public buildings with floor areas greater than 3,000 m^2 in 2013, it is expected that the trends of annual increase will continue.

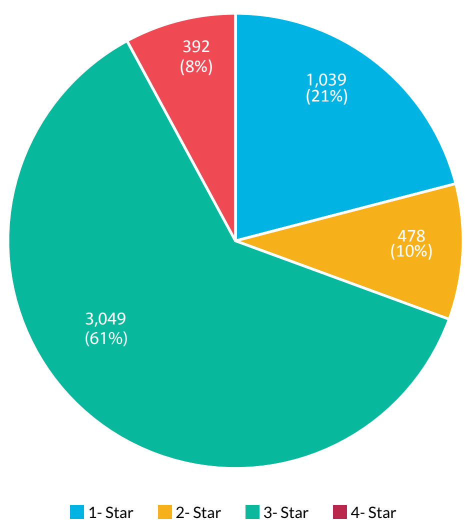
The main challenge faced by building certification programs is in establishing the case that attracts property owners to participate. Thus the competitiveness of G-SEED program can only be strengthened if there is sufficient evidence documented on the benefits that arise from certification – whether in the form of maintenance costs saved or rise in property value – which serves as the basis for property developers and owners to determine whether to make investments on improving the "greenness" of their buildings. As illustrated in the annual number of certification issuance, government policies are critical in building the case for support. However, the role of the private sector should not be overlooked in improving the certification procedures and standards. For example,

Figure 19: Number of G-SEED certifications issued by year



Source: MOLIT, 2014

Figure 20: Distribution of G-SEED grades for certified buildings



Source: MOLIT, 2014

LEED Accredited Professionals – individuals with a level of competence and education related to green buildings – have been at the forefront of propagating the LEED scheme to the public and ensuring that its standards continue to reflect the evolving building technologies.

4. Assessment

Despite the emissions-reduction efforts made under the First Five-Year Plan (2009-2013), the total energy consumption and GHG emissions in the ROK increased noticeably with GDP growth. Although emissions in the urban sector – particularly building and transport – followed this trend, government policies on green homeland and transport offered a broad range of benefits and positive outcomes. Some targets set for the urban sector have been met, while most actions and programs implemented still require additional time to show tangible outcomes. Much of the benefits observed to date are by nature qualitative and considering the given timeframe of the Five-Year Plan, it is still premature to objectively measure the results in quantitative terms.

4.1 Quantitative Assessment

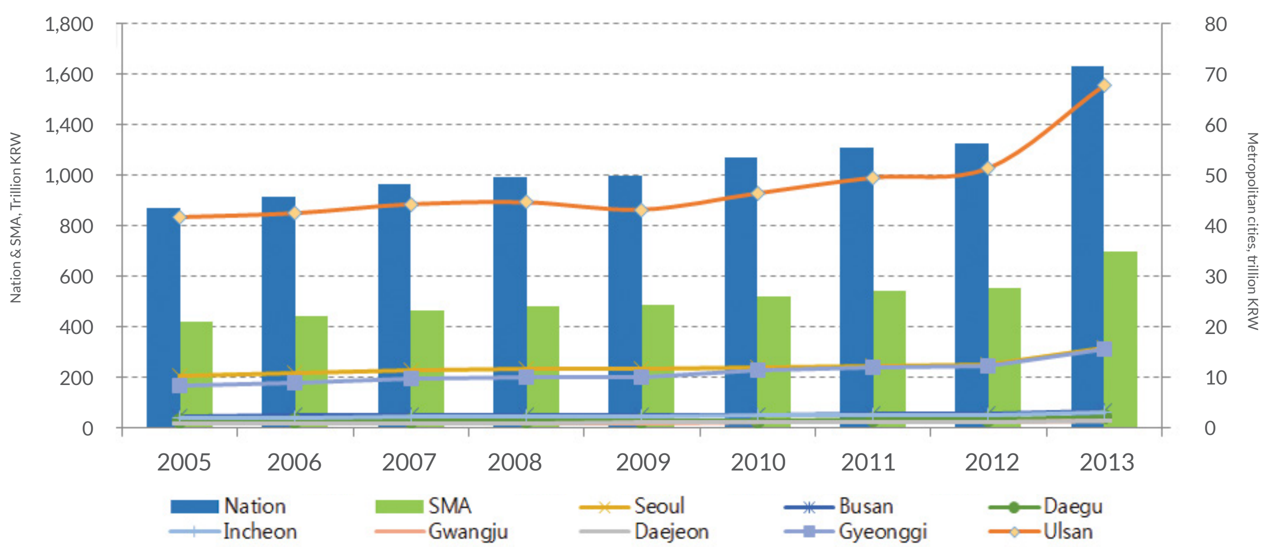
The gross regional domestic product (GRDP) in most urban areas in the ROK continued to experience a steady increase. As seen in Figure 20, the national GRDP increased by 29.1% from 2008 to 2013, while the combined GRDP in seven metropolitan cities grew by 23.1%. Despite a rapid growth observed across the nation's mid-sized cities, the Seoul Metropolitan Area (SMA – including Incheon and Gyeonggi Province) and the six metropolitan cities together produced the bulk of GRDP – 66.2% in 2008 and 66% in 2013.

Energy Use and GHG Emissions

The energy consumption by most of the major metropolitan cities increased along with GRDP as shown in Figure 21. However, a positive trend is evident; while the total GRDP increased by 15.2% from 2008 to 2013, the rise in energy consumption of the seven metropolitan cities was limited at 9.4%. In particular, Seoul and Busan – the two largest cities in the ROK – have been able to decrease their energy consumption by 0.1% and 10.1%, despite the increase in GRDP by 21.8% and 15.8%, respectively.

The transport and buildings sectors showed substantial increases in energy use between 2008 and 2013. Table 20 reveals that both sectors have had 3.9%-4.5% increases in energy consumption during the period 2008-2013. However, it is important to recognize that their shares in the nation's total energy use have decreased remarkably, as compared to the industry sector over this period. The degree of annual increases in energy

Figure 21: GRDP in metropolitan cities and SMA (2005-2013)



Source: KEMCO, 2013; KEMCO, 2014

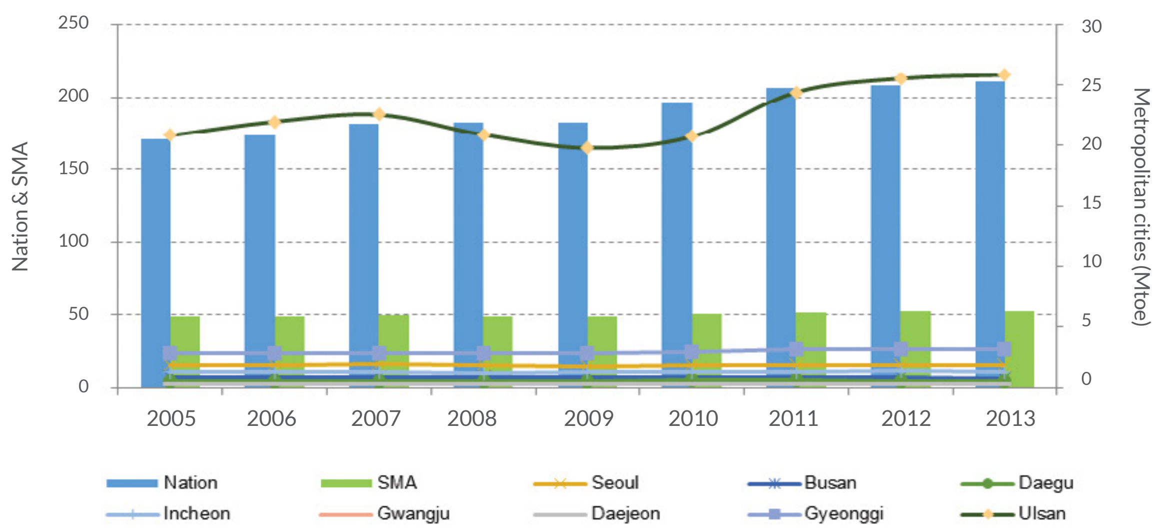
consumption has also become less apparent, although this tendency needs to be evaluated strictly against the changes in GRDP.

The trends in GHG emissions from the two sectors showed different patterns. While the transport sector continued to build up its emissions with time, the building sector revealed a decrease between 2008 and 2012. Nevertheless, the transportation sector's share of emissions in the nation's total has been on a decrease since 2005. It is worth noting that the building sector's share of emissions dropped dramatically from 15.49% to 8.77% during 2000-2012, which is attributed to the increased preference for electricity and city gas over oil and coal.

Target Accomplishments – Green Cities

Notable achievements have been made in terms of green city planning – in line with the targets set by the Five-Year Plan – specifically on the pilot testing of "green city" concepts and engaging in urban regeneration. Although a selected number of these initiatives have been completed, many are still ongoing. As for urban regeneration programs, the MLTM designated Changwon and Jeonju as pilot cities for three years (2011-2014). Both test-beds now showcase notable green city features. The regeneration program in Changwon, for example, included greening of parking areas, ecological restoration of the city's main stream, and construction of artificial waterways, which has

Figure 22: GHG reductions achieved by the public sector



Source: KEEI, 2013; KEEI, 2014

Table 20: Final energy use by sectors during 2000-2013

Unit: thousand toe

Sector	2000	2005	2008	2009	2010	2011	2012	2013
Total	149,852	170,854	182,575	182,066	195,587	205,863	208,120	210,247
Transport (% of total)	30,945 20.7%	35,559 20.8%	35,793 19.6%	35,930 19.7%	36,938 18.9%	36,875 17.9%	37,143 17.8%	37,330 17.8%
Buildings (% of total)	32,370 21.6%	36,861 21.6%	36,225 19.8%	35,722 19.6%	37,256 19.0%	37,542 18.2%	37,884 18.2%	37,341 17.7%
Industry (% of total)	83,912 56.0%	94,366 55.2%	106,458 58.3%	106,119 58.3%	116,910 59.8%	126,886 61.6%	128,324 61.7%	130,906 62.3%

Source: KEMCO, 2014; KEEI, 2014

helped revitalize the city (i.e., increase in the number of road shops, pedestrian visits to downtown) and enhance environmental quality (i.e., increase in the amount of cold wind which can alleviate urban heat island phenomenon; Daewuk Kim et.al. 2013). Encouraged by results from the two test-bed cities, the MLTM initiated a more ambitious program by designating 13 cities nationwide to participate in the urban regeneration program, which is expected to be completed before 2017. Thanks to such efforts, the area of urban forests in the nation increased significantly, by 10.6% in 2009-2013, which is equivalent to a 7.2% increase in terms of green areas per urban settler. All in all, the green city initiative exceeded the targets set by the Five-Year Plan, but their outcomes in terms of GHG and energy reduction remain to be evaluated.

Target Accomplishments – Transportation

For the transport sector, the most important target set by the Five-Year Plan was to increase the share of public transit by 53% and rail transit system by 25% in 2012. The actual share of public transit and rail system in total domestic passenger trips for 2012 were estimated at 45.31% and 12.04%, respectively, demonstrating that government efforts were short of the target. However, the number of passengers in major public transit modes showed positive trends since the 2000s as depicted in Figure 22. In particular, bus passengers increased remarkably partly due to the phased introduction of the quasi-public bus system by metropolitan cities since 2004, as well as significant improvements in the quality services and facilities. The construction of new and expansion of existing rail networks – Korea Train eXpress (KTX), Light Rail Transit (LRT), and Metro (subway) – have helped sustain the increase in passenger carriages.

Another notable achievement in the transport sector is the bicycle program. From 2010 to 2012, a total of 1,757 km of cycle paths were constructed along the nation's major waterfronts, opening a route connecting Seoul and Busan. Bike lanes constructed by local governments reached 3,921 km during 2009-2011, triggering a bicycle boom among the general public. However, such efforts were unable to meet the targets set under the Five-Year Plan; the rate of bicycle use and its share in transport modalities only reached 12.9% and 2.16% (MOPAS, 2012), respectively, well below the respective targets of 25 % and 5%. The total length of the nation's bicycle lanes stand at 19,717 km as of 2014.

Other achievements by relevant ministries in the transport sector are summarized in Table 23. Between 2009 and 2013, the national rail

Table 21: Changes in energy-related GHG level by the transport and building sector (2000-2012)

Unit: million CO_2eq

		2000	2005	2008	2009	2010	2011	2012
Energy-related total		406.6	462	502.5	509.3	561.8	590.2	591.9
Transport (% of total)		68.6	80.4	82.8	83.7	85.4	85	86.4
		16.87%	17.40%	16.48%	16.43%	15.20%	14.40%	14.60%
System	Road	63.2	75.5	78.1	79.2	81.0	80.6	82.1
	Rail	1.0	0.8	0.6	0.6	0.6	0.5	0.5
	Air	1.4	1.0	1.0	1.1	1.1	1.2	1.2
	Shipping	2.7	2.7	2.6	2.4	2.3	2.3	2.1
	Others	0.3	0.4	0.4	0.4	0.5	0.5	0.5
Building (% of total		63.0	61.6	54.4	51.7	52.3	52.1	51.9
		15.49%	13.33%	10.83%	10.15%	9.31%	8.83%	8.77%

Sources: KTI, 2013; GIR, 2014

infrastructure was constantly expanded, primarily from the extension of the high-speed rail system, Korea Train eXpress (KTX). The urban rail system was also extended to improve the coverage of existing lines, while two new LRT lines opened in metropolitan cities. To facilitate multi-modal transfer system, a total of 10 multi-modal transfer centers were designated, of which Dongnae (Busan) and Dongdaegu stations were designated as national centers.

Target Accomplishments – Green Buildings

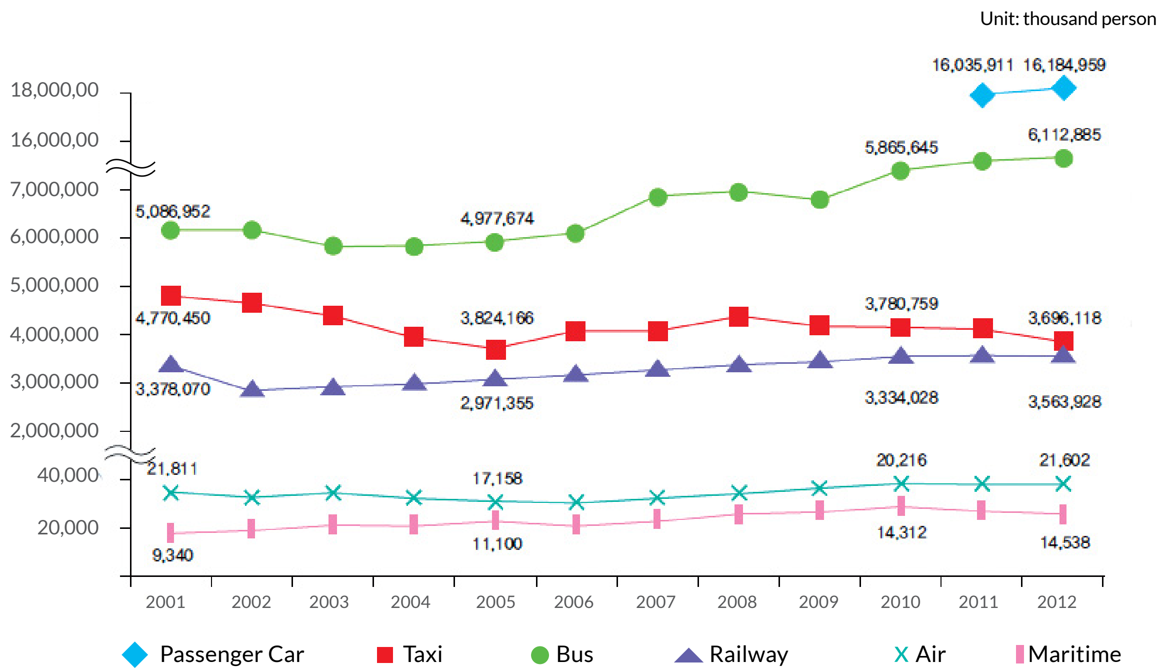
Finally, the building sector also showed positive progress in meeting the targets set under the Five-Year Plan. Upgraded building design codes and tightening of criteria set forth by existing building certification schemes – which were linked to various government incentives and subsidies – were able to bring about significant changes in engineering practices and investment decision-making; the quantitative outcomes of these government efforts are well presented in the previous sections of this chapter.

Table 22: Some achievements of the Green City Initiative

Initiative	Name of Program	Targets FYP	Achieved (Status)	Contents
Green City	Low-carbon green city adaptive to climate change	17	2 (Ongoing)	Gangneung, Gwangwon-Do Geomdan, Incheon,
	EcoRich City		42 (completed)	2009: 11, 2010: 11, 2011: 10
	Low-carbon green village		6 (completed) 1 (ongoing)	2010: Gwangsan-gu (Gwangju City), Gongju City, Wanju-Gun, Bongwha-Gun, 2011: Pocheon City, HwaCheon-Gun 2013: HongCheon-Gun
	Urban regeneration projects	No specific targets; stated only in the plan	2011: 2 cities (Completed) 2012: selected 13 areas (ongoing)	Changwon and Jeonju Busan (Dong-gu), Seoul (Jonro-gu), Daegu (Nam-gu), Gwanju (Dong-gu), Cheongju, Gunsan, Mokpo, Youngju, Changwon, (Taebaek), Gongju, Cheonan, Suncheon

Sources: MLTM et al., 2014

Figure 23: Trends in passenger transport (2001-2012)



Sources: Korea Transport Database Center, 2013

Another pivotal target set under the Five-Year Plan was the creation of "a million green homes" by 2020; green homes refer to homes that either adopt environmentally friendly design standards and/or self-generate power to meet its needs by exploiting new and renewable (NRE) energy sources. Initiated by MOTIE, programs that subsidize NRE installations have led to an exponential growth in the number of green homes, as shown in Table 24. It should be noted that the MLTM's figures pertain to the number of new public rental housing constructed with better design standards, while green homes subsidized by MOTIE are remodeled homes that are partly or fully powered by NRE sources.

4.2 Qualitative Assessment

The agenda of greening the nation's homeland and transportation system involves reforming urban communities with complex physical and socioeconomic systems and intermingled functions. Mitigation efforts at the onset require a package of integrated and comprehensive policy directions and frameworks at both national and subnational levels, engaging both the urban planners and the local community. In this sense, the central government was successful in making timely responses, especially in terms of developing the necessary institutional and legal frameworks along with policy actions and programs. Immediately after the release of the Five-Year Plan, all relevant ministries and its affiliates actively coordinated to produce a set of coherent policy directions, which were to help achieve the target set for green cities, transportation, and buildings. In 2009, the MLTM developed the Guidelines for Low Carbon Green Growth City, a blueprint for all relevant activities on city development and urban planning. Table 25 shows some of the legal and institutional initiatives undertaken.

The central government's low-carbon green growth agenda has had a notable impact, especially in terms of enhancing public perceptions on climate change and environmental sustainability issues. Increased public awareness translated into a social movement, inciting local government officials to proactively take part in the nation's green growth transformation. For example, there was stiff competition among local governments in being designated as the nation's pilot green cities. Local authorities rushed to conceptualize and brand their cities as green, which was followed by local plans and ordinances related to green growth. Some cities even changed their slogans incorporating messages related to green growth, such as "Changwon Environmental Capital," "Green Capital City of Cheongju," and "Korea Capital Ecocity Suncheon."

Table 23: Major improvements in the rail transport system (2009-2013)

Sector	2009	2010	2011	2012	2013
Railway extension (km)	3	179	2	13	-
Korea Train eXpress (km)	-	164.8	180.4	49.3	-
Subway extension (km)	34	23	29	11	-
Light rail transit (km)	-	-	22 (Gimhae)	33 (Uijeonbu)	-
Multi-modal transfer center	-	8		2	-
Transfer center on expressways	-	-	-	2	2
Transit mall	1 (Daegu)	-	-	-	2 under construction (Busan, Seoul)
Eco-drive trained (persons)	-	2,167	3,777	4,610	4,993

Source: KTI, 2013; Korea Transport Database Center, 2014

Intensified government intervention in the urban sector to reduce GHG emissions involved a combination of capacity building, development planning, and GHG emissions data management, engaging urban planners and engineers. Multiple urban planning strategies and city models such as compact cities, transit-oriented development, and integrated urban spatial models were researched and validated before applied to meet the ROK's circumstances. In the process, expert knowledge in urban planning, including the building and transport sector, has been substantially upgraded. Since 2008, the Korea Transport Database Center has been responsible for generating the annual report on the GHG inventory by the transport sector in collaboration with the Greenhouse Gas Inventory and Research Center. Also, the government's large investments in the development of electric cars helped Korean manufacturers achieve world-class quality battery and motor technologies (PCGG, 2013), even though the domestic market for electric cars still remains at an early development stage.

5. Takeaways and Recommendations

Developing countries experiencing high urbanization and motorization growth rates are expected to encounter similar urban challenges that the ROK has attempted to resolve to date. Issues related to urban development are inherently complex and require persistent, long-term efforts. The replicability of the nation's approach and strategies may be limited, as different countries have varying demographic, social, and geographical conditions. For example, ROK's urban development has been featured and supported by early commitments to infrastructure investments (e.g., introducing subway systems in the 1970s) and the presence of a strong construction industry, which may not be the case in many developing countries. Yet, ROK's progress made under the "green homeland and transportation" agenda offers several recommendations for countries that intend to pursue green growth.

Table 24: Number of green homes (2005-2013)

	2009	2010	2011	2012	2013	Total
MLTM	0	73,000	81,592	141,798	133,385	429,775
MOTIE	18,845	29,857	37,684	54,663	30,495	171,544

Source: KTI, 2013; Korea Transport Database Center, 2014

Table 25: Legal and institutional framework for the urban sector

Act	• Sustainable Transportation Logistics Development Act • Special Act on the Support and Activation of Urban Regeneration • Act on the Creation and Support of Green Buildings	2009, MLTM 2012, MLTN 2013, MLTM
Guidelines	• Guidelines for Low-Carbon Green City • Revised Standard for Sustainable New Town Planning • Guideline for Environmentally Friendly Sustainable City	2009, MLTM 2010, MLTM 2013, ME
Plans	• Master Plan for Architectural Policy (2010-2014) • Master Plan for National Bicycle Road • Comprehensive Plan for Development of Sustainable Transport Logistics • Master Plan for Multi-Modal Transfer Center Development (2011-2015)	2010, MLTM 2010, MOPAS 2011, KOTI 2013, KOTI

Greening the urban sector fundamentally requires engaging numerous stakeholders such as ministries, public bodies as well as subnational governments with varying or even conflicting interests. For instance, a variety of green city models were conceptualized under different names led by different ministries and local government authorities in the ROK, which inevitably sparked disagreements and conflicts. MoE's interests in environmental protection and ecological rehabilitation were often in conflict with MLTM's upholding of economic return of investments. Locally driven initiatives for urban greening are no exception from the disparities in the level of central government's financial assistance and local government demands (Wang, 2009). Therefore, the roles of respective stakeholders should be established at the onset through centrally coordinated efforts.

Strategies on mitigation of GHG emissions should not consider urban issues as being isolated from one another. For example, spatial zoning and land use in urban areas may be a direct result of transportation planning. On the other hand, land-use planning with zoning codes that regulate the density and size of buildings directly influence the choice of residence and mode of transport. Thus, greening of urban development must take a holistic approach, maximizing synergies in spatial planning, transportation, housing, and environment management, such as maintaining trip distances short and workplaces within reach of public transport. Between 2005 and 2012, Seoul was able to decrease the share of automobile use from 26.3% to 20.4%, which translated into an increased share of walking from 4.8% to 23.4%. The regeneration of inner city areas to deter urban sprawling and investments on pedestrian-friendly spaces were critical to achieving such outcomes.

Furthermore, developing countries should learn how Korea has successfully regarded the activity of commuting as a public service offering, characterized by topnotch service delivery standard and promotion of self-discipline. Similar to what Korea has done, major cities in developing countries are continuously expanding by creating new cities on the outskirts of the capital city. This requires seamless commuting within and outside the capital, thereby requiring an integrated transport infrastructure. One of the modes of commuting is the bus, and Korea's current bus system demonstrates a good case of utmost respect to time instead of profit, which is the opposite case in many developing countries. Being a slave to the clock, punctuality is the major benchmark of performance. Thus, Korean transport system requires buses to arrive and leave on time at designated stops, strictly following the fixed schedule. Developing countries, on the other hand, grapple with unregulated private buses – many of which are already old, dilapidated, and heavy smoke belchers – and its drivers are treating the road as a race track to get the most number of passengers, and reach their quota for the day. Thus, congested buses would stop whenever and wherever to squeeze in as many bodies as possible and rake in more profits, which leads to more traffic, pollution, and accidents. This unpleasant scene makes commuting an everyday struggle for survival.

In an urban jungle, nothing is as powerful as an efficient, accessible, and affordable public transport service. Although Korea has still a long way to go to significantly reduce the number of cars on the road, it has achieved great strides in terms of increasing public transport ridership. Through its integrated bus and subway system – which showcases an impressive convergence of IT and transport technologies – as well as its aggressive policies designed to curb the demand for private car ownership, passengers from all walks of life would perceive – in many instances – that the use of public transport is much more efficient, convenient, and cheaper than driving private vehicles. The words of the former mayor of Bogota, Enrique Peñalosa resonate well in this regard when he emphasized that "a developed country is where the rich use public transport." It is worth noting that Korea's progress in this area was not achieved flawlessly as coming up with the proper strategy is largely the result of a tedious series of trials and errors, the lessons of which could be useful for developing countries that are undergoing similar transitions and reforms in their transport system. Against this backdrop, the major takeaway from Korea is its continuous effort to shift its urban transport policy from being too focused on technical efficiency to a more human-centric approach. This entails putting human welfare at the heart of transport infrastructure planning such that it becomes user-friendly not just for the majority of the public but also for children, women, disabled, elderly, and even foreigners.

In terms of the ROK's experience in the building sector, it highlights the importance of this sector in making a low-carbon transition. Faced with tough climatic conditions – featuring hot and humid summers, and long and bitterly cold winters – the nation's buildings have struggled to find ways of reducing the high energy demand from the increased use of cooling and heating systems. The government took the lead in developing the necessary technologies, and launching voluntary programs that incentivize energy efficient investments. Supported by the nation's globally competitive construction and engineering firms, the government took a phased approach in introducing design codes that help minimize energy loss and improve the quality of service. Moreover, the bar was set higher for buildings occupied by public entities – such as the ministerial and local government offices, schools, public hospitals and state-run community centers – under the belief that the public sector should set a model for the business sector.

Preference for economic growth over environmental sustainability is bound to persist in developing countries. One should note that many of the ROK's programs that focus on urban GHG emission cuts are in nature mid- to long-term initiatives that involve infrastructure restructuring. As opposed to management changes, infrastructural measures require many years for completion, and are difficult and costly to reverse. The lock-in effects of infrastructure and technology choices made by the ROK during its stage of rapid economic growth are the primary reason for sustained increase in GHG emissions by the transportation sector. In other words, infrastructure decisions made by the ROK during the 1970s and 1980s have failed to reflect the social costs of environmental degradation and GHG emissions resulting from the investments. For example, the bold restoration of the Cheonggye stream in Seoul – which has become the city's most attractive area to locals and tourists – involved demolition of an overpass that had left the stream covered for 40 years. Perhaps, the nation's restricted area and steep landscape have played a positive role in keeping cities compact and optimized available infrastructure. The ROK's experiences emphasize how developing countries have the opportunity to take long-planning horizons and make smarter decisions in urban infrastructure, as opposed to focusing simply on realizing immediate increases in urban infrastructural capacity.

References

EBN News. 2015. "Website of EBN News." Accessed August 28, 2015. http://www.ebn.co.kr/news/view/720952.

Enforcement Decree for the Framework Act on Low-Carbon Green Growth. 2010. Republic of Korea Statutes Presidential Decree No. 25456.

Framework Act on Low-Carbon Green Growth. 2010. Republic of Korea Statutes Act No. 11965.

Gangwon Newspaper. 2015. "Website of Gangwon Newspaper." Accessed August 28, 2015. http://www.gwnews.org/news/articleView.html?idxno=42845.

GGGI (Global Green Growth Institute). 2011. *Green Growth in Motion: Sharing Korea's Experience*. Seoul: GGGI.

GIR (Greenhouse Gas Inventory & Research Center of Korea). 2014. 2014 National Greenhouse Gas Inventory Report. Seoul: GIR. Accessed August 29, 2015. http://www.gir.go.kr/home/board/read.oardCategoryId(%ED%81%B4%EB%A6%AD)2014.

Jang, Jin-Gyu, ed. 2011. *Green Growth*. New Engines of Growth. National Research Council for Economics, Humanities and Social Science, Random House Korea Inc. Seoul, March 2011, ISBN: 978-89-255-4278-2 (93350).

Joint Work of Relevant Ministries. 2012. *The Second Five-Year Plan for Green Growth (2014-2018)*. Accessed April 17, 2015. http://www.greengrowth.go.kr/?page_id=2452.

Kamal-Chaoui, Lamia, Fabio Grazi, Jongwan Joo, and Marissa Plouin. 2011. "The Implementation of the Korean Green Growth Strategy in Urban Areas." OECD Regional Development Working Papers, No. 2011/02, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/5kg8bf4l4lvg-en.

KEEI (Korea Energy Economics Institute) 2007. *Energy Statistics Monthly*. Seoul: Korea Energy Economics Institute.

KEMCO (Korea Energy Management Corporation). 2013. *Energy Statistics Handbook 2013*. Yongin: Korea Energy Management Corporation.

KEMCO (Korea Energy Management Corporation). 2014. *Energy Statistics Handbook 2014*. Yongin: Korea Energy Management Corporation.

Kim, Dae-Wuk, Eung-Ho Jung, and Jae-Gyu Cha. 2013. "Simulation of Changes in Nearby Thermal Environment According to Green Roof in Low-Rise Residential Area of Daegu." *Journal of the Korean Housing Association* 24 (3): 45–53. doi: http://dx.doi.org/10.6107/JKHA.2013.24.3.0.

Kim, Dae-Kyung. 2014. "Jongro-gu creates urban farmland and honors "2014 The Year of Urban Farmland Completion"." *Wikitree*, August 24. http://m.wikitree.co.kr/main/news_view.php?id=155452.

Korea Gas Newspaper. 2014. "Additional 25 billion KRW support for green home program." *Korea Gas Newspaper*, August 24.

Korea Meteorological Administration. 2006. "Data observed from six stations: Seoul, Incheon, Gangneung, Daegu, Mokpo, and Busan." Brochure prepared for the press call, Seoul.

Korea Transportation Safety Authority. 2015. "Website of Korea Transportation Safety Authority." Accessed August 28, 2015. www.ts2020.kr.

Korea Railroad Corp.. 2015. "Website of Korea Railroad Corp.." Accessed August 28, 2015. www.korail.com.

KOSIS (Korean Statistical Information Service). 2014. "Korean Statistical Information Service." Statistics Database, KOSIS, Seoul. Accessed August 25, 2015. http://kosis.kr/.

KOSTAT (Statistics Korea). 2014. "Korean Statistical Information Service." Statistics Database, KOSTAT, Seoul. Accessed August 25, 2015. http://kostat.go.kr/.

KOTI (Korea Transport Institute). 2014. 2013 *National Transport Statistics of Korea*. Ilsan: Korea Transport Database Center.

IEA/OECD (International Energy Agency/Organization for Economic Cooperation and Development). 2008. *World Energy Outlook 2008*. Paris: IEA.

IEA/OECD (International Energy Agency/Organization for Economic Cooperation and Development). 2010. *World Energy Outlook 2010*. Paris: IEA.

Ministry of Land, Infrastructure, and Transport, Ministry of Education, Science and Technology, Ministry of Public Administration and Security, Ministry of Knowledge Economy, Ministry of Environment, and Korea Forest Service. 2009. *Strategies for Green City and Green Building Initiatives*. Accessed August 20, 2015. http://www.korea.kr/common/download.do?tblKey=EDN&fileId=197617.

MLTM (Ministry of Land, Infrastructure, and Transport). 2010. *Implementation Plan for Green Growth*. MLTM, Seoul, January.

MLTM (Ministry of Land, Infrastructure, and Transport). 2013. 2010-2013 *Yearly Statistics*. Seoul: MLTM.

MLTM and MKE (Ministry of Land, Infrastructure, and Transport and Ministry of Knowledge Economy). 2009. *Green Transportation Strategy*.

MoE (Ministry of Environment). 2014. “First Biennial Update Report of the Republic of Korea Under the United Nations Framework Convention on Climate Change.” Greenhouse Gas Inventory & Research Center of Korea, Seoul.

MOLIT (Ministry of Land, Infrastructure, and Transport). 2013. *Building Energy Grade Standard Energy Efficiency Rating Certification Standards*. Accessed August 20, 2015. http://www.law.go.kr/lsInfoP.do?lsiSeq=140422#0000.

MOLIT (Ministry of Land, Infrastructure, and Transport). 2014. *Regulations on Green Building Certification Green Building Certification Resources*. Accessed August 20, 2015. http://www.molit.go.kr/USR/BORD0201/m_34879/DTL.jsp?mode=view&idx=30081.

MOLIT (Ministry of Land, Infrastructure, and Transport). 2015. “Green Building Certification Resources.” Website of the Ministry of Transportation. Accessed August 27, 2015. http://www.molit.go.kr/USR/BORD0201/m_34879/DTL.jsp?mode=view&idx=30081.

MOPAS (Ministry of Public Administration and Security). 2008. *Comprehensive Plan on Bicycle Promotion*.

MOPAS (Ministry of Public Administration and Security). 2012. *Assessment of Bicycle Infrastructure Construction Project*. Final Report, Ministry of Public Administration and Security, Seoul, December.

MOTIE and KEEI (Ministry of Trade, Industry and Energy, and Korea Energy Economics Institute). 2013. *Yearbook of Regional Energy Statistics. Seoul:* Ministry of Trade, Industry and Energy and Korea Energy Economics Institute. Accessed August 23, 2015. http://www.keei.re.kr/keei/download/RES2013.pdf.

MOTIE and KEEI (Ministry of Trade, Industry and Energy, and Korea Energy Economics Institute). 2014. *Yearbook of Regional Energy Statistics*. Seoul: Ministry of Trade, Industry and Energy and Korea Energy Economics Institute. Accessed August 23, 2015. http://211.35.37.147:8088/attachfile/EI0501/RES2014.pdf.

OECD. 2012. OECD *Urban Policy Reviews*, *Korea 2012*, OECD Publishing, Paris.DOI: http://dx.doi.org/10.1787/9789264174153-en.

Park, Jae-Gil and Keun-Hyun Park. 2011. “Urbanization and urban policies in Korea.” *Space and Environment* 45.

PCGG (Presidential Committee on Green Growth). 2009a. *National Strategy for Green Growth (2009-2050)*. Accessed April 17, 2015. http://www.greengrowth.go.kr/?page_id=2450.

PCGG (Presidential Committee on Green Growth). 2009b. *The Five-Year Action Plan for Green Growth (2009-2013)*. Accessed April 17, 2015. http://www.greengrowth.go.kr/?page_id=2452.

PCGG (Presidential Committee for Green Growth). 2013. "Status and Directions for Developing and Fostering Electric Car." Memorandum of the first meeting memorandum of the 4th PCGG, Seoul, October 30.

Prime Minister's Office, Ministry of Strategy and Finance, Ministry of Education, Science and Technology, Ministry of Foreign Affairs, Ministry of Knowledge Economy, Ministry of Environment, Ministry of Land, Infrastructure, and Transport. 2008. *The First National Energy Basic Plan (2008-2030).* Accessed April 17, 2015. http://energyjustice.kr/zbxe/48310.

SMG (Seoul Metropolitan Government). 2015a. "Website of Seoul Metropolitan Government." Accessed August 27, 2015. http://english.seoul.go.kr/.

SMG (Seoul Metropolitan Government). 2015b. "Seoul Policy Archive." Website of Seoul Metropolitan Government. Accessed August 27, 2015. https://seoulsolution.kr.

SMG (Seoul Metropolitan Government). 2015c. "Seoul, ready to share with the world" Website of Seoul Metropolitan Government. Accessed August 27, 2015. http://env.seoul.go.kr/archives/37971.

Transportation News. 2015. "Website of Transportation News." Accessed August 28, 2015. http://www.gyotongn.com/news/articleView.html?idxno=146979.

Vuchic, Vukan R. 2005. "Transport for Livable Cities." CURP Press, Center for Urban Policy Research, Rutgers, The State University of New Jersey, New Bruinswick, NJ, USA.

Wang, K.I. 2009. "A Low-carbon Green City Project in Korea." Proceedings of the United Nations Project Office on Governance Session in the 5th Initiative Conference: Governance Strategies for Pro-environmental Urban Policies in Developing Countries, Jeollabuk-do, July 6.

Global Green Growth Institute

Korea's Green Growth Experience: Process, Outcomes and Lessons Learned

Chapter 8: Conclusion

CHAPTER 8

CONCLUSION

Summary

The ROK's boldness in pursuing green growth, regardless of the outcomes, is already making a significant contribution in advancing green growth as a development paradigm. It has been widely recognized as the only country so far to have operationalized green growth on a national scale by setting ambitious targets and implementing action plans. It has its fair share of criticisms, obviously such as questions regarding the degree of "greenness" of the ROK's green growth model, ambiguity in substance and results, and imbalance between top-down and bottom-up communication. Green growth as a policy approach remains embedded in the ROK's development strategy with the release of the Second Five-Year Plan for Green Growth (2014-2018), which will focus on achieving substantial outcomes in integrating green growth and the creative economy through the convergence of green technology and ICT. Looking to the future, unlocking the short- and long-term economic, social, and environmental benefits of green growth and demonstrating tangible results on the ground remain the critical tests for the ROK's low-carbon green growth model. If this strategy succeeds in reaping positive results at home, it could create strong ripple effects beyond the ROK's borders.

1. Conclusion

An objective assessment of the ROK's green grown regime is crucial in shaping the overall future of green growth, considering the country's remarkable leadership in advancing green growth as a domestic and global agenda. Since the ROK was once a developing country that has achieved a developed status within a single generation, its experience could offer useful lessons for both developing and developed countries. This concluding chapter applies a critical lens to the current status of the ROK's green growth policy. It tackles the key milestones, from the perspectives of:

(1) the advancement of green growth as a national agenda;
(2) its role in building a solid foundation for the nation's climate change mitigation policy;
(3) the potential of green technology to serve as a new growth engine; and
(4) the growing international recognition of the ROK as a green power.

Likewise, this chapter also highlights the significant setbacks along the way such as:

(1) the conceptual limitations of low-carbon green growth;
(2) unsatisfactory achievement to date; and
(3) inadequate bottom-up communication.

It also presents the ROK's medium-term green growth strategy by introducing the Second Five-Year Plan for Green Growth (2014-2018). This chapter concludes by highlighting key takeaways from the ROK's green growth experience and the concomitant challenges going forward.

1.1 Key Milestones

Green Growth as a national agenda – in words and in action

The ROK is the only country by far that adopted green growth as a development strategy on a national scale – backed up by explicit laws, high-level institutions, comprehensive goals, and specific timeframes (both short-term and long-term). A confluence of various factors has made this possible, but the most significant is the strong political will of the Lee Myung-Bak administration to set low-carbon green growth as a national vision that would hopefully endure leadership changes and enable the nation to punch above its weight as a rising "green" power in international affairs. The public declaration of green growth even took place at the historic 60th founding anniversary of the ROK in 2008, when former President Lee expressed his utmost optimism that green growth would continue or even surpass what the ROK has achieved in the past 60 years.

The succeeding developments revealed that the nation's pursuit of green growth does not stop at mere talk. Both the ruling and opposition parties of the National Assembly agreed to pass the Framework Act on Low Carbon Green Growth in 2010, which laid the foundation for the legal and institutional framework for green growth. The key aspects of this landmark legislation are the institutionalization of green growth at the national level and the formation of consultative bodies to stir multi-stakeholder participation. These policy innovations provide a good governance structure and coordination mechanism for green growth planning and implementation.

Adopting green growth as a national agenda is unlikely to succeed without strong public support. To gain public approval, the ROK government highlighted the economic benefits of green growth and the scope for improving the quality of life by reducing GHG emissions (Jones and Yoo, 2012). Moreover, the Framework Act on Low Carbon, Green Growth has specific provisions (Articles 58 and 59) for intensive public awareness campaigns and education for the "practice of green life."[1] In a survey conducted by Hankook Research (with 95% confidence level and sampling error of 3.1%), majority or 96.7% of 1,000 adult Koreans agreed that the next government should continue green growth as one of its key policy priorities. In another national survey in 2013, up to 97% of Koreans agreed that the green growth policy should be promoted again by the next government, and 84% responded that it has helped in resolving climate change and the energy crisis (Kang, 2012).

The ROK's shift toward a proactive governance that directly tackles climate change has resulted in an ideational transition that helps counter the criticisms. It also marked a period where green growth has become an inviolable political ideology and where low-carbon and clean energy schemes have become widely accepted as "appropriate policy," even "best practice." Green growth builds upon the alarming public concern over climate change impacts that have become evident since the early 1990s. The urgency of climate change response has greatly assisted the ROK government in mobilizing widespread support across Korean society for more ambitious policies (Lee, 2013b).

Solid foundation created for GHG emissions reduction and climate change response

One of the main objectives of the ROK's green growth policy is to mitigate climate change. It anticipates a post-Kyoto Protocol order where the nation will be classified as a developed country bearing mandatory obligations on emissions reduction. In 2009, the government announced its national target of reducing its GHG emissions by 30% below BAU levels by 2020. Although the National GHG Inventory Reports noted that the country's recent emission reduction efforts have been insufficient in meeting the annual targets, the MoE announced the new National Roadmap for Reduction of GHG Emissions in early 2014, which continues to uphold the ultimate target of a 30% cut in emissions by 2020. It maintains the same BAU projection and reduction measures for seven priority sectors of the economy as strategically set by the government in 2011.

To enforce its climate mitigation policy, the ROK became the first Asian country to pass a law on emissions trading scheme (ETS) effective 2015 despite strong opposition from the industrial sector over the policy's implications on the international competitiveness of the ROK's industries. The highly debated ETS bill passed in May 2012 was able to win an almost unanimous approval of the national assembly as it was well justified for its intention

1 | Article 58 (Facilitation of Green Life Campaigns) Section 2 states that the government may provide relevant organizations with financial and administrative support to conduct green life campaigns as voluntary action movements driven by the private sector. Article 59 (Education and Public Relations Activities for Practice of Green Life) calls for expanding education and public relations activities for low-carbon green growth involving the schools and media organizations.

of greening the nation's fossil-fuel dependent industries and fostering green technology innovation (Yoo, 2012). While some countries veer away from setting emissions caps and reduction targets because it is politically unpopular and involves painful trade-offs, the ROK's ambitious target supported by its bold ratification of the ETS bill has been deemed impressive for a non-Annex 1 country. Given this bold move, the country is better positioned in future climate negotiations to set the bar high on emissions reduction for other countries and influence them to redirect their development efforts along a low-carbon green pathway.

Tapping new growth engines through green technology

Green growth makes economic sense for the ROK through the diffusion of green technology given its promising market potential. The nation has succeeded in the past in gaining a competitive advantage in key industries such as shipbuilding, steel, electronics, and ICT following the principle of selection and concentration. The new administration recognizes the fact that given the small domestic market, aging workforce, and increasing competition with emerging economies, notably China, the ROK has to find its new niche in the global marketplace. In this regard, the green industry is deemed to be one of the strategic entry points in the context of climate change response and tightening environmental regulations in international trade. Technological innovation is the pivot for turning the conflicting relationship between economic growth and environmental sustainability into a mutually beneficial one. Under the succeeding administration's signature vision (President Park Geun-Hye), the "creative economy," the green industry has a key role to play in achieving such vision by unleashing potential growth nodes.

Through intensive R&D efforts, the PCGG reported that the ROK has narrowed the technological gap in green technology vis-à-vis the global leaders from 48.7% in 2009 to 22.2% in 2011. Although not all technological breakthroughs have fully translated into growth in employment, productivity, and export activity, there have been positive signals indicating potentials for greater success in the future.

Some of the key examples of the nation's growing industries include secondary cells, LEDs, intelligent transportation systems, and renewable energy systems.

Growing international recognition of the ROK as a green power

What makes the ROK's experience an interesting case study for green growth is that the country not only promotes green growth at home, but also banks on its status as a rising middle power to disseminate green growth as a new development paradigm for developing countries. The continuity of green growth policy in the ROK is also attributed to the essential role of green growth in uplifting the nation's reputation as a rising middle power on the global stage.

The ROK's "me first" or "first mover" diplomacy and leadership in domestic climate policy initiatives have been well received internationally, and has empowered the nation to play a bridging role to help break long-standing stalemates in climate negotiations. For instance, the ROK acted as an effective mediator in the COP16 in Cancun as it was able to converge the interests of both developed and developing countries in taking positive action on its low-carbon development strategy (Ikenberry and Mo, 2013).[2] The nation also stands out as a green policy entrepreneur in other countries through its foreign aid system as it aims to expand the green component of its official development assistance (ODA) from 11% of the total ODA to 30% by 2020. For instance, the ROK mobilized US$ 200 million for the East Asia Climate Partnership (EACP) to help Asian countries address climate change and pursue green growth. Moreover, the nation has led discussions on green growth during the G-20 Summit in 2010 and other high-level meetings. The government also pursues a dynamic South-South sharing and spreading of green growth strategies to the developing world by building the "green-triangle"[3] – the Global Green Growth Institute (GGGI), Green Technology Center (GTC), and the Green Climate Fund (GCF) – which are key organizations (either established and/or hosted by the ROK) playing a catalytic role in advancing green growth internationally.

2 | The Cancun Agreement articulated that "a low-carbon development strategy is indispensable to sustainable development" (para 6) and that "addressing climate change requires a paradigm shift toward building a low-carbon society that offers substantial opportunities and ensures continued growth and sustainable development" (para 10).

In light of these efforts, the country has indeed elevated its international standing by assuming more active roles in regional and global affairs through "green diplomacy" (Hwang, 2010). The ROK has invested so much to gain an international reputation of being a trailblazer in green growth, playing a vital role in bridging developed and developing countries in addressing climate change and providing efficient policy directions that could help them achieve green growth on a grander scale (Kang et al., 2010). While many developing countries look up to the ROK's achievement as a great national accomplishment, and even attempt to embrace the nation's growth model to replicate its economic miracle, the developed countries also hope to derive useful lessons from the ROK if it succeeds in making an impact through green growth.

1.2 Key Limitations

Limits in the concept of low-carbon green growth

From a conceptual standpoint, the degree of "greenness" of the ROK's green growth model remains debatable. It has been criticized for focusing too much on "growth" while overlooking the "green" aspects. In other words, there is a continued preference for market-driven growth that prioritizes the economy over the environment.

The "green" aspects of the ROK's low-carbon green growth model have primarily focused on reducing GHG emissions, which is intrinsically interlinked to the nation's economic and environmental challenges. The mutual benefits in lowering emissions are significant; it can help improve economic competitiveness, minimize environmental impacts, and enhance human well-being. However, emission cuts do not spontaneously create such added value. As a matter of fact, a low-carbon transition can even precipitate environmental degradation and entrench unpredicted social inequalities if it is not appropriately targeted at specific groups and meticulously implemented. It is in this context that the ROK's Five-Year Plan for Green Growth reveals gaps in addressing environmental and social needs. A large portion of the priority agenda items (and their performance indicators) for realizing green growth have been anchored on issues concerning energy intensity, deploying low-carbon goods and services, enhancing the technological levels, and boosting export volumes. The target of the Five-Year Plan to place the nation among the top-30 countries in the Environmental Performance Index (EPI)[4] for 2013, was set under the agenda item titled "becoming a role model for the international community as a green growth leader" (an item intentionally omitted for detailed assessment in this report) without specifying the concrete action plans for meeting this goal.

Even with the nation's huge efforts to reorient its development toward a greener pathway, improving the country's long-term environmental performance remains a long shot as the ROK ranked only 43rd out of 178 countries in the EPI 2014. In addition, social equity concerns were not fully considered in the green growth equation given the definition[5] of green growth (under the Framework Act on Low Carbon Green Growth) that only mentions the economy-environment nexus. Rendering inadequate attention to the social dimension of green growth could be attributed to how incredibly fast green growth has been elevated as a national agenda to the extent of bypassing social equity considerations. Due to mounting international pressure to reduce emissions and the nation's urgent need for energy security, the development of the enabling systems and policies for green growth was done very fast, leaving little room for matters related to social welfare, gender equality, poverty reduction, and growing income disparity. If green growth is deemed as a tool to achieve sustainable development, it has to strike a balance among the three pillars – economic, environmental, and social – to make it more holistic and responsive to social problems that are also linked to economic and environmental issues.

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3 | The ROK envisioned combining the elements of strategy, finance, and technology in pursuing green growth to form the so-called "green-triangle." In this regard, the government initiated the establishment of GGGI in 2010 (green growth strategy), hosted the secretariat of the GCF in 2012 (green finance), and created the GTC in 2012 (green technology). The ROK's financial contribution to these institutions seeks to create a positive synergy that helps catalyze the diffusion of green growth as a new development model for developing countries.

4 | The EPI is an index that "ranks how well countries perform on high-priority environmental issues in two broad policy areas: protection of human health from environmental harm and protection of ecosystems."

5 | Article 2 defines "green growth" as "growth achieved by saving and using energy and resources efficiently to reduce climate change and damage to the environment, securing new growth engines through research and development of green technology, creating new job opportunities, and achieving harmony between the economy and environment."

Table 1: Summary of outcomes under the 6 policy directions of the First Five-Year Plan for Green Growth examined in this report

Category	2011
Low Carbon Society Effective reduction of GHG emissions	• Setting of national GHG reduction target equivalent to 30% from BAU levels by the year 2020, which is the most ambitious target based on levels recommended by the IPCC for developing countries • Establishment of the Greenhouse Gas Inventory and Research Center (GIR) to operate as the information hub of national emissions that supports the setting of national GHG reduction targets and implementation of nationwide mitigation programs • Launch of the Korea Emissions Trading Scheme (K-ETS) in January 2015, which marked a stage of full-fledged mitigation actions based on market-driven mechanisms, despite the strong opposition of industries
Energy Efficiency and Renewable Energy Reduction of the use of fossil fuels and enhancement of energy self-sufficiency	• Introduction of a new overarching national energy masterplan (First National Basic Energy Plan) to help the existing policy framework to redirect and coherently align to the targets of reducing GHG emissions, moving away from supply-side to demand-side management practices, and supporting development and deployment of renewable energy technologies • Launch of the Renewable Portfolio Standard (RPS) in 2013 to replace the existing Feed-In Tariff (FIT) scheme, which places a stringent mandate on national power producers to meet targets for a proportion of their energy to come from renewables
Green Technology Innovation Development of green technologies for creation of new growth engines	• Success in narrowing the technological gap vis-à-vis its global counterparts by adopting the formula of "selection and concentration" – identifying 27 key green technology areas of focus based on nationwide assessment of innovation potentials – and boosting related public R&D investments • Secondary cells and LED goods, which have been strongly backed by government incentives for innovation and domestic market growth, have become the nation's leading export items with increasing dominance in the global market; other technology items such as energy storage systems, renewable energy systems and electric vehicles have made positive progress to become globally competitive
Green Lifestyle Green life revolution	• Increased public awareness and participation across all sectors of the community in reducing GHG emissions, through successful launch of the nationwide movement for low-carbon green growth (the Green Start Movement) and establishment of Local Green Growth Committees with the given roles of preparing and implementing green growth plans at the grassroots level • A wide range of government-led initiatives such as green procurement, carbon labeling, green education, and pay-as-you-throw waste management programs have entered a stage of maturity, serving a bottom-up momentum to pursue green life practices
Green Homeland and Transportation Creation of green homeland and transportation	• A multiple number of "pilot projects" for greening of city operations and urban regeneration carried out by ministries and local governments have helped limit growth in urban energy consumption with respect to their growth in GRDP during 2009-2013. The total area of urban forest increased by 10.6% from 34,800 to 38,500 ha between 2009 and 2013 • Share of public transportation system has continued its growth to reach 45.3% by 2012, although such achievement is well below the government target of 53% by 2012. The number of bus passenger trips in metropolitan cities has increased remarkably after the introduction of quasi-public bus system in 2004 and improvements in services and facilities • Adoption of strengthened building codes and increased participation in energy-efficiency building certifications have helped prevent further growth in GHG emissions from the building sector, which made up for 8.77% of the nation's total emissions in 2012 as opposed to 10.83% in 2008
Green Industries Greening of traditionally supported industries and nurturing green industries	• The total revenue of green industries – which includes sales of equipment, resources, facilities, and services that reduce emissions – have continued to increase to cover 1.44% of the nation's total industrial turnover by 2013 from 0.96% in 2009 • Key industries such as steel, petrochemical, oil refining, semiconductor, and display actively pursued strategies to cut down on GHG emissions on a company-wide level, through measures such as enhancing energy efficiency and production process, and expanding the use of waste resources like waste energy. • However, continued rise in energy consumption (and stagnating energy intensities) of the industrial sector still remains as the nation's major obstacle to low-carbon growth; industrial growth propelled the ROK's economic recovery from the 2008 financial crisis but impeded the achievement of energy-efficiency targets

Source: GIR, 2014

Lack of actual accomplishment

The real test for green growth's endurance and sustainability as a development policy is whether or not it can deliver its promised benefits. However, it is still premature to comprehensively assess the outcomes of the ROK's green growth efforts but the progress to date has been criticized for its vague substance and weak results. In the first place, the vision set by the Lee administration for the ROK to become the world's leading "green power" (to rank seventh by 2020 and fifth by 2050) remains ambiguous as it was not formally defined by concrete baseline and measurements. Even the PCGG recognized the criticism that the nation's green growth policy has not been guided by appropriate metrics and indicators to come up with measureable progress (Yang, 2013).

Moreover, reducing GHG emissions and enhancing energy security have not yet produced promising results thus far. Imported fossil fuel remains the lifeblood of the ROK's economy and energy consumption has increased continuously as more industrial facilities were added to weather the global financial crisis in 2008. This was exacerbated by regular sharp increases in energy consumption due to extreme weather events. The government's plan of decoupling the GHG emissions with economic growth in 2014 did not materialize. It cannot be denied that, in the case of the ROK, energy consumption and GHG emissions are still directly proportional to economic growth. Considering the fact that one of the major objectives of the nation's green growth strategy is to achieve energy efficiency and reduce GHG emissions, the recent progress has not been impressive.

As long as the nation's industrial structure remains concentrated on manufacturing, bringing about fundamental changes in the patterns of energy consumption remains a big challenge. The country recovered from the financial crunch in 2008 by reviving its industrial exports (mainly with China providing a huge domestic market for Korean products) and taking advantage of favorable exchange rates. Accordingly, it is difficult to curb energy consumption and improve energy efficiency without reforming the energy price structure. The ROK's energy pricing policy tends to focus on macroeconomic objectives, specifically price stabilization and boosting the manufacturing sector's international competitiveness (Jhung and Park, 2010). From 2002 to 2010, electricity consumption rose by 56% while power utility bills only increased by 15%. This sudden surge in energy consumption has caused power shortages and could threaten national energy security. The subsidy to keep electricity prices low is harming the environment as it encourages more power consumption and higher GHG emissions and also tolerates high energy intensity in the industrial sector (Jones and Yoo, 2012).

Given the persistent rise in energy consumption, the only way to reduce GHG emissions is to increase the supply of renewable energy and to develop innovative technologies to support it. However, in the pursuit of doing so, the central government was unable to come up with effective incentives for local governments to harness renewable energy due to lack of social buy-in. Deployment plans for wind and tidal power generation were delayed after facing opposition from the local residents due to concerns over compensation for damage and fishery rights and heated debates on ecological depletion. Although the nation has succeeded in narrowing the technological gap on renewable energy with developed countries, it has not yet created a stable market for renewable energy facilities and the current pace of market penetration is not meeting expectations.

Developing the technology for GHG emission reduction requires time and its current level of commercialization is in the slow lane such as in the case of deploying green cars and carbon capture storage (CCS). The ROK's GHG emissions reduction target reveals its lack of practicality as it does not only lack accurate evaluation of technical standards but also a thorough analysis of the timeframe for commercialization. Such experience stressed the importance of creating a reduction plan of absolute energy use in the first place, before relying on the technology per se. The government has shown that the nation is eager to be seen as a leader in the development of climate policies, so it has taken on a strong target to justify its efforts. Nonetheless, being unable to produce solid results from such efforts reflects the still mediocre performance of the government's green growth policy.

Weak bottom-up communication

The ROK's traditional top-down planning approach has served the country well in the past and has also been instrumental in advancing green growth as a national agenda. However, since green growth requires a fundamental shift of mindset and lifestyle, it requires a solid bottom-up communication, especially at the grassroots level to effectively influence people's behavior and habits. While the overall public sentiment is in favor of green growth, as revealed in surveys, many of the promotional programs on GHG reduction, energy efficiency, green transportation, and the like have struggled to induce stakeholder participation on a full scale due to weak marketing strategies (largely because it is not well tailored for specific target groups), inadequate incentive mechanisms, and poor sharing of information especially at the early stage of policy formulation.

Strengthening bottom-up communication is a challenging reform needed in the ROK's governance system given its successful post-war history of rapid economic growth built on top-down central planning. However, as the nation begins to mature as a democratic country, its people will inevitably demand more sincerity from government in terms of reaching out to the public, conducting bottom-up consultation, and achieving a consensus especially on policies that will have far-reaching implications on the majority.

In most cases, information, education, and communication campaigns only take place when the policy has already been designed or is in the process of being implemented. The ROK government's strategy of seeking quick solutions (based on the nation's *ppali ppali*[6] culture) to the extent that public consultation is compromised may have worked well during the post-war period, but not for today's modern democratic Korean society. Thus, there is a stronger call to build a truly meaningful governance system characterized by active exchanges of opinions and coordination of policy directions in the earlier stages of development planning.

1.3 The New Five-Year Plan for Green Growth (2014-2018)

While the grand take-off of green growth in the ROK as a new development strategy was indeed noteworthy, its endurance as a long-term policy remains to be tested under changing political leadership. In support of the new administration's launch of "creative economy" as the signature advocacy, "green growth" as a policy approach is still embedded in the nation's development strategy with the release of the Second Five-Year Plan for Green Growth (2014-2018). The deputy minister for economic affairs of MOFA noted that the creative economy touted by President Park encompasses green growth, especially in creating innovative business opportunities and jobs as part of global efforts for sustainable development and emission reduction (Kim, 2013). It should be noted that the

Figure 1: Comparison of the first and second plans for green growth

Source: PCGG, 2014

6 | "Ppali ppali" is a common Korean expression meaning "hurry up." Doing things fast has become part of the daily culture in Korea as seen in many aspects of government and business, particularly in the services sector.

First Five-Year Plan (2009-2013) was designed to establish the necessary institutional framework that would launch and sustain green growth policies in the future; it was not intended to complete the nation's transition to green growth considering the long-term timeframe required to address the issues of climate change and energy security. Drawing on the lessons and limitations in the course of implementing the first plan, the second plan aims to focus on the following areas:

(1) establishing a low-carbon socioeconomic structure;

(2) achieving a creative economy through the convergence of green technology and ICT; and

(3) building a pleasant living environment safe from the harms of climate change.

The preparation of the Second Five-Year Plan involved six expert meetings and two discussion meetings with the relevant government agencies for the drafting of the strategy. The external experts gathered to evaluate the First Five-Year Plan followed by the formulation of detailed tasks for each government department. After PCGG's final review of the draft, the plan was completed on May 21, 2014. The second plan is intended to deliver more concrete results, particularly in the strategic promotion of core areas such as system building for the sustainable energy system, capacity building on climate change response, and reduction of GHGs.

1.4 Takeaways and Recommendations

The ROK is a rare example of green growth strategy being developed and implemented on a national scale as the government's central agenda. In terms of persuasive force, nothing is as powerful and inspiring as the first mover who paves the way forward. The fact that the nation rose to be a high-income country from a GDP per capita of US$ 155 in 1960 further adds to its relevance. In addition to the matter of political leadership, developing countries could benefit from learning how the ROK has approached the green growth agenda, as well as the institutional process through which all downstream strategies, plans, and projects were developed and implemented. The ROK's green growth strategy was a strictly top-down affair and given the reality of most developing countries, it could serve as a useful model in the planning and execution of their respective strategies.

Figure 2: Basic structure of the second plan

Vision :	Realization of People's Happiness through the Harmonious Development between Economy and Environment				
3 Strategies	Establishing a Low-carbon Socioeconomic Infrastructure		Achieving a Creative Economy through the Convergence of Green Technology and ICT	Building a Pleasant Living Environment Safe from the Harms of Climate Change	
5 Directions	Effective GHG Reduction	Establishing a Sustainable Energy System	Forming an Ecosystem for Green, Creative Industries	Realizing a Sustainable Green Society	Strengthening Global Green Cooperation
20 Core Tasks	Systematic implementation of GHG reduction roadmap	Reinforcing energy demand management	Developing cutting-edge green technology	Strengthening the capacity for climate change adaptation	Effectively responding to climate talks
	Establishing the ETS and vitalizing the carbon market	Increasing the supply of new and renewable energy	Fostering green, creative industries	Enlarging the basis for eco-friendly living environment	Extending regional cooperation in green growtl and its global spread
	Setting a long-term national reduction target	Building a dispersion type generation system	Setting an economic structure for resource circulation	Forming green space in the national territory	Enhancing cooperation wit developing countries and internal stability
	Expanding carbon sinks	Securing the safety of energy facilities	Rationalizing regulation and cultivating green talent	Expanding the bases for green welfare and governance	Reinforcing cooperation with and support of GGGI and GCF

Source: PCGG, 2014

The nation's experience offers the following lessons for developing countries:

(1) it shows that green growth can be adopted as the government's central agenda in a democratic country;

(2) its strategy demonstrates the need for a judicious balance between national and global interests; and

(3) it underscores the importance of a top-down approach and the benefits of a strong political momentum.

Amid the share of praises and criticisms, much of the value of the ROK's experience to the global community stems not from its success or failure, but in its attempt for a nationwide transition, notwithstanding the risk of public backlash. The fact that the nation was one of the first to foray into such an uncharted territory, while some of the world's major economies were hesitant to act, is in itself a significant contribution in the quest for green growth.

As the ROK continues to promote green growth as a strategic facet of its foreign policy, it has to overcome significant challenges. First, governments of developing countries are reluctant to commit their limited resources to policy experimentation on a national scale. History has shown that growth alone is hard to realize; hence, green growth is perceived as an additional layer of complexity on what is already a difficult endeavor. For low-income countries lacking in capacity, green growth may also imply increased reliance on developed countries for technical assistance, financing, and technology transfer, with correspondingly diminished control over their path toward economic development. Second, the lack of government leadership has a negative impact on the private sector. Firms require a stable business environment to make long-term investment decisions. A clear indication from the government on its future policies is necessary to provide this certainty. Non-existent or halfway measures, on the other hand, signal continuance of the status quo and result in technological lock-in that is costly to rectify.

Indeed, the challenges at home for the ROK to pursue green growth as a development policy are as daunting as its challenges abroad. Changing the way how countries view economic prosperity through a green growth lens is no easy task and making green growth responsive to a country's unique needs is likewise a complicated mission considering how countries differ in their stages of development, natural resource endowment, political structure, institutional capacity, and development priorities. In working with developing countries, the ROK has to conform to the principle that unless green growth can contribute to poverty reduction and socioeconomic progress in the near to medium term, it will be a hard sell in developing countries (OECD, 2011). Furthermore, diffusing green growth abroad will falter if it fails to embrace country ownership. It can only be well integrated and mainstreamed in the national planning processes if it is demand-driven and led by the countries because, green growth, after all, should enable – and not dictate – development.

In the bigger picture, green growth has reinvigorated the sustainable development agenda and contributed to boosting optimism and activism in tapping new sources of growth by explicitly stressing "growth out of green" (Park, 2013). One of the findings of the first Green Growth Best Practice (GGBP) report is that "green growth can unlock substantial economic, social, and environmental benefits, both short-term and long-term" through resource efficiency, support for green technology and business innovation, and investments on risk mitigation to facilitate the transition to green development (GGBP, 2014). To consistently trickle down such benefits to the grassroots will be the critical test for green growth going forward and with this challenge in mind, all eyes are on the ROK.

References

Burton, Jones. 2013. "What Happened to Green Growth?" *The Korea Times*, July 17. Accessed May 17, 2015. http://www.koreatimes.co.kr/www/news/opinon/2013/07/197_139423.html.

Enforcement Decree for the Framework Act on Low-Carbon Green Growth. 2010. Republic of Korea Statutes Presidential Decree No. 25456.

Framework Act on Low-Carbon Green Growth. 2010. Republic of Korea Statutes Act No. 11965.

GGBP (Green Growth Best Practice). 2014. *Green Growth in Practice: Lessons from Country Experiences.*

Hwang, Jang-jin. 2010. "Lee Launches Green Diplomacy in Australia." *The Korea Herald*, March 30. Accessed May 17, 2015. http://www.koreaherald.com/common_prog/newsprint.php?ud=20090305000020&dt=2.

Ikenberry, G. John, and Jongryn Mo. 2013. *The Rise of Korean Leadership: Emerging Powers and Liberal International Order.* New York: Palgrave Macmillan.

Jhung, Han-kyung, and Kwang-soo Park. 2010. "A Study of Market-Friendly Energy Price Systems." Korea Energy Economics Institute 10-25, Korea Energy Economics Institute, Seoul.

Jones, Randall S., and Byung-seo Yoo. 2012. "Achieving the "Low Carbon, Green Growth" Vision in Korea." *OECD Economics Department Working Papers*, No. 964, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/5k97gkdc52jl-en.

Joint Work of Relevant Ministries. 2012. *The Second Five-Year Plan for Green Growth (2014-2018).* Accessed April 17, 2015. http://www.greengrowth.go.kr/?page_id=2452.

Kang, Sung-jin, Tae-yong Jung, Jae-eun Ahn, So-young Lim, Yul Kwon, Jione Jung, and Chang-gil Kim. 2010. "Green Growth: Global Cooperation." NRCS Green Growth Research 10-02-04(2), National Research Council for Economics, Humanities and Social Sciences, Seoul.

Kang, Hyun-kyung. 2012. "Cheong Wa Dae Sells Green Growth Legacy - Review of Hankook Research." *The Korea Times*, January 23. Accessed May 17, 2015. http://www.koreatimes.co.kr/www/news/nation/2012/01/113_103522.html.

Kim, Sarah. 2013. "Commitment to Green Growth Reaps Rewards." *Korea Joong-Ang Daily*, June 5. Accessed May 17, 2015. http://koreajoongangdaily.joins.com/news/article/article.aspx?aid=2972621.

Kim, Sung-young, and Elizabeth Thurbon. 2014. "Green Growth: Rebooted in South Korea, Booted out in Australia." *The Conversation*, February 7. Accessed May 17, 2015. http://theconversation.com/green growth-rebooted-in-south-korea-booted-out-in-australia-22243.

Lee, Ho-jeong. 2013a. "Where has the Green Growth Gone?" *Korea Joong-Ang Daily*, June 27. Accessed May 17, 2015. http://koreajoongangdaily.joins.com/news/article/article.aspx?aid=2973696.

Lee, Jae-seung. 2013b. "Low-Carbon Green Growth and South Korea's Governance of Climate Change" In *Climate Governance in the Developing World*, edited by David Held, Charles Roger, and Eva-Maria Nag. London: Polity Press.

Lee, Soon-hyun. 2013c. "Park's "Creative Economy" Just Repackaged so-called "Green" Projects." *The Hankyoreh*, November 28.

OECD. 2011. "Green Growth and Developing Countries: A Summary for Policy Makers." Brochure prepared for the OECD Meeting of the Council at Ministerial Level, Paris, May 25-26.

Olbrich, Philipp, and David Shim. 2012. "South Korea's Quest for Global Influence." *Global Asia* 7 (3): 100-107.

Park, Jeong-won. 2013. "The Evolution of Green Growth Policy: An Unwelcome Intrusion on Global Environmental Governance?" *East Asian Economic Integration* 17 (2):207-241.

PCGG (Presidential Committee on Green Growth). 2009a. *National Strategy for Green Growth (2009-2050)*. Accessed April 17, 2015. http://www.greengrowth.go.kr/?page_id=2450.

PCGG (Presidential Committee on Green Growth). 2009b. *The Five-Year Action Plan for Green Growth (2009-2013)*. Accessed April 17, 2015. http://www.greengrowth.go.kr/?page_id=2452.

PCGG (Presidential Committee on Green Growth). 2014. "Green Growth Korea, Now and the Future." PCGG Brochure, Presidential Committee on Green Growth, Seoul.

Prime Minister's Office, Ministry of Strategy and Finance, Ministry of Education, Science and Technology, Ministry of Foreign Affairs, Ministry of Knowledge Economy, Ministry of Environment, Ministry of Land, Infrastructure, and Transport. 2008. *The First National Energy Basic Plan (2008-2030)*. Accessed April 17. http://energyjustice.kr/zbxe/48310.

Shim, David. 2010. "Green Growth: South Korea's Panacea?" *In Korea 2010: Politics, Economy and Society*, edited by Rüdiger Fran, Jim Hoare, Patrick Köllner, and Susan Pares, 165-187. Leiden: Brill.

Shin, Hyon-hee. 2013a. "South Korea Ditching "Green Growth"." *The Korea Herald*, March 30. Accessed May 17, 2015. https://my.news.yahoo.com/south-korea-ditching-green growth-074004352.html.

Shin, Hyon-hee. 2013b. "Korea Eyes Era of "Green Growth 2.0"." *The Korea Herald*, November 11. Accessed May 17, 2015. http://www.koreaherald.com/view.php?ud=20131110000342.

Yoo, Chang-min. 2012. "South Korea Steams Ahead." PwC Carbon Finance Online, Samil PricewaterohouseCoopers, Seoul.

Yonhap News. 2013. "South Korea to Promote Green Growth via "Creative Economy" Vision: PM." *Global Post*, October 21. Accessed July 27, 2015. http://www.globalpost.com/dispatch/news/yonhap-news-agency/131021/s-korea-promote-green-growth-creative-economy-vision-pm.

Yang, Soo-gil. 2013. "Korea's Green Growth: Looking Back, Looking Forward." Paper presented at the Global Green Growth Summit, Songdo, Incheon City, June 10-11.

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Based in Seoul, GGGI is an intergovernmental organization founded to support and promote a new model of economic growth known as "green growth." The organization partners with countries to help them build economies that grow strongly and are more efficient and sustainable in the use of natural resources, less carbon intensive, and more resilient to climate change. GGGI's experts are already working with governments around the world, building their capacity and working collaboratively on green growth policies that can impact the lives of millions.

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