MAKING THE MOST OF THE G8+5 CLIMATE CHANGE PROCESS

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ACCELERATING STRUCTURAL CHANGE AND TECHNOLOGY DIFFUSION ON A GLOBAL SCALE

CEPS TASK FORCE REPORT

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This report is based on discussions in the CEPS Task Force on "EU Climate Change Strategy and the Gleneagles Plan of Action: The G8+5 Climate Change Dialogue". The Task Force met several times over a concentrated period from November 2006 to September 2007. Participants in this CEPS Task Force included senior executives from a broad range of industries – including energy production and supply companies, energy-intensive industries and service companies – and representatives from business associations and non-governmental environmental organisations. A list of members and invited guests and speakers appears in Appendix 5.

The members of the Task Force engaged in extensive debates in the course of several meetings and submitted comments on earlier drafts of this report. Its contents contain the general tone and direction of the discussion, but its recommendations do not necessarily reflect a full common position agreed by all members of the Task Force, nor do they necessarily represent the views of the institutions to which the members belong.

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PREFACE

Tackling climate change poses one of the world's greatest challenges. The growing need for energy from fossil fuels, amongst other activities, contributes to the increases in greenhouse gases (GHGs) associated with climate change. This will require fundamental changes in the way we produce and consume energy. In this CEPS Task Force, which has been my pleasure to chair, we discussed and finally identified a list of concrete measures that have the potential both to reduce greenhouse gas (GHG) emissions and stimulate long-term structural change and technology development and diffusion. Structural change calls for an action-based approach and supporting measures to achieve the necessary reductions. I believe that such action-based approaches can help integrate targets and timetables, as they are agreed, with consistent and comparable policies and measures. Such integration will facilitate a robust global climate change agreement, which we all hope will be struck in Copenhagen in late 2009.

The CEPS Task Force has brought together representatives from different stakeholders that included senior executives from a broad range of industries – including energy production and supply companies, energy-intensive industries and service companies – and representatives from business associations and non-governmental environmental organisations. The members of the Task Force engaged in extensive debates in the course of several meetings. During the meetings, they also had ample opportunity to discuss these issues with officials from the EU institutions, member states and international organisations.

I want to thank the members of the Task Force for their active and positive contributions throughout the meetings. Although each member endorses the general content of the report, one should not conclude that all members subscribe to every sentence of the text. I would also like to thank Noriko Fujiwara from CEPS who, in collaboration with Christian Egenhofer, has been leading the effort to draft this report.

Gunnar Still
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EXECUTIVE SUMMARY

Climate change has become a major topic of the G8 meetings since the launch of the Gleneagles Dialogue on Climate Change, Clean Energy and Sustainable Development in 2005. This initiative has sought to explore new approaches to international cooperation on clean energy technologies between developed and emerging economies. At the 2007 UN conference on climate change in Bali, a formal process was launched to address countries' commitments in the so-called 'post-2012 period' after the first commitment period of the Kyoto Protocol, aiming to meet the objective of UNFCCC itself to avoid 'dangerous climate change'. In the EU, the EU heads of state and government have agreed on the need for a comprehensive package of responses to energy needs and climate change, welcoming the Commission's proposal. Moreover, a new strategy for EU industrial policy intends to create incentives to unlock the full potential of low carbon and resource-efficient goods, technologies and services in the EU in order to make Europe a 'forerunner' in these markets.

Against this background, this report identifies a number of concrete measures that could reduce greenhouse gas (GHG) emissions, while at the same time stimulating structural change and technology development and diffusion. The report calls for supporting action-based approaches, which are essential to achieve the necessary reductions in GHG emissions, inform the post-2012 negotiations and address the most urgent issues such as surging energy demand and the need for clean energy technologies in emerging economies. An action-based approach can be regarded as a way of integrating targets and timetables, as they are agreed, with consistent and comparable policies and measures. With a view to a long-term climate strategy, this report attempts to present a portfolio of actions that can be implemented and accelerated on a global scale – especially in the G8+5 countries and the EU, and could become a basis on which these developed and developing countries can cooperate.

I. Key messages

Merits of action-based approaches

1) There seems to be an emerging consensus on a push for policies to accelerate structural change and transition towards a low carbon economy, no matter how the post-2012 discussions develop. This trend can be facilitated by putting stronger emphasis on action-based approaches, closer cooperation between governments and stakeholders, and research into the scope for sector-specific mitigation options as witnessed in the implementation of the Gleneagles Plan of Action. Action-based approaches play an important role in achieving the emission reduction targets of the Kyoto Protocol and in putting into place the infrastructure, technologies and experience that will help to stimulate the further decarbonisation of development in the post-2012 period. Action-based approaches could also influence discussions on the post-2012 agreement in terms of direction, speed and depth by encouraging the sharing of data and knowledge, by facilitating the comparability of actions and by improving transparency. At the same time, such approaches could gain more support if guided by the level of ambition (e.g. a call for developed countries to reduce GHG emissions by 60–80% by 2050 from 1990 levels (European Council, 2007)).

2) Countries are more likely to undertake actions and reduce emissions if their efforts are acknowledged. A common yardstick would enable assessment of the progress made through domestic measures, e.g. in terms of reductions against business-as-usual levels or in costs. Such an instrument could also increase trust in the international negotiations. Ultimately, a yardstick could develop into a benchmark against which the performance of countries could be measured and thus become part of a compliance mechanism in a future climate-change regime.

Carbon pricing and its limits

3) Action-based approaches that put a constraint on emissions will also ensure that the value of carbon is increasingly reflected in prices. This move will in turn enhance the efficiency of the market by providing

incentives for consumers and businesses to save energy, improve efficiency and use less carbon-intensive energy sources. At the same time, it will encourage businesses to invest in low-carbon technologies or may trigger the establishment of new services such as energy service companies. The more visible and universal price signals are, the more robust these incentives should be. A precondition is that the carbon intensity of products and services is correctly reflected in the decisions of market participants. Still, although carbon pricing is necessary, it is not enough on its own. Market failures that justify intervention are typically associated with i) technology development, demonstration and deployment; ii) energy efficiency in the domestic sector; and iii) changes in consumer behaviour. Governments can learn from best practices. It must be also kept in mind that climate change objectives need to be balanced against other environmental, economic and public policy objectives in order to foster sustainable development.

The untapped potential in emerging economies

4) Experience suggests that primary energy use in developing countries can be cut by 30-50% because the cost of energy savings is negligible compared with the cost of increasing energy supply. While energy intensity started declining mostly as a result of structural changes in emerging economies (and to an extent in economies in transition), much of the technical potential across the supply, transmission and use of energy is still to be tapped. Even so, major challenges remain. Without changes in policy frameworks and appropriate instruments to facilitate investment in new technologies, emerging economies are likely to follow a carbon-intensive development path. In most emerging economies, there are strong pressures for the quick expansion of energy supply, notably for power generation and transport fuels, with little short-term emphasis on substituting fossil fuels. Technological cooperation combined with capacity-building can help in the important area of fuel-switching. Most probably, such efforts will necessitate substantial financial transfers from developed to developing and emerging economies among other steps towards enhancing adaptive capacity, because given their limited domestic sources, the latter will likely continue in most cases to prioritise growth over mitigation. Furthermore, the increase of financial transfers can be seen as a first sign of developed countries'

determination to fulfil their commitments under the UN Framework Convention on Climate Change (UNFCCC) to take a lead in the fight against climate change.

Specific action-based approaches

This report further analyses some examples of action-based approaches for energy supply, sectoral initiatives for global industry, an integrated road transport policy, buildings and appliances.

Energy supply: Avoiding being locked into high-carbon technologies

5) The EU set a target of a 20–30% GHG emissions cut from the 1990 levels by 2020, motivated by the ambition that future climate change will be limited to an increase of no more than 2°C above pre-industrial levels. Improving the efficiency of existing equipment is important for reducing emissions but will not be enough to meet the target. The main challenge is how to encourage the replacement of existing assets by low-carbon technologies and investment in near-zero carbon technologies such as renewables, nuclear power, and carbon capture and storage (CCS) in order to avoid being locked into high-carbon capital technologies. In the absence of a robust, global, long-term price signal for GHG emissions, for example through a global climate-change agreement, the single most important instrument for the EU is the EU emissions trading scheme (EU ETS). Both the level of the *cap* – i.e. the scarcity and by extension the price of allowances – and *allocations* will be crucial for the future structure of the capital stock of the ETS sector. The allocation rules (for distributing allowances) for the trading periods beginning in 2013 and beyond will be fundamental for stimulating investment in low-carbon technologies.

6) In addition, systems supporting the deployment of existing but not yet competitively advantageous technologies such as renewables could be effective. The International Energy Agency, for instance, estimates that each doubling of such capacity can lower costs by 18–20%, although this kind of 'learning' differs across technologies, mainly depending on how mature they are. This is the reason why support systems for renewables and the EU flagship programme for CCS are needed. Nevertheless, incentives should be technology-neutral to the extent possible to encourage innovation and

entrepreneurship, thus devising the most cost-effective solutions. Other advantageous technologies such as combined heat and power (CHP) and district heating and cooling may not reach their full potential because of market and non-market barriers or the lack of an appropriate framework, improved data or analytical tools.

Approaches for industrial sectors

7) As sectoral approaches and their designs evolve, questions about how they can fit into existing policies and practices become more urgent. New initiatives such as sectoral approaches will most likely be expected to complement existing frameworks rather than replace them.

8) There are four ways in which sectoral approaches could constructively interact with EU policy priorities in a significant way and thereby increase support from both governments and stakeholders. These relate to collecting data and formulating sectoral performance benchmarks.

- Sectoral performance benchmarks can be used for setting a cap if they are based on best practice or the best available technology in a sector.
- Sectoral benchmarks can be also used for allocation, at least as long as free allocation continues.
- The linking of emissions trading schemes would be facilitated and accelerated by coordination of the central design options such as cap-setting, (free) allocation, and monitoring, reporting and verification. Sectoral approaches can assist the coordination efforts.
- Sectoral performance benchmarks could be a useful tool for measuring, reporting and verifying actions and extended to a possible sectoral clean-development mechanism.

Integrated approaches to mobility –the example of cars and vans

9) Unlike industry sectors such as cement and steel, transport and mobility involve a whole range of actors along the chain, ranging from fuel suppliers to product development and to consumers and users. Thus, responsibility for emissions is diffused across a number of integrated, yet separate components and actors: fuels, engine and

vehicle technologies, infrastructure, consumer preferences and driving behaviour. Although this situation will necessitate an integrated approach based on flexibility and alternative options, the capacity of governments to implement integrated approaches is still limited and has to be developed. Experiences from integrated approaches such as the Auto-Oil and the European Climate Change Programme indicate the need for a high level of transparency and the inclusion of major stakeholders (especially legislators) as well as considerable resources for independent, high-quality scientific support. A particular challenge for policy-makers will be to find a consensus on the contributions of the various components of the transport sector to emission reductions, for example, through assigning specific targets. Uneven contributions by the different components would not only risk jeopardising the least-cost abatement goal but eventually political acceptability and, by extension, implementation. Flexibility for stakeholders in reaching their specific targets would reduce this risk by balancing initially uneven allocations to some extent. In the end, the success of integrated approaches will depend on the successful development of suitable performance indicators for those stakeholders responsible for the different components: manufacturers, fuel producers, governments as infrastructure providers and consumers as buyers and drivers. Suitable indicators are a precondition for i) developing targets, ii) monitoring progress and iii) enforcing compliance. The definitive test for the success of an integrated approach is whether the aggregate emission reductions envisaged are achieved.

An integrated approach will be aided by an efficient system based on a set of fiscal instruments, for example, the use of fuel, vehicle or circulation taxes as incentives for consumers to buy low-carbon or more efficient vehicles or to switch to more climate-friendly driving behaviour.

End-use energy efficiency

Energy efficiency holds the biggest potential across all sectors to reduce GHG emissions in the short and medium term. This report singles out *buildings* and *appliances*, for which there is significant scope for emission reductions. Implementing a wide range of available techniques for insulation, heating and lighting or for the replacement of appliances could

reduce energy consumption by 20–50%, often in a cost-effective way with a payback period of 10 years or less.

Buildings

10) Considerable 'no-regret options' exist in thermal insulation, high performance windows and solar shading, airtight structural details, ventilation and heat/cold recovery systems, supported by the integration of renewable energy production in buildings. Even so, in order to reach the full potential that buildings offer, the current EU focus on new buildings will need to be enlarged to include existing buildings (i.e. renovations) and buildings smaller than the current legislated threshold of 1,000 square metres. Concentration on new, innovative low-energy and low-GHG techniques for new buildings is crucial to avoid lock-in with respect to the new housing stock but fails to address the majority of emissions in the buildings sector.

11) Experience in the EU and elsewhere suggests that the full potential is best reached by combining different policy measures, such as more stringent regulation, the (re-)introduction of financial stimuli, better information campaigns and training in the construction and maintenance industries. For the EU, where the principal competencies in energy matters lie with the member states, an immediate way forward would be to screen and compare member state policies to identify best practices. This step requires increased resources in terms of both money and staff in EU administrations in addition to continued political commitment. Comparisons among the member states are facilitated by indicators, which, for example, could be developed further by the European Commission in conjunction with stakeholders.

Appliances

12) Another important area of emissions in terms of scope for reductions is appliances. More than 500 million appliances with old technology are in use in developed country markets. Household appliances will also be among the fastest-growing sources of CO_2 emissions in developing countries. A major reason why the potential of appliances is not reached is the long life cycle of domestic appliances.

13) This Task Force has identified a number of actions that could assist in reaching the full potential of emission reductions that appliances offer. These include
   - undistorted energy (and electricity) price-setting that reflects the real energy costs and specifically the costs of carbon;
   - smart information and labelling campaigns to encourage consumers to examine the economic and environmental effects of their choices based on a life-cycle perspective that incorporates, for example, not only emissions from material use but also benefits from (eco-)design. Global information and labelling campaigns could overcome or even prevent potential trade barriers stemming from the development of diverse technical standards in different countries;
   - government incentive schemes to increase the rate of replacement by encouraging consumers to replace energy-inefficient equipment with highly energy-efficient products, particularly cooling appliances;
   - assessment of the potential that additional finance from international financial institutions could have in speeding up replacement in emerging economies, especially of cooling appliances; and
   - enforcement of existing laws and regulations, e.g. the one-watt standby initiative.

II. Recommendations

The Task Force has formulated the following recommendations:

1) The EU and other governments should support action-based approaches not just because they can reduce emissions here and now but also because they can enhance knowledge about the potential of various abatement options and their costs.
2) Governments must provide a clear signal that the value of carbon will be reflected in energy and other prices to ensure that the objective of reducing GHG emissions can be appropriately incorporated into investment decisions, as many low-carbon technologies are getting closer to becoming economical.

3) Until a robust, global carbon-price signal emerges from a post-2012 agreement, governments should continue to support the deployment of promising low-carbon technologies such as renewables and CCS to bring down the costs of the technologies.

Energy supply

4) Action-based approaches must focus on encouraging the replacement of existing assets in the energy supply sector to avoid lock-in with respect to a high-carbon capital stock.
5) The EU must use the review of the EU ETS to ensure that allocation rules provide incentives for investment in sustainable low-carbon technologies.
6) In parallel, governments should improve their data and analytical tools to develop strategies for other promising technologies such as CHP and district heating and cooling.

Approaches for industrial sectors

7) Governments and industry together should test various concepts of sectoral approaches in practice (proof of concept) by undertaking pilot projects in key countries and sectors to assess whether four challenges – technical issues related to data definition and collection, the risks of anti-competitive behaviour, workable incentives for governments and industry in developing countries, and a suitable governance structure – can be pragmatically solved.
8) The governments of developed countries in cooperation with industry and international bodies should make progress in capacity-building in the governments or industries of developing countries.
9) Industry should reinforce its efforts to develop performance benchmarks that are practical to use and are acceptable in sectors across a range of developed and developing economies.
10) Industry sectors should attempt to develop a common framework that sets out principles for monitoring, reporting and verification or principles and processes to develop benchmarks and provide information to governments and international organisations.
11) Industry sectors should particularly bring together the results of existing successful works on monitoring and verification or those on indicators and data collection.

12) Industry and governments should harmonise the data formats of various databases.

Integrated approaches to mobility – the example of cars and vans

13) To provide incentives for consumers and drivers, governments must reform the system based on fuel, vehicle or circulation taxes to encourage consumers to buy low-carbon or more efficient vehicles or to switch to more climate-friendly driving behaviour.

14) As there are market failures and other barriers that pricing/taxation alone will not overcome, the EU should attempt to devise an integrated policy for the various components of the transport sector – fuels, engine and vehicle technologies, infrastructure, consumer preferences and driving behaviour – to achieve emission reductions at the lowest cost.

15) EU funding in the transport sector should be targeted towards sustainable transport infrastructures, sustainable transport solutions and technology research and deployment.

16) The EU should develop suitable indicators, inter alia, to i) determine targets, which can be reached in a technologically- and economically-reasonable way ii) monitor progress and iii) enforce compliance, in order to ensure that targets are measurable and enforceable. Flexibility in how to reach their targets should be given to the individual stakeholders in order to realise the most cost-efficient potential.

End-use energy efficiency

Buildings

17) The EU should put stronger emphasis on existing buildings and dwellings, where the principal potential lies.

18) To reach the full potential in buildings and dwellings, the EU and other governments should combine different policy measures in parallel, such as more stringent regulation, (re-)introduction of financial stimuli, and better information campaigns and training in the construction and maintenance industries.

19) The EU should continue to focus on screening and comparing member state policies to identify best practices, but will need to make available more resources for these activities.

20) The European Commission, together with stakeholders associated with the buildings sector, could further develop appropriate indicators to aid comparability.

Appliances

21) To reach the potential for emission reductions related to appliances, governments must
    a) ensure an undistorted energy (and electricity) price that reflects the real costs of energy, including the costs of carbon;
    b) initiate smart information and labelling campaigns to encourage consumers to examine the economic and environmental effects of their choices based on a life-cycle perspective that incorporates, for example, not only emissions from material use but also benefits from eco-design; and
    c) implement and enforce existing decisions and laws such as the one-watt standby initiative.

22) Governments should also
    d) launch government incentive schemes to increase the rate of replacement, especially of cooling appliances; and
    e) assess the potential that additional finance from international financial institutions could have in speeding up replacement in emerging economies, particularly of cooling appliances.

INTRODUCTION

Climate change has been at the top of the G8 agenda since 2005. The UK's G8 presidency launched a process to accelerate worldwide action on climate change, engaging five major emerging economies – Brazil, China, India, Mexico and South Africa – in discussions towards a global agreement, which became known as the Gleneagles Dialogue on Climate Change, Clean Energy and Sustainable Development. The backbone of the 2005 Gleneagles commitments is the Gleneagles Plan of Action (Box 1), which pledges to promote innovation, energy efficiency and conservation, to improve policy, regulatory and financing frameworks and to accelerate the deployment of cleaner (particularly lower-emitting) technologies. Among other things, the opportunity for cost-effective investment in cleaner energy technologies and greater efficiency is highlighted. Implementation of the commitments made in the Gleneagles Plan of Action has been monitored in the course of the Dialogue in close cooperation with the International Energy Agency (IEA), the World Bank and other initiatives.

The G8 summit in Germany in June 2007 stressed 'actions' on all fronts. It led to a common understanding about the need for long-term action and the importance of the UN climate process as the 'appropriate forum' for negotiating future global efforts on climate change, while addressing possible contributions from emerging economies through a range of actions leading to carbon-intensity reductions. The Gleneagles Dialogue will wrap up the two-year discussion and prepare a report to the G8 summit due in Japan in July 2008. The Japanese G8 presidency has identified climate change as one of the main themes for the summit. It prioritises the following three principles for establishing an effective framework beyond 2012: the participation of all major emitters, including developing countries; flexibility and diversity; and compatibility between

environmental protection and economic growth by utilising energy conservation and other technologies.[1]

Box 1. Six priorities of the Gleneagles Plan of Action

1. Energy use in buildings (building standards, renewable energy and efficiency partnerships to outreach to developing countries; procurement and management of public buildings), appliances (coordination of international policies on labelling, standard-setting and testing procedures), surface transport, aviation and industry (voluntary initiatives, the improvement of energy efficiency performance, cross-border partnerships and technology transfer)
2. Cleaner fossil fuels for power generation (research, dissemination and demonstration, clean coal, the reduction of gas flaring, renewables and electricity grids)
3. Efforts for strengthening international cooperation and R&D
4. The financing of the transition to clean energy with a focus on improving the investment climate and developing market
5. Adaptation
6. Work to tackle illegal logging with a focus on halting environmental degradation and moving towards sustainability.

The final stage of the Gleneagles Dialogue will likely benefit from the momentum gained in the 2007 UN conference on climate change in Bali with the announcement of the Bali Action Plan. The Bali Action Plan has launched a formal process to discuss a post-2012 agreement through the creation of a new Ad-hoc Working Group on a Long-term Cooperative Action Plan (AWG-LCA) under the UN Framework Convention on Climate Change (UNFCCC). The first meeting of this group in Bangkok in April 2008 saw agreement on a work programme and the schedule for workshops focused on specific themes. Discussions will likely centre on the

[1] For further information on the G8 Tokyo summit, see the website of the Japanese Ministry of Foreign Affairs (http://www.mofa.go.jp/policy/economy/summit/2008/index.html).

main building blocks for a post-2012 agreement, which include both widely-agreed themes such as mitigation, adaptation, finance and technology as well as emerging topics such as avoided deforestation and sectoral approaches.

Moreover, a Major Economies Meeting, initially proposed by the US, took on a new dimension when France, which is to take over the EU presidency in the second half of 2008, hosted the subsequent meeting on 17/18 April 2008 with an emphasis on sectoral approaches. It is expected that there will be increasing interaction and synergy among processes such as the Gleneagles Dialogue, the AWG-LCA and the Major Economies Meeting, while each process in turn draws wider participation from emerging and developing economies.

Although its share of global CO_2 emissions is relatively small, the EU has been one of the most vocal advocates for the fight against climate change and for leading global efforts towards a global climate change agreement. In 2007, the EU heads of state and government agreed on a "firm independent commitment" to at least a 20% reduction in greenhouse gas (GHG) emissions by 2020 from 1990 levels, which can be increased to 30% on the conclusion of an international agreement (European Council, 2007).[2] This target was proposed as part of an integrated energy and climate change package.[3] Other commitments include a binding target of sourcing 20% of the EU's total energy consumption from renewable energy by 2020 and a binding minimum target of sourcing a 10% share of biofuels in overall EU transport petrol and diesel consumption by 2020. In the push for technology, the EU has also agreed on the development of a strategic energy technology plan and a carbon capture and storage (CCS) policy (see section 3.4). Discussions on the further spread of efforts on GHG emission reductions (European Commission 2008a) and renewables among member states (European Commission 2008b), changes to the design of the EU

[2] The 30% cut is a commitment on the condition that other developed countries also commit themselves to GHG emission reductions as part of an international agreement. At the same time, the EU has advocated that developed countries reduce their emissions collectively by 60% to 80% by 2050 from 1990 levels.

[3] See the European Commission's website and related articles under the heading "Energy for a Changing World" (http://ec.europa.eu/energy/energy_policy/documents_en.htm).

emissions trading scheme (ETS) after 2012 (European Commission 2008c) or the development of CCS pilot projects (European Commission 2008d) have begun since the publication of the Commission's integrated proposal for a climate action and renewable energy (CARE) package in January 2008 (European Commission 2008e).[4] The EU heads of state and government set out a clear timetable, recognising the CARE package as "a good starting point and basis for agreement" to be reached before the end of 2008 and to be ready for adoption in early 2009 at the latest (European Council, 2008).

Meanwhile, a new strategy for EU industrial policy (European Commission, 2007) intends to create incentives to unlock the full potential of low carbon or resource-efficient goods, technologies and services in the EU to make Europe a 'forerunner' in these markets. The new strategy addresses the triple objective of competitiveness, energy and the environment, and calls for an integrated approach to mobilise action by all stakeholders. The main challenge is to explore how to move to a low-carbon economy while aiding the competitiveness of European industry. From this perspective, the High Level Group on Competitiveness, Energy and the Environment produced five reports from June 2006 to November 2007.[5] The reports recognise the need for:

i) specific measures to minimise the risk of carbon leakage in cost-effective ways, especially in energy-intensive industries;

ii) flexibility and price certainty as provided through the liberalisation of energy markets and long-term energy supply contracts;

iii) getting the policy framework right, along with the urgency of stimulating the investment needed in the energy sector;

iv) ensuring that the investment signals provided through market mechanisms (the ETS and an international carbon market) are more long-term and predictable;

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[4] For further information, see the European Commission's website and related articles under the heading "Climate Action" (http://ec.europa.eu/energy/climate_actions/index_en.htm; and http://ec.europa.eu/environment/climat/climate_action.htm).

[5] See the European Commission's website and related articles under the heading "Sustainable Development, Climate Change and Competitiveness" (http://ec.europa.eu/enterprise/environment/index_en.htm).

v) a more strategic approach to technology development and deployment through a combination of technology push and pull; and

vi) global sectoral approaches to help progress international action.

Against this background, CEPS has convened a Task Force to identify a number of concrete measures for combating climate change that could reduce GHG emissions while at the same time stimulating structural change and technology diffusion. This Task Force report builds on the existing literature that has identified a number of policies and measures that could simultaneously accelerate structural change and improve cost-effectiveness.[6] In general, it calls for action-based approaches that can play an important role in achieving the emission reduction targets of the Kyoto Protocol and in putting into place the infrastructure, technologies and experience needed. With a view towards a long-term climate strategy, it attempts to present a portfolio of actions that can be implemented and accelerated on a global scale, especially in the G8+5 countries and the EU.

After setting the context for actions against climate change in chapter 1, chapter 2 highlights the importance of long-term structural change for the global low-carbon economy. Chapter 3 lists some crucial policies to accelerate structural change and to enable an action-based system to work. Chapter 4 draws brief conclusions.

The main findings of the report are contained in the Executive Summary, including its sections on key messages and recommendations.

The report has five appendices. Appendix 1 illustrates a global cost curve for GHG abatement measures beyond business-as-usual levels. Appendix 2 compares shares of world GHG emissions, per capita emissions and GHG intensity in the G8+5 countries. Appendix 3 summarises the major global partnerships on energy and climate change, listing their main participants. Appendix 4 introduces the Report of the Transport Sub-group. Appendix 5 presents a list of members of the Task Force and invited guests and speakers.

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[6] This includes, for example, the 'wedges approach' (Pacala & Socolow, 2004), the WBCSD pathways study (WBCSD, 2005 and 2006), the Stern (2007) review on climate change and most recently, the McKinsey study undertaken on behalf of Vattenfall (Vattenfall, 2006) as well as a CEPS study that examines the costs and benefits of various technology options (Egenhofer et al., 2006).

1. SETTING THE CONTEXT FOR ACTION TO MITIGATE CLIMATE CHANGE

To meet the considerable challenge of reducing GHG emissions and stabilising atmospheric concentrations to avoid 'dangerous climate change' will require a combination of initiatives and policies integrating global action under UNFCCC with domestic actions and international cooperation.

1.1 The state of the climate and pathways towards long-term stabilisation

According to the Intergovernmental Panel on Climate Change (IPCC), there is persuasive evidence that most of the temperature rise that has occurred over the last 50 years is attributable to human activity. As GHG concentrations continue to increase, the potential impact of GHG emissions on people and ecosystems may prove to be significant. In their contribution to the Fourth Assessment Report in 2007, Working Group 1 of the IPCC highlights the unprecedented level of observed climate change. For the next two decades, it projects a rise of about 0.2°C per decade across a range of emission scenarios. And even with the concentrations of all GHGs and aerosols being kept constant at year 2000 levels, a rise of about 0.1°C per decade could be anticipated. The same body finds that this is likely to trigger serious consequences for humanity and other forms of life. Ramifications include a rise in sea levels, thus endangering coastal areas and small islands, as well as provoking a greater frequency of extreme weather events, impacts on agricultural production and higher incidences of the spread of diseases, damage to infrastructure or migration.

The principal source of global GHG emissions is CO_2, on which this report concentrates. Roughly speaking, about 60% of total GHG emissions

come from the use of fossil fuels and 20% from land-use changes, e.g. deforestation. The rest is attributed to GHGs other than CO_2.

Global atmospheric CO_2 concentration has grown, rising from a pre-industrial value of about 280 ppm to 379 ppm in 2005. Annual fossil CO_2 emissions have increased from an average of 23.5 $GtCO_2$ per year in the 1990s to 26.4 $GtCO_2$ per year in 2000–05. Based on the current understanding of climate carbon-cycle feedback, model studies suggest that stabilising CO_2 at 450 ppm would require reductions of cumulative emissions over the 21st century from an average of approximately 2,460 $GtCO_2$ to around 1,800 $GtCO_2$ (IPCC, Working Group 1, 2007). In response to this challenge, the World Business Council for Sustainable Development (WBCSD) (2005) illustrated how a world with global carbon emissions at or below 33 $GtCO_2$[7] per year could be realised by 2050, stabilising CO_2 concentrations in the atmosphere at no more than 550 ppm and made clear the magnitude of changes that would have to take place. A study by McKinsey on behalf of Vattenfall (Vattenfall, 2006) has identified more than 30 measures that can be undertaken at a CO_2 price of up to €50 per tonne (see Appendix 1).

1.2 The G8+5 countries and the EU

The G8+5 countries – Canada, France, Germany, Italy, Japan, Russia, the UK and the US plus Brazil, China, India, Mexico and South Africa – are responsible for about 55% of global GHG emissions (see Appendix 2). The G8 countries are currently responsible for some 63% of world GDP (Federal Government of Germany, 2007b). Even so, the emerging economies are rapidly closing the gap. The IMF expects that by 2015, China will outpace Europe in terms of its share of global GDP, with China accounting for 19% and Europe for 17% (Federal Government of Germany, 2007a). The significance of increasing emissions from the five emerging economies, especially China, is discussed further in chapter 2.

An agreement by the G8+5 countries on policies and measures could constitute a major step forward not only because they account for a large

[7] WBCSD(2005) expresses emissions in tonne of carbon but this report expresses emissions data in tonne of carbon dioxide. Thus, 9 GtC is converted to 33$GtCO_2$, multiplying by 44/12.

share of the global economy but also because they could exert leadership in the regions for which they stand. The G8+5 group can be seen as a microcosm of the broader global picture. Appendix 2 shows that within the G8+5 group, there are major differences between countries in terms of shares of GHG emissions (Figure A2.1), per capita emissions (Figure A2.2) and GHG intensity (GHG emissions per unit of GDP) (Figure A2.3). Among these indicators, the intensity indicator requires careful treatment because it tends to reflect the structure of energy production rather than consumption. For example, Canada scores higher in energy intensity than does the US, even though the majority of energy produced in the former tends to be consumed in the latter.[8]

The share of the EU25 in global CO_2 emissions is relatively small, currently standing at 15% (see Figure A2.2, Appendix 2). Politically, however, the EU has been one of the most vocal advocates for combating global climate change and for leading global efforts towards a global climate-change agreement. At the same time, the EU is playing a key role in the development of emerging carbon markets, in both running the world's largest allowance market (see Table 1) and generating considerable demand for clean development mechanism (CDM) credits (Capoor & Ambrosi, 2007, p. 22).

Table 1. Carbon market at a glance, volumes and values in 2005–06

	2005 volume ($MtCO_2e$)	**2005 value ($ million)**	**2006 volume ($MtCO_2e$)**	**2006 value ($ million)**
Allowances				
EU ETS	321	7,908	1,101	24,357
New South Wales	6	59	20	225
Chicago Climate Exchange	1	3	10	38
UK ETS	0	1	na	Na
Sub-total	328	7,971	1,131	24,620

[8] Canada is the single largest foreign supplier of energy to the US, providing 17% of US oil imports and meeting 18% of the US demand for natural gas (see the website of the US Department of State, "Background Note: Canada", http://www.state.gov/r/pa/ei/bgn/2089.htm).

Project-based transactions				
Primary CDM	341	2,417	450	4,813
Secondary CDM	10	221	25	444
Joint implementation	11	68	16	141
Other compliance	20	187	17	79
Sub-total	382	2,894	508	5,477
Total	710	10,864	1,639	30,098

Source: Capoor & Ambrosi (2007), Table 1, p. 3.

1.3 International processes for discussions or negotiations

The UN plays a central role in developing a coordinated approach to climate change. Given the complexity of the matter as well as the lack of agreement within the UN, recently there have been additional attempts at better international coordination. This section provides an overview of UN processes and additional initiatives. While this section concentrates on processes for discussions or negotiations, any substance brought on the agenda of these processes is addressed in the next section, 1.4.

UN processes

Under the UNFCCC and the Kyoto Protocol processes, two major discussion tracks are currently running in parallel (e.g. Carter et al., 2008; Höhne et al., 2008).

Ad-hoc Working Group (AWG)

The AWG on Further Commitments for Annex I Parties consists of parties that have ratified the Kyoto Protocol. It is expected to consider commitments for the post-2012 period for Annex I Parties under the Protocol (Art. 3.9) with a view to ensuring that there is no gap between the first and second commitment periods. The AWG has discussed the costs and benefits of current and future policies, measures and technologies, along with their mitigation potential, effectiveness and efficiency.

Ad-hoc Working Group on Long-term Cooperative Action

It was agreed in December 2007 to set up the AWG-LCA as a follow-up process to the Dialogue on Long-term Cooperative Action to address climate change by enhancing implementation of the Convention. The Dialogue resulted in a series of exploratory workshops under four broad themes – sustainable development, adaptation, technology potential and market-based opportunities – some of which have become possible building blocks for a post-2012 agreement. The AWG-LCA is mandated to launch a comprehensive process to enable the full, effective and sustained implementation of the Convention through long-term cooperative action up to and beyond 2012. The new body must complete its work by the UN Climate Change Conference in Copenhagen (COP15) in December 2009. The first meeting, which took place in Bangkok, Thailand from 31 March to 4April 2008, set out the work plan for implementing the Bali Action Plan. Comparability of effort has been high on the agenda. This meeting acknowledged the importance of comparability supported by an agreed yardstick (for comparability of effort, see section 1.4).

Initiatives and activities contributing to the UN processes

With the intention of complementing the UNFCCC and the Kyoto Protocol processes, a series of other initiatives and activities have also been undertaken, mainly within existing international fora including the G8. For a summary of the major global partnerships on energy and climate change, see Appendix 3, Tables A3.1-4. These initiatives can contribute to the UN processes not only by allowing for exchanges of information about respective climate and energy policies, but also by fostering international cooperation on key aspects (e.g. energy efficiency).

G8+5 and the Globe G8+5 Climate Change Dialogue

During the UK's G8 presidency in 2005, the G8 countries agreed on the Gleneagles Plan of Action on clean energy and climate change, which explicitly includes five emerging economies: Brazil, China, India, Mexico and South Africa. The World Bank and the IEA have been tasked with the research, planning and knowledge dissemination for the implementation of the Gleneagles Plan of Action. The final report will be submitted to the Japanese presidency hosting the G8 summit in July 2008.

Moreover, the GLOBE[9] G8+5 Climate Change Dialogue, launched to shadow the G8 process, is expected to ensure input from stakeholders including business[10] and environmental non-governmental organisations (NGOs). The fifth meeting of their Legislators Forum will convene in the Japanese Parliament in June 2008.

Major Economies Meetings

The Major Economies Meeting on Energy Security and Climate Change is an initiative by the US to develop and contribute to a post-2012 framework on energy security and climate change.[11] The third meeting in France in April 2008 (marking the first shift of the venue from the US) focused on sectoral approaches for addressing climate change.

Asia–Pacific Partnership on Clean Development and Climate

The Asia–Pacific Partnership on Clean Development and Climate[12] focuses on sector-specific approaches and technology cooperation. The Partnership envisages international cooperation involving both the public and private sectors (i.e. a public–private partnership) with the principal aim of developing and diffusing technologies mainly through technology push (see section 3.3).

Bilateral or multilateral partnerships

Lastly, there have been attempts to explore bilateral or multilateral partnerships that are specific to individual topics such as CCS, biofuels, renewables and energy efficiency (see Appendix 3, Tables A3.1-4).

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[9] GLOBE stands for the Global Legislators Organisation for a Balanced Environment, an organisation comprising legislators across the world, including G8+5 countries.

[10] The WBCSD has been active in putting climate change policy on the mainstream business agenda. Its output includes the pathways study (WBCSD, 2005) quoted in section 1.1.

[11] The invited countries, entities and organisations are Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Mexico, Russia, South Korea, South Africa, the UK, the EU, the European Commission and the UN.

[12] The members are Australia, Canada, China, India, Japan, the Republic of Korea and the US. For an overview, see Fujiwara (2007).

1.4 Building blocks for a post-2012 agreement

In the course of ongoing discussions in the UN processes and additional initiatives, some main themes appear to have developed into possible building blocks for a post-2012 agreement with various degrees of support from participating countries and organisations. This section covers adaptation, avoided deforestation and sectoral approaches. Equally important are carbon markets and technology, which are introduced in sections 3.1 to 3.3.

Adaptation

Irrespective of the intensity of a global response to climate change, there will be a need for adaptation to climate change. Adaptation measures in many cases will provide local benefits without taking long lead times, even before mitigation measures can have an effect. Depending on the temperature changes that occur, the costs of adaptation will rise sharply. Stern (2007) estimates them to be in the range of $15-150 billion each year (0.05-0.5% of GDP) for the construction of new infrastructure and buildings resilient to climate change in OECD countries. The World Bank (2006) estimates that the costs of 'climate proofing' and investment amounts to between $10 billion and $40 billion annually. The UNFCCC (2007) calculates that the additional investment and financial flows needed for adaptation in the infrastructure will total $2-41 billion for non-Annex I Parties and $8-130 billion globally in the year 2030. The challenge of adaptation will be even more acute in developing countries, which are vulnerable to climate change but short of resources to implement adaptation measures, meaning that there will need to be major transfers of money from developed to developing countries.

Avoided deforestation

Deforestation amounts to 18% of CO_2 emissions globally – more than the share of the global transport sector (Stern, 2007). In some cases, CO_2 emissions related to land-use change and forestry are not included in emissions figures because of uncertainties associated with their calculation. Nevertheless, they matter in a global perspective, since CO_2 emissions from land-use change and forestry are a principal source of emissions in countries such as Indonesia and Brazil. Avoiding deforestation can be a cost-effective policy. It is estimated that the opportunity cost of forest

protection (e.g. avoiding deforestation) in eight countries accounting for 70% of emissions from land use could be about $5 billion per year initially, with marginal costs rising over time (Stern, 2007). Yet again, as is the case for adaptation, action would require commitment to the immediate release of finance from developed countries.

Sectoral approaches

Sectoral approaches have rapidly become the focus of post-2012 discussions, but exactly what they mean and what they can deliver remain unanswered. There have been proposals for several types of sectoral approaches. One type is an industry-led "sector-wide transnational approach" to commitments (Baron, 2006; Baron et al., 2007). The Bali Action Plan 1(b) (iv) calls for consideration of "cooperative sectoral approaches and sector-specific actions". Another type is a government-led approach as a method or tool for setting country- or region-based targets founded on an analysis of mitigation potentials, which has been explored in AWG workshops.[13] The Bali Action Plan 1(b)(i) proposes for consideration "measurable, reportable and verifiable nationally appropriate mitigation commitments or action, including quantified emission limitation and reduction objectives, by all developed country Parties, while ensuring the comparability of efforts among them, taking into account differences in their national circumstances". For elucidation, a "sector-wide transnational approach" is introduced in section 3.5, simply referred to 'sectoral approaches'. This section only covers the concept of sectoral approaches as a method of setting country-based targets or, more broadly, as a basis for developed countries to take on "measurable, reportable and verifiable" commitments or action with a view to ensuring the comparability of efforts.

It can be foreseen that countries will make their own commitments in the absence of globally agreed and coordinated commitments. Some countries may strongly focus on domestic policies, including technology standards, renewable or energy-efficiency commitments, domestic trading schemes and policies targeting the domestic or transport sectors. Other countries or regions such as the EU may prefer legally binding

[13] For further information, see the UNFCCC website (http://unfccc.int/kyoto_protocol/items/3878.php).

commitments in the form of absolute or intensity targets. Given the uncertainty about a post-2012 agreement, despite an urgent need to reduce emissions, some governments and many stakeholders have shown an increasing interest in action-based approaches. The advantages of such approaches are that they can be implemented here and now – without waiting until a global agreement can be found – and they will reduce emissions. The outcome, however, will most likely be a more complex and decentralised system, leading to questions about the comparability of efforts.

The comparability of efforts will depend on the existence of some sort of agreed or common yardstick, against which the progress of domestic measures can be assessed. In the absence of a common yardstick, there will be a risk of continuous finger-pointing that one country is doing more than another. An example of such a yardstick is the IEA energy indicators.[14] While the comparability of efforts is a necessary condition for making an action-based system work, it is not sufficient on its own. Countries that have pledged emission reductions need to know in advance that they will be held responsible for achieving what they pledge and for accepting the eventual consequences for non-compliance or lack of performance. Provided the comparability of measures is ensured and that there is a shared understanding about the consequences of (non-)compliance or lack of performance, country or regional commitments based on national or regional priorities may yield at least some measurable reductions. Nevertheless, there is a risk that proliferating actions in many countries will lead to ever-diverging approaches, which could make reaching a global agreement more difficult. The biggest risk of such a system, however, would appear to be that countries or regions are invited to pick and choose.

[14] For further information, see the IEA website (http://www.iea.org/Textbase/country/maps/world/prod.htm) and (http://www.iea.org/G8/index.asp).

2. LONG-TERM STRUCTURAL CHANGE FOR THE GLOBAL LOW-CARBON ECONOMY

The demand for primary energy is projected to increase globally by a factor of 1.6 to 3.5 between now and 2050 and in non-OECD countries by a factor of 2.3 to 5.2 (World Bank, 2006). The estimates of the IEA's reference scenario put the investment needs of the energy sector in developing countries at an average cost of $300 billion per year for the period 2003–30, of which 65% is for the electricity sector alone. According to the WETO-H_2 reference projection, energy consumption in developing countries will overtake that of developed countries shortly after 2010 and will account for two-thirds of the world total in 2050 (European Commission, 2006a).

The World Bank (2006) holds that developing countries need an annual investment for electricity supply of $165 billion through to 2010, increasing at 3% per year to 2030. There is currently a large financing gap in the energy sector of about $80 billion per year, or about 50% of the actual needs for electricity generation. The under-investment in energy is estimated to reduce GDP growth in some countries by as much as 1–4% per annum. International financial institutions, donors and foreign direct investment can help fill the gap by about $10 billion per year with existing instruments (World Bank, 2006). Closing the remaining gap will depend on the pace of implementing sector reforms to attract private investment.

Experience suggests that primary energy use in developing countries can be cut by 30–50%, because the cost of energy savings is negligible compared with the cost of increasing energy supply. Therefore, accelerating cost-effective improvements in energy efficiency will be a priority in increasing energy supply. While energy intensity started declining mostly

as a result of structural changes in developing countries and economies in transition, much of the technical potential across the supply, transmission and use of energy is still to be tapped (World Bank, 2007).

The costs of reducing GHG emissions can be further lowered through increased end-use energy efficiency, a multi-gas/multi-sector strategy, international emissions trading or the carbon markets in general (World Bank, 2006).

Nevertheless, without changes in policy frameworks and appropriate instruments to facilitate investment in new technologies, developing countries are likely to follow a carbon-intensive development path. Developing countries are believed to account for over three-quarters of the increase in global CO_2 emissions between 2004 and 2030 in the IEA reference scenario. The share of developing countries in global CO_2 emissions will rise from 39% in 2004 to over 50% by 2030. Their share of global CO_2 emissions is growing faster than their share of energy demand because their incremental energy use is more carbon-intensive than that of the OECD and transition economies (IEA, 2006a).

There are strong pressures on emerging economies for the quick expansion of energy supply, notably for power generation and transport fuels. Although there is little scope for substituting oil as the principal fuel in transport, power can be generated by a variety of fuels such as natural gas, nuclear power, renewables, coal, and combined heat and power (CHP), which has a high degree of efficiency. These economies are scrambling to meet growing demand for generation capacity very quickly. They are often doing so by using the existing capital stock and technology and by making use of domestic reserves of coal, wherever possible, in spite of the higher recurrent costs at a later stage through efficiency losses and local or regional environmental damage. There is a major risk of a lock-in of the power sector into coal. The investment taking place in the next 10–20 years could consequently lock in very high emissions for the next half-century (World Bank, 2006).

China is the most striking example. According to the IEA (2004), coal-fired power in China is estimated to rise to 560 GW by 2020 (from 247 GW in 2002). In the same period, China intends to 'only' install 67 GW in additional natural gas-fired power stations. The option of an additional 47 GW of gas-fired generation based on combined cycle gas turbine plants substituting merely 50 GW of incremental coal capacity would bring

savings of around 213 million tonnes per year (Heller, 2006), or about half the Kyoto Protocol commitment of the EU-15.

Other problems in developing countries range from domestic energy pricing (e.g. energy subsidies, fiscal policies to soften the impact of fuel supply scarcity on final consumer prices, the absence of differentiation according to the polluting potential of fuels) to government failure in the enforcement of environmental regulations or investment in untested technologies. Such factors can slow down the introduction of more efficient technologies that are already cost-effective in developed countries, e.g. supercritical boilers for coal-fired power stations. Moreover, low levels of capacity relative to demand make it difficult for operators to take plants offline to improve energy efficiency and delivery, with implications for local residents and industry. Hence, old and carbon-intensive infrastructure tends to remain in operation despite the cost-effectiveness of upgrading (Stern, 2007).[15]

A special case is public infrastructure, which predetermines through its long lifespan production and consumption patterns over a long period. Decisions taken by governments today are highly influential in terms of reducing emissions for decades to come.

[15] For an overview of the Chinese situation, see IEA (2006b).

3. CRUCIAL POLICIES FOR ACCELERATING STRUCTURAL CHANGE

In the absence of a comprehensive global agreement, there are a number of crucial policies that have the potential to accelerate structural change.

3.1 The role of a carbon price

Within the EU and member states, there is already a plethora of policies – some of them imperfect – for setting a price on carbon. These include the EU ETS, member state taxes, and agreements between governments and industry. The UK, for example, has launched the Energy Performance Commitment scheme to target emissions from large entities such as supermarkets, hotels, and central and local government. It remains essential that a carbon price be eventually reflected in the price of the final product. Without a universal price on carbon, it is uncertain how far these efforts will spread to global commodities.

A carbon price encourages businesses to take the least costly actions, for example, those aimed at energy-efficiency improvements. There may also be advantages for first-mover businesses, which can substantially reduce their carbon footprint. Consumers appear to increasingly demand low-carbon products.

Nonetheless, carbon pricing alone is not sufficient. Even if the costs of climate change were borne directly by GHG emitters, leading to higher fossil-fuel prices, climate change is associated with market failures and barriers. The literature has identified a number of market deficiencies

related to the development and adoption of new technologies.[16] First, owing to 'knowledge spillover', innovating firms cannot keep other firms from also benefiting from their new knowledge and, therefore, cannot capture for themselves all the benefits of innovation. Second, there are 'adoption spillovers', which imply that the cost or value of a new technology to one user may depend on how many other users have adopted the technology, and thus adoption is not as straightforward a matter as it appears. Third, market shortcomings arise through incomplete information. For example, incomplete information can be a barrier when a builder or landlord chooses the level of investment in energy efficiency in a building but a later purchaser or tenant pays the energy bills.

Moreover, a problem may occur when factoring the cost of carbon in the cost of materials. It is possible that the entire carbon footprint is not always reflected for various reasons, for example because of different methodologies to account for inputs, including indirect emissions or the life cycle (e.g. production, subsequent recycling and the end of a product's life). Finally, uncertainty associated with returns to investment in innovation is particularly significant. Based on these market deficiencies, methodological problems or uncertainty about investment, it is reasonable to suggest that the policy prescription of economists to 'put a price' on GHG emissions, thereby inducing individuals and firms to internalise the cost of environmental externalities, does not always unlock the full potential. This issue highlights the potential for non-pricing measures to play a complementary role. For instance, technology measures (see section 3.3) not only rely on pricing but also on government support for R&D as well as public procurement, product labelling and certification. Integrated approaches to transport (see section 3.6) are based on a combination of measures ranging from pricing to consumer information and driver training.

[16] These technology market problems are particularly relevant for climate policy, which develops over decades or centuries and thus requires much more dramatic changes in technology. See Jaffe et al. (2005) for an overview.

3.2 Carbon markets

The Kyoto Protocol has attached major importance to carbon markets and has introduced international emissions trading alongside the CDMs and joint implementation (JI) (Arts. 6, 12 and 17) under the Protocol.

Uncertainty about countries' commitments after the first commitment period of the Kyoto Protocol (the 'post-2012 period') poses a challenge to the development and organisation of future carbon markets. Unless countries agree on rules for further commitments, there will be no assigned amount of units to parties beyond 2012. If there is no assigned amount of units approved by parties, each party may make its own commitment and any cap-and-trade emissions trading scheme will face the problem of finding the basis of cap-setting. Until there is a single carbon market on a global scale, emerging domestic and regional carbon markets will be likely to play an active role through their linking at least in the short term.

Linking domestic and regional emissions trading schemes is possible. There are two main options for linking: government-driven linking through international agreements and market-driven linking resulting from traders' search for arbitrage. While formal linking through international agreements may be an option for the long term, informal linking through arbitrage may be a preferred option in the short to mid-term.

Linking through international agreements

To date, a number of countries, states and provinces are developing concepts for emissions trading schemes. These include the Regional Greenhouse Gas Initiative in north eastern American states and Canadian provinces and the Western Regional Climate Action Initiative (an international scheme encompassing California, western US states and Canadian provinces). Various proposals for a US cap-and-trade scheme have been submitted to the US Senate. In Australia, the National Emissions Trading Taskforce has proposed a national emissions trading scheme. These schemes exhibit design features that are significantly different from those of the EU ETS with regard to sector coverage, commitments, allocation and even monitoring, reporting and verification. The designs of these emissions trading schemes are driven by the respective conditions of the domestic political economies with little or no concern for the effects on linking.

Linking as a result of traders' search for arbitrage

It is highly likely that participants in emissions trading schemes will search for arbitrage possibilities among carbon markets or commodities. Carbon prices will converge as long as most national or regional emissions trading schemes allow operators to use allowances generated through Kyoto Protocol project mechanisms (i.e. CDM/JI) or comparable domestic offset mechanisms for their compliance and there is sufficient volume of such allowances.

After 2012, a few more commodities may be created through the introduction of new mechanisms. A sectoral crediting mechanism (SCM) could evolve from the CDM or be 'implanted' in the Kyoto Protocol framework as another flexibility mechanism (Baron & Ellis, 2006). Such a mechanism generates credits for emission reductions on a sectoral basis. The challenge is to match the magnitude of credits the SCM could generate with the demand for emission reductions. Against the risk of over-supply, Baron (2006) suggests that parties could agree to either discount the value of SCM credits or adopt baselines that are below business-as-usual ones, such as no-lose sectoral targets (Schmidt et al., 2006). If emerging economies agree to take up no-lose targets, these economies will in effect move from the CDM to a multilateral mechanism trading (green) assigned amount units.

3.3 Technology

Most of the (post-2012) climate literature stresses the crucial role of technology in stabilising GHG emission concentrations at low costs, the need for a portfolio of R&D investments across a spectrum of technologies and integration of energy technology development as part of a larger and comprehensive climate-change strategy (e.g. Humphreys, 2001; Edmonds, 2003; Barrett, 2002 and 2003; Stern, 2007).[17]

In general, the costs of new and carbon-saving technologies tend to fall over time. The cost reduction can be achieved through three main approaches: i) carbon pricing in the form of taxes or emissions trading; ii) government support for research, development, demonstration and, in some sectors, early-stage deployment of technology; and iii) measures that

[17] For an overview, see Egenhofer et al. (2007); Fischer et al. (2008).

create conditions that enable consumers to choose clean technologies. For example, public procurement can be used to create the critical mass for market penetration (e.g. 'green procurement') while product labelling and certification can inform consumers about the best choices. Furthermore, governments could promote actions such as trade policies, the removal of technical, legal and administrative barriers to technology transfer, sound economic policies, regulatory frameworks and transparency – all of which create an environment conducive to private and public technology transfer.

Technology-oriented agreements (TOAs) have the potential to address important failures in the market with respect to technological innovation (e.g. de Coninck et al., 2007). Examples of such agreements are renewable energy quotas or feed-in tariffs but also EU or global energy efficiency or car efficiency standards. Still, they will operate best in conjunction with appropriate policies aimed at emission reductions, particularly market-based ones. TOAs could be negotiated separately or linked together, or incorporated into a national climate-change policy. TOAs that are more modest can be negotiated and implemented by a smaller set of countries, potentially outside the UNFCCC (see Appendix 3, Tables A3.1-4).

On the other hand, TOAs could become an effective substitute for an emissions-based strategy focusing on a limited category of standards, mandates or substantial incentives that could be applied on a sector-by-sector or a technology-by-technology basis. This approach may make the most sense for specific sectors or settings: sectors that are highly trade-sensitive, in which reaching agreements on targets and timetables is likely to be too difficult; sectors not otherwise covered by policies aimed at emission reductions; sectors that can benefit from international coordination; and situations in which significant ancillary benefits are foreseen.

Arguably, new technologies are most likely to evolve in not only developed countries but also in some emerging economies. Implementation of effective R&D and policies targeting emission reductions are crucial to the long-term success of technology development. Climate-friendly technologies will benefit all countries including developing and transition ones. For the latter, problems related to poverty, limited capacity and governance among others loom larger as barriers than the market failures. Thus, it is naïve to expect the aforementioned market-based strategies for emission reductions and innovation that are effective in developed

countries to generate similar effects in developing and transition economies.

For the least-developed countries, access to technology is a key issue. Arrangements for technology finance could be considered together with the funding of avoided deforestation or adaptation as a package deal (see section 1.4). On the other hand, some emerging economies need concession-based finance for wider technology cooperation on a larger scale. Concessionary finance could be one of the instruments used to ensure low-carbon investment in these economies.[18] Carbon markets could finance some of the investment needs foreseen in the long term. Yet the revenues expected from their contributions will probably be insufficient, certainly in the short term, which requires additional resources.

3.4 Energy

There are a number of non-market barriers to the uptake of new supply and distribution technologies such as political acceptability, potential safety questions and the lack of a regulatory framework. Among these, the most important barrier in the EU to further diffusion of more efficient and low-carbon technologies concerns energy prices. Such technologies would be expected to come to the market as a result of a significantly higher carbon price. Which technologies will be able to penetrate the market depends *inter alia* on fuel costs, including those resulting from the climate constraint (i.e. carbon prices) as well as on the development of capital costs (see section 3.1). It is difficult to forecast price developments that depend, to some degree, on learning effects, i.e. cost reductions stemming from the deployment of technologies. Herein lies the reason for governments to 'force' through policies on the deployment of technologies, for example, for renewables or possibly CCS. There is a risk that the absence of a significant carbon price or subsidies will lock new investment into an unsustainable future. On the other hand, there is a risk that such deployment policies will create vested interests seeking economic rent from government regulation.

[18] The World Bank (2006) has estimated that up to $30 billion per year would be needed to decarbonise power generation in non-OECD countries.

Natural gas

The combined cycle gas turbine is already the most successful power generation technology, with its share in the EU expected to be 22% by 2030. Further improvements in thermal efficiency from a current 53–59% or even 63% are feasible. The gas turbine cycle for CHP also has the potential to achieve further improvements in both electric and steam conversion of up to 2%.

Coal

According to IEA or the European Commission, new coal-generation technologies (i.e. supercritical coal power, integrated gasification combined cycle and direct coal-fired combined cycle plants) can achieve conversion efficiency of 50% or more as opposed to current efficiency, which is around 40%.

Carbon capture and storage

One might expect that coal burning will continue to generate high levels of emissions because major developed and developing countries are expected to continue to rely, for security of supply, on fossil fuels (mainly coal) to generate power. Nonetheless, fossil fuels can be used with minimal atmospheric CO_2 emissions, but only on the condition that the CO_2 is captured and stored in geological structures. This idea has sparked interest in existing techniques of post-, pre- and oxy-fuel combustion. The European Council has endorsed the European Commission's (2007 and 2008) proposals for a carbon capture and sequestration policy. The Commission has proposed a legal and policy framework for carbon capture and geological storage as well as an incentive framework, support programmes and external elements such as technology cooperation with key countries on CCS (European Commission, 2008d).

Renewables

The uptake of emerging and future technologies (e.g. new renewables such as wind, biomass and photovoltaic (PV)) depends on their competitiveness with existing technologies. Policies can play an important role, however, by bringing down costs through R&D subsidies along with support mechanisms that ensure a certain level of market penetration. Increased

market penetration has historically contributed to reducing costs (i.e. the learning-curve concept). According to the IEA, renewables are no different from other technologies in their potential for cost savings. A doubling of the capacity reduces costs by 10–20% (Jansen et al., 2005).

Nuclear power

In principle, nuclear power will be a potential source of GHG emission reductions over the next 50 years. With a market share of 32% for the EU-25, the potential for nuclear power to avoid emissions ranges between 700 million tonnes of CO_2 – if the share of nuclear power were to be replaced by the current energy mix – and 300 million tonnes of CO_2 if nuclear power were to be replaced by gas. Yet at present, nuclear power faces stagnation and, according to most forecasts, decline. The main reasons for stagnation and decline are costs, safety, waste and proliferation.

District heating and cooling, combined heat and power

District heating and cooling (DHC) can make an important contribution to improvements in the efficiency of buildings in terms of both the quality of the energy feeding a building and the building itself. Building owners can take measures at the building level while considering energy supply. The integrated production of heat and power achieves a considerably higher primary energy conversion than separate generation. A typical efficiency value for CHP is approximately 85% for the combined heat and electricity generation, compared to a typical efficiency value for conventional thermal electricity-only plant of 35-45% and for heat only boilers of up to 90%. Even so, a difference in (diurnal) demand patterns for heat and power constrains the scope for operating such a capacity in a flexible manner.

The crucial value of district heating lies in further development of renewable energy sources. It is important to underline the role of district heating as an infrastructure to use surplus heat from efficient electricity production (e.g. CHP, surplus heat from the incineration of municipal waste or industrial processes).

The demand for comfort cooling is experiencing very high growth in Europe and elsewhere. This demand is generally met by an electricity-driven system, which often puts strains on electricity networks (e.g. peak demand in summer for cooling) and provokes environmental concerns

over refrigerant gases. Another solution is district cooling, which enables the use of surplus heat and the intake of renewable energy sources.

3.5 Sectoral approaches

Sectoral approaches to address climate change focus on the need for global coordination (Egenhofer and Fujiwara 2008), be it voluntary cooperation or coordination or a post-2012 framework to account for the transnational character of the industries. Such approaches have been promoted for more than one reason. Recently there have been increasing concerns with (the lack of) a level-playing field, shared by energy-intensive industries producing goods in countries subject to carbon constraints but trading on a global commodity market. While sectoral cooperation can moderate competitiveness concerns, it adds complexity and requires a careful balancing act to deal with potential winners and losers. On the other hand, emerging economies would be interested in sectoral approaches as an additional driver to accelerate technology and financial transfer from developed countries. The key is to engage not only governments but also industry in emerging economies. An example is sectoral cooperation on improving the performance of the least-efficient companies.

To date, much of the progress so far work has been attributed to industry-led sectoral approaches. Existing industry-led sectoral approaches remain bottom-up in collecting information about the status of a sector, e.g. performance benchmarking. Therefore, they can put national policies and measures as well as international negotiations onto a firmer footing in at least several different ways: identifying win–win mitigation options, discovering hitherto unknown abatement potentials in developed and emerging economies, and realising cost-effective solutions based on the sound knowledge of an industry.

As sectoral approaches emerge and their likely designs evolve, discussions have shifted from concept to practice. Questions about how they can fit into existing policies and practices grow more urgent. New initiatives such as sectoral approaches will most likely be expected to complement existing frameworks rather than replace them.

Sectoral approaches could constructively interact with EU policy priorities to a significant extent and thereby increase support from both governments and stakeholders in four ways. These relate to collecting data and formulating sectoral performance benchmarks.

- Sectoral performance benchmarks can be used for setting a cap if they are based on best practice or the best available technology in a sector.
- Sectoral benchmarks can be also used for allocation at least as long as free allocation continues.
- The linking of emissions trading schemes could be facilitated and accelerated by coordination in central design options such as cap-setting, (free) allocation and monitoring, reporting and verification. Sectoral approaches can aid this kind of coordination.
- Sectoral performance benchmarks could be a useful tool for the monitoring, reporting and verification of actions and extended to a possible sectoral CDM.

3.6 An integrated approach to transport

Transport services facilitate the movement of goods and services, stimulate economic growth and improve human welfare. Mobility is the backbone of economies and daily life. In 2000, transport contributed worldwide to 14% of global GHG emissions (Stern, 2007) or 21–25% of emissions from the energy sector in developed countries (IEA, 2006a). Within the EU, 93% of all transport emissions originate from road transport (EEA, 2007). Road transport emissions, especially those from goods transport, are projected to continue rising at the previous rate. From 1990 to 2004, goods transport grew by more than 50% (EEA, 2007). Nevertheless, there is better understanding that the world's continuing and growing demand for mobility cannot be met simply by expanding today's means of transport.

The transport value chain is a complex matter, consisting of different components, including engine and vehicle technologies, fuels, infrastructure and drivers' behaviour (see Appendix 4).[19] As a result, any policy will have to tackle interaction among these different components in the transport value chain. The CAR21 High Level Group, a multi-stakeholder group of EU and member states policy makers, NGOs and car industry, has advocated an integrated approach as a guarantee to achieving a given objective at the least societal cost. An integrated approach involves all the stakeholders in securing solutions to meet policy objectives.

[19] Appendix 4 presents the contribution of the Transport Sub-group.

There are two main challenges to an integrated approach. The first challenge is to define and find a balance among the contributions of the various components of the transport value chain. Uneven contributions by these components will risk undermining not only the least-cost goal but also, ultimately, political acceptability. Second, any such integrated approach faces the challenge of enforcing commitments on the part of the various components. The failure of one component, for example infrastructure or fuel quality, may have knock-on effects, leading to the underperformance of the entire transport sector.

There are important precursors to integrated approaches such as the Auto-Oil Programme and European Climate Change Programme. In both cases, there has been significant involvement by all the stakeholders, although the Auto-Oil Programme has been criticised for its lack of representation of environmental NGOs. Any lessons from the programme would be concerned with the need for a high level of transparency and a good degree of access to data. An important element of the schemes has been comprehensive impact assessments, which could help to determine the cost-effectiveness of all available measures within the relevant sectors (e.g. automotives, fuel, drivers or consumers) and to prioritise such measures. It has become equally clear that in formulating measures, policy-makers will most likely need to take into account cost-effectiveness as well as other criteria such as environmental value, political acceptability, affordability and technical feasibility. During the decision-making process, it is important that political actors are able to support the integrated approach through their activities and regulatory decisions, which requires the level of the commitments to result from the development of the approach.

Each sector should strive to live up to its commitments while trusting in others' delivery of commitments, and should be accountable for achieving compliance. Nonetheless, the critical tasks of enforcing policies and measures and achieving the overall environmental objectives remain in the hands of policy-makers. The tasks will most likely require clear provisions regarding accountability and compliance mechanisms. Those compliance mechanisms may also comprise the possibility to use project-based mechanisms and reduce emissions in other regions or sectors, where abatement costs are lower. These aspects will be facilitated by a high level of concreteness, making the measurement of compliance easier. However, too high standards on measurement certainty must not exclude low-cost

abatement potentials, but programmatic approaches should be applied where appropriate.

The activities of the manufacturers can be measured against specific yardsticks as part of the common yardsticks discussed in section 1.4. For instance, the car industry participating in an integrated approach is responsible for continuous technological improvements in cars (see Table A4.1 in Appendix 4). Performance would be assessed against specific energy-efficiency targets, which should differ according to certain characteristics, like weight. In order to reduce costs, the manufacturers should be allowed maximum flexibility in complying with these targets. Similarly, fuel providers are responsible for providing high quality low-carbon fuels. A proper yardstick could be the carbon intensity of fuel measured on a well-to-wheel basis. For governments, R&D support could serve as one indicator in the field of technology policy. Proper yardsticks for infrastructure and transport policy are more complex, but nevertheless possible (Box 2). Programmatic project approaches in the transport sector can also serve as an example for defining manageable indicators.

Box 2. Urban transport indicators

The Asia Pacific Energy Research Centre (2007) has developed two indicators, which are termed "urban transport indicators": a road indicator and an offset indicator. The road indicator is calculated for the purpose of identifying the major factors of passenger-vehicle energy consumption in urban areas. Three key variables are selected: the number of passenger vehicle stocks, road length and the average vehicle distance travelled. The road indicator is calculated as a weighted (50:20:30) average of each variable. The offset indicator is developed for the analysis of those factors that can reduce growth in urban passenger-vehicle energy consumption. Here again, three variables are chosen: energy-efficiency improvement for passenger vehicles, accessibility or rail or subway infrastructure and governance. The offset indicator is calculated as a weighted (30:40:30) average of each variable. Using these indicators, sets of data from 1995 and 2005 in 10 Asian cities, (the changes in) city-specific contributing or offsetting factors to gasoline consumption are identified.

Finally, measures of an integrated approach cannot be seen in isolation. They will be enhanced by pricing through fuel, registration and circulation taxes or other tools. These elements could be part of the most

effective package of measures to reduce GHG emissions stemming from transport, in conjunction with the yardsticks for measurement.

Successful implementation of an integrated approach in the EU could become an example for other countries, as they consider similar approaches adapted to national circumstances.

3.7 End-use energy efficiency

The EU has committed itself to reducing 20% of its energy consumption compared with projections for 2020. To achieve this, the rate of energy-efficiency improvements will need to more than double if compared with historic rates. The European Commission (2006b) estimates that savings of more than €100 billion annually by 2020 are realistic, given full implementation and enforcement of existing and future measures. The IEA (2006a) and IPCC Working Group 3 (2007) draw similar conclusions on the global level. In the 'world alternative policy scenario' formulated by the IEA (2006a), energy efficiency accounts for almost 80% of the avoided CO_2 emissions with the remainder stemming from fuel-switching. Greater efficiency in the use of fuels and electricity and in energy production accounts for about 36%, 30% and 13% respectively of the emissions saved (IEA, 2006a).

The European Commission (2006b) has identified the building sector as a top priority. The building sector is estimated to have respective potential savings of 27% and 30% in residential and commercial buildings. Additional potential is estimated to lie in the transport sector (26%) and in the manufacturing industry (25%).

Buildings including dwellings

Globally, buildings contribute about 40% of the overall GHG emissions (WBCSD, 2007). There is a wide range of available techniques for insulation, heating, cooling, ventilation and lighting to reduce the carbon footprint from buildings. In the past, the main policy focus was on new buildings. While concentration on new, innovative low-energy and low-GHG techniques for new buildings is crucial from an innovation point of view, it does not tackle the emissions from existing buildings. The European Commission has thus proposed to expand the scope of the Directive on the Energy Performance of Buildings (2002/91/EC) (European Council, 2003), *inter alia*, by significantly lowering the threshold for the

minimum performance requirements for major renovations (European Commission, 2005).

There is a consensus in the literature and among policy-makers that efforts towards energy efficiency and energy conservation in the domestic sectors face numerous barriers. These include a lack of information, which leads to inaction and disbelief among the wider public with respect to energy-saving issues. Another barrier is the complexity of the tenant/landlord relationship and its effects on long-term investment. Further obstacles are misleading prices, technical hurdles such as a lack of standardisation, a lack of (upfront) money, a lack of professional craftsmen and in some cases, a lack of regulation. Hence, solutions lie in a variety of approaches combining strengthened rules, the (re-)introduction of financial stimuli and better information campaigns. All these measures depend on well-defined policy packages, the integration of regulations, financial support and access to information. For the EU, where the principal competencies rest with the member states, an immediate way forward would be to screen and compare member state policies to identify best practices and, most importantly, to ensure implementation at member state, regional and local levels. This step requires an increase in resources in terms of both money and staff in EU administrations in addition to continued political commitment.

Appliances

It is estimated that improved domestic appliances could reduce energy consumption by 20–50%, often in cost-effective ways with a payback period of 10 years or less (e.g. Ecofys (2004), WBCSD (2007) and Egenhofer et al. (2006). According to the European Committee of Domestic Equipment Manufacturers (Mebane & Piccinno, 2006), the current best-available technology in appliances represents an improvement of up to 70% compared with the average energy consumption 10 years ago. This potential, however, is not reached or transformed into energy savings because of the long life cycle of domestic appliances. For instance, 22 Mt of CO_2 emissions could be avoided in Europe every year by replacing 188 million obsolete and energy-inefficient appliances that are 10 or more years old but are still in use. Globally, more than 500 million inefficient appliances are in use in developed country markets (Mebane & Piccinno, 2006).

Household appliances are also anticipated to be among the fastest-growing sources of CO_2 emissions in developing countries, notably in emerging economies. It is thought that in the next decade, several hundreds of millions of families around the world will buy and start to use appliances, meaning that more than a billion appliances could be put into use.

This Task Force has identified the following key elements for a successful strategy on appliances:

- As in all other policy areas analysed above, the keys to success in end-use efficiency include undistorted energy prices (more specifically, electricity prices) reflecting the real energy costs, including the costs of carbon. In principle, this will give a market signal to consumers to buy appliances that are more efficient. This step alone, however, will not be enough. Additionally, consumers need to be informed about the economic and environmental consequences of their choices, e.g. through smart information and labelling campaigns. Yet such policies will only work if there are efficiency criteria for assessing new products, e.g. benefits from a life-cycle perspective incorporating emissions from material use. International measurement standards would allow better comparisons of products while overcoming or even avoiding trade barriers owing to diverse technical standards developing in the different countries.
- One of the main obstacles to the diffusion of more efficient appliances has been the slow rate of replacement. This situation calls for programmes that encourage consumers to replace energy-inefficient equipment with highly energy-efficient products, especially with respect to cooling appliances such as refrigerators, which run 24 hours. Such behaviour can (and will almost certainly have to) be facilitated by government incentive schemes. An open question is how such a government incentive scheme is best designed, e.g. whether it should target consumers or producers. Most existing schemes are directed at consumers through a subsidy at the point of sale or by other means. Another possibility would be tax credits for firms against the share of corporate income tax in proportion to the sales of appliances. The tax credits could be allocated for every supplementary appliance sold by a company in a given year that is highly energy efficient compared with a prior reference period.

- The challenge in emerging economies is considerable not only because of energy pricing, information campaigns and labelling, but also because of difficulties in governments' additional funding for consumers to replace existing appliances with more efficient ones. Hence, added finance from external sources including international financial institutions might be needed.
- Finally, for developed and developing countries alike, a major challenge is the enforcement of existing rules.

4. CONCLUDING REMARKS

The policy proposals developed in chapter 3 cover carbon markets, technology support, energy investment needs, sectoral approaches, integrated approaches and end-use efficiency improvements. Most of the proposals can be taken partly or wholly, alone or combined in a flexible manner. The proposals can be fed into political processes (e.g. the G8+5) supported by dialogues with civil society (e.g. the GLOBE G8+5 Climate Change Dialogue) or policy research delegated to international institutions (e.g. the IEA and World Bank) or both.

As previously indicated, the IEA and the World Bank play a major role in implementing the Gleneagles Plan of Action.[20] While the former continues to help governments to adopt measures for energy savings (e.g. IEA energy efficiency indicators, section 1.4) and new technology or to build up international technology cooperation, the latter, in close cooperation with the UNFCCC, has introduced the Clean Energy for Development Investment Framework (World Bank, 2006) and the Action Plan (World Bank, 2007). These two recent initiatives deserve particular attention. The World Bank Group Action Plan provides for an energy programme in response to the demands of the framework (see chapter 2 in this report). The Action Plan also supports the Africa Energy Scale-up Plan, the transition towards a low-carbon economy especially in emerging economies, and countries' adaptation to climate variability and change. It furthermore explores options for enhanced financial products. The Action Plan is also committed to continued dialogue with governments and the

[20] For further information, see the websites of the IEA and World Bank (http://www.iea.org/G8/index.asp), (http://www.worldbank.org/). See also IEA (2007).

private sector on new approaches to accelerate the transition towards a low-carbon economy. Similar messages have been delivered by the UNFCCC Dialogue on Long-term Cooperative Action in a report on the analysis of investment and financial flows (UNFCCC, 2007). Among other things, the report points to the role of private-sector investment, the demand for investment and financial flows to developing countries, improvement in and an optimal combination of mechanisms such as carbon markets, the UNFCCC financial mechanism, national policies, and in some cases, new and additional resources. Moreover, it looks into a variety of potential mitigation options on a sector basis ranging from energy supply and industry to buildings and transportation.

Given the uncertainty about countries' commitments in the post-2012 period, the proliferation of domestic political actions, processes and the gradual development of (fragmented) carbon markets, there have been calls for a complementary focus on more action-oriented approaches, closer cooperation between governments and stakeholders, and research into potential options for sector-specific mitigation. These changes have been reflected not only in the implementation of the Gleneagles Plan of Action but also in the ways in which the UN processes are currently running. There seems to be an emerging consensus on a joint push for policies to accelerate structural change and transition towards a low-carbon economy, no matter how the post-2012 discussions develop. Such policies could and even should play a crucial role in influencing discussions on a global agreement in terms of direction, speed and depth. This report lists a set of policies that could accelerate structural change, namely, technology support, carbon markets, energy investment needs, sectoral approaches, integrated approaches and end-use efficiency improvements. Proposals for these policies could be incorporated into the existing political processes and in delegated policy research in a flexible manner.

BIBLIOGRAPHY

Asia Pacific Energy Research Centre (APERC) (2007), *Urban transport energy use in the APEC region: Trends and options*, APERC, Tokyo.

Barrett, S. (2002), "Towards a Better Climate Treaty", *World Economics*, Vol. 3, No. 2.

––––––––– (2003), *Environment and statecraft*, Oxford: Oxford University Press.

Baron, R. (2006), *Sectoral Approaches to GHG Mitigation: Scenarios for Integration*, OECD/IEA Information Paper, OECD and IEA, Paris.

Baron, R. and J. Ellis (2006), *Sectoral Crediting Mechanisms for Greenhouse Gas Mitigation: Institutional and Operational Issues*, COM/ENV/EPOC/IEA/SLT (2006)4, OECD and IEA, Paris.

Baron, R., J. Reinaud, M. Genasci and C. Philibert (2007), *Sectoral Approaches to Greenhouse Gas Mitigation — Exploring Issues for Heavy Industry,* OECD/IEA Information Paper, Paris.

Baumert, K. and J. Pershing (2004), *Climate Data: Insights and Observations*, Pew Center on Global Climate Change, Arlington, VA (retrieved from http://www.pewclimate.org).

Capoor, K. and P. Ambrosi, (2007), *State and Trends of the Carbon Market 2007*, World Bank, Washington, D.C., May.

Carter, S., K. Kulovesi, K. Levin, L. Mead and Y. Yamineva (eds) (2008), "Summary of the First Session of the Ad Hoc Working Group on Long-term Cooperative Action and the Fifth Session of the Ad Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol: 31 March – 4 April 2008", *Earth Negotiations Bulletin,* International Institute for Sustainable Development, Vol. 12, No. 362, 7 April.

De Coninck, H., C. Fischer, R.G. Newell and T. Ueno (2007), *International Technology-Oriented Agreements to Address Climate Change*, RFF Discussion Paper 06-50, Resources for the Future, Washington, D.C.

Ecofys (2004), *Mitigation of CO2 emissions from* building, report prepared by Ecofys for EURIMA and EurACE.

Edmonds, J. (2003), "Toward the Development of a Global Energy Technology Strategy to Address Climate Change", paper prepared for a Strategic Roundtable on Global Energy Scenarios at the "22nd World Gas Conference", held in Tokyo, 2 June.

Egenhofer, C. and N. Fujiwara (2008), *Global Sectoral Industry Approaches to Climate Change: The Way Forward*, CEPS Task Force Report, CEPS, Brussels, May.

Egenhofer, C., L. Milford, N. Fujiwara, T. Brewer and M. Alessi (2007), *Low-carbon Technologies in the Post-Bali Period: Accelerating their Development and Deployment*, ECP Report No. 4, presented at COP/MOP, Bali, Indonesia on 7 December 2007, European Climate Platform (ECP), Brussels.

Egenhofer, C., J.C. Jansen, S.J.A. Bakker and J. Jussila Hammes (2006), *Revisiting EU Policy Options for Tackling Climate Change: A Social Cost-Benefit Analysis of GHG Emissions Reduction Strategies*, CEPS/ECN, Brussels.

European Commission (2005), Communication from the Commission to the Council, the European Parliament and the European Economic and Social Committee and the Committee of the Regions, Winning the battle against global climate change, COM(2005) 35 final, 9 February.

––––––––– (2006a), *World energy technology outlook – 2050, WETO-H_2,* Directorate-General for Research and Directorate-General for Energy and Transport, European Commission, Brussels.

––––––––– (2006b), Communication on an Action Plan for Energy Efficiency: Realising the Potential, COM(2006) 545, European Commission, Brussels, 19 October.

––––––––– (2007), Communication on the Mid-term Review of Industrial Policy: A Contribution to the EU's Growth and Jobs Strategy, COM(2007) 374, European Commission, Brussels, 4 July.

––––––––– (2008a), Proposal for a Decision of the European Parliament and the Council on the effort of Member States to reduce their greenhouse

gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020, COM(2008) 17final, 23 January.

––––––––– (2008b), Proposal for a Directive of the European Parliament and the Council on the promotion of the use of energy from renewable sources, COM(2008) 19 final, 23 January.

––––––––– (2008c), Proposal for a Directive of the European Parliament and of the Council amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading system of the Community, COM(2008) 16 final, 23 January.

––––––––– (2008d), Proposal for a Directive of the European Parliament and of the Council on the geological storage of carbon dioxide and amending Council Directives 85/337/EEC, 96/61/EC, Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC and Regulation (EC) No. 1013/2006, COM(2008) 18 final, European Commission, Brussels, 23 January.

––––––––– (2008e), Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, 20 20 by 2020: Europe's climate change opportunity, COM(2008) 30final, 23 January.

European Council (2003), Directive 2002/91/EC of 16 December 2002 on the Energy Performance of Buildings, OJ L 1, 4.1.2003.

––––––––– (2007), Presidency Conclusions of the Brussels European Council of 8-9 March, 7224/07, CONCL 1, Brussels, 2 May.

––––––––– (2008), Presidency Conclusions of the Brussels European Council of 13-14 March, 7652/08, CONCL 1, Brussels, 14 March.

European Environment Agency (EEA) (2007), Greenhouse gas emissions trends and projections in Europe 2007. EEA Report, 5/2007.

Federal Government of Germany (2007a), "Growth and Responsibility – Leitmotif for Germany's G8 Presidency", published as "Highlights of the German Presidency's Agenda", G8 Summit 2007, Berlin.

––––––––– (2007b), "G8 – Economic power", G8 Summit 2007, Berlin (retrieved from http://www.g-8.de/Webs/G8/EN/Background/Economics/wirtschaftskraft.html).

Fischer, C., C. Egenhofer and M. Alessi (2008), "The critical role of technology for international climate change policy", in C. Egenhofer

(ed.), *Beyond Bali: Strategic Issues for the Post-2012 Climate Change Regime*, CEPS, Brussels, April, pp. 118-133.

Fujiwara, N. (2007), *The Asia–Pacific Partnership on Clean Development and Climate: What it is and what it is not*, CEPS Policy Brief No. 144, CEPS, Brussels, October.

Heller, T.C. (2006), "Diversifying power generation in China", in M. Colombier and J. Loup (eds), *Bringing Developing Countries into the Energy Equation,* Analyses IDDRI No. 2/2006, Institut du Developpement Durable et des Relations Internationales, Paris, pp. 31-42.

Hoehne, N., F. Yamin and E. Haitis (2008), "History and status of the international negotiations on a future climate agreement", in C. Egenhofer (ed.), *Beyond Bali: Strategic Issues for the Post-2012 Climate Change Regime*, CEPS, Brussels, April, pp. 13-35.

Humphreys (2001), "The nation's energy future: The role of renewable energy and energy efficiency", testimony before the US House Committee on Science, 28 February.

International Energy Agency (IEA) (2004), *World Energy Outlook 2004*, IEA, Paris.

––––––––– (2006a), *World Energy Outlook 2006*, IEA, Paris.

––––––––– (2006b), *China's Power Sector Reforms*, IEA/OECD, Paris.

––––––––– (2007), "Toward a clean, clever and competitive energy future", IEA/OECD, Paris.

Intergovernmental Panel on Climate Change (IPCC) (2005), *Special Report on CO_2 Capture and Storage: Summary for Policy-makers*, IPCC, Geneva.

IPCC, Working Group 1 (2007), "Contribution of Working Group 1 to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change: Summary for Policy-makers", IPCC, Geneva.

IPCC, Working Group 3 (2007), "Contribution of Working Group 3 to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change: Summary for Policy-makers", IPCC, Geneva.

Jaffe, A.B., R.G. Newell and R.N. Stavins (2005), "A Tale of Two Market Failures – Technology and Environmental Policy", *Ecological Economics*, Vol. 54, Nos. 2-3, pp. 164-174.

Jansen, J.C., K. Gialoglou and C. Egenhofer (2005), *Market stimulation of renewable electricity in the EU: What degree of harmonisation of support mechanisms is required?*, CEPS Task Force Report, CEPS, Brussels.

Mebane, W. and E. Piccinno (2006), *The cost-effectiveness of production tax credits in transforming the market for home appliances and harnessing manufacturers' competitiveness*, European Committee of Domestic Equipment Manufacturers, Brussels.

Pacala, S. and R. Socolow (2004), "Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies", *Science*, Vol. 305, 13 August, pp. 968-972.

Schmidt, J., N. Helme, J. Lee and M. Houdashell (2006), *Sector-based approach to the post-2012 climate change policy architecture*, Center for Clean Air Policy, Washington, D.C.

Stern, N. (2007), *The Stern Review on the Economics of Climate Change*, Cambridge: Cambridge University Press.

UN Framework Convention on Climate Change (UNFCCC) (2007), *Report on the analysis of existing and potential investment and financial flows relevant to the development of an effective and appropriate international response to climate change*, Dialogue Working Paper No. 8, Dialogue on Long-term Cooperative Action to Address Climate Change by Enhancing Implementation of the Convention, Fourth Workshop, Vienna.

Vattenfall (2006), *Curbing climate change: An outline of a framework leading to a low carbon emitting society*, Vattenfall, Stockholm, January.

World Bank (2006), *An investment framework for clean energy and development: A progress report*, Vice Presidency for Sustainable Development, World Bank, Washington, D.C., 1 September.

––––––––– (2007), *Clean Energy for the Development Investment Framework: The World Bank Group Action Plan*, World Bank, Washington, D.C., 28 March.

World Business Council for Sustainable Development (WBCSD) (2005), *Pathways to 2050: Energy & climate change*, WBCSD, Geneva.

––––––––– (2006), *Powering a sustainable future: An agenda for concerted action*, WBCSD, Geneva.

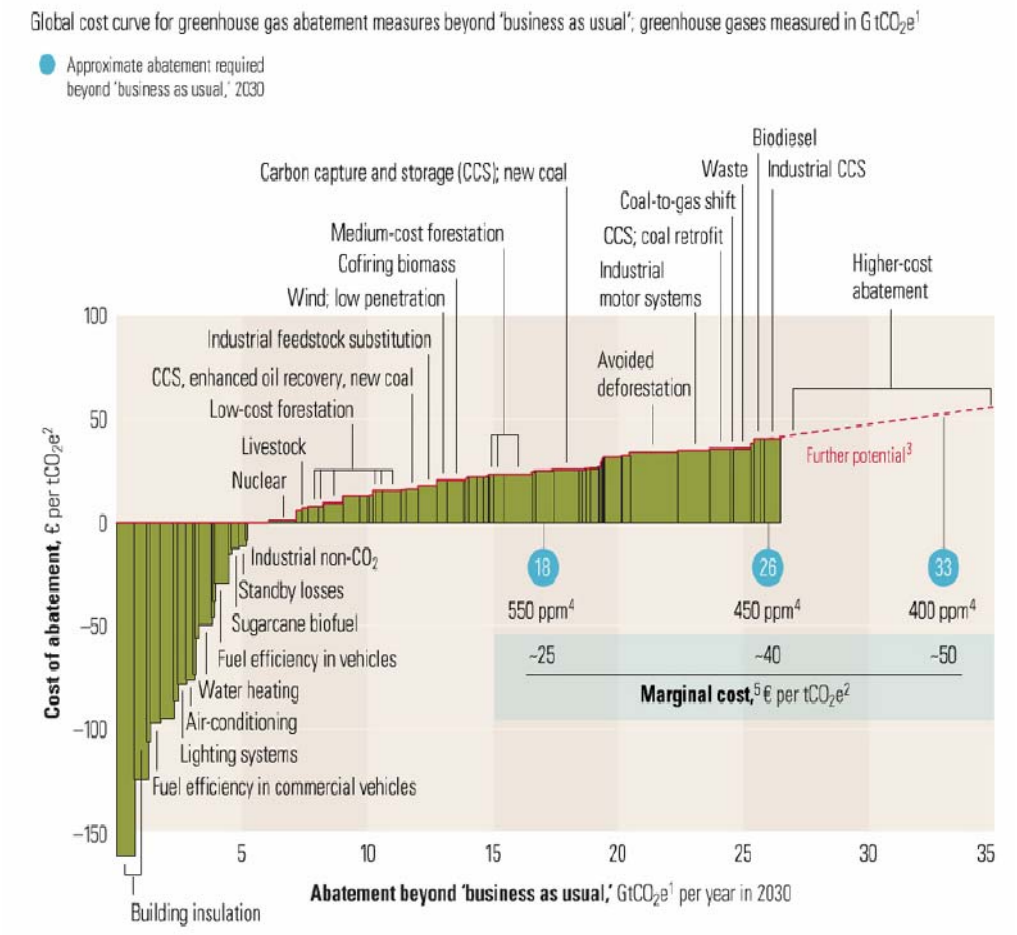
––––––––– (2007), *Policy directions to 2050: A business contribution to the dialogues on cooperative action*, WBCSD, Geneva.

GLOSSARY OF ABBREVIATIONS

AWG	Ad-hoc Working Group (on Further Commitments for Annex I Parties)
AWG-LCA	Ad-hoc Working Group on a Long-term Cooperative Action Plan
CARE	Climate action and renewable energy
CCS	Carbon capture and storage
CDM	Clean development mechanism
CHP	Combined heat and power
ETS	Emissions trading scheme
GHG	Greenhouse gas
GLOBE	Global Legislators Organisation for a Balanced Environment
GtC	Gigatonne of carbon
$GtCO_2$	Gigatonne of carbon dioxide
GW	Gigawatt
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
JI	Joint implementation
$MtCO_2e$	Million tonnes of carbon dioxide equivalent (quantities of GHGs)
NGCC	Natural gas combined cycle (plants)
NGO	Non-governmental organisation
ppm	Parts per million
SCM	Sectoral crediting mechanism
TOA	Technology-oriented agreement
UNFCCC	UN Framework Convention on Climate Change
WBCSD	World Business Council for Sustainable Development
WETO	World energy, technology and climate policy outlook (produced by the European Commission)
WSSD	World Summit on Sustainable Development

APPENDIX 1. GLOBAL COST CURVE FOR GREENHOUSE GAS ABATEMENT MEASURES

Figure A1.1 Global costs of GHG abatement

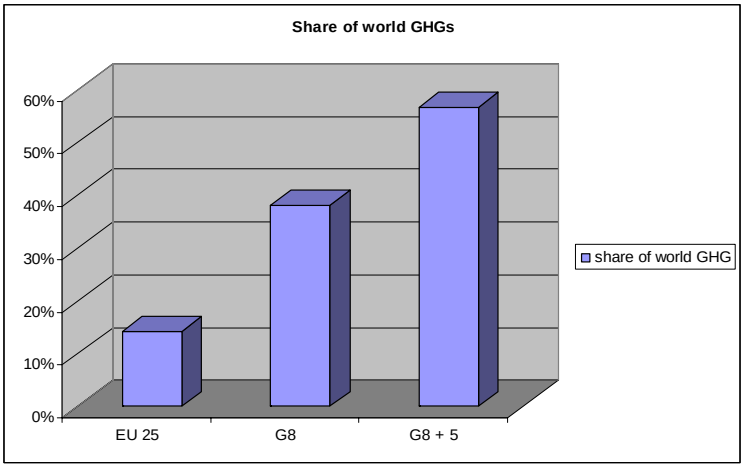


[1] $GtCO_2e$ = gigaton of carbon dioxide equivalent; "business as usual" based on emissions growth driven mainly by increasing demand for energy and transport around the world and by tropical deforestation.
[2] tCO_2e = ton of carbon dioxide equivalent.
[3] Measures costing more than €40 a ton were not the focus of this study.
[4] Atmospheric concentration of all greenhouse gases recalculated into CO_2 equivalents; ppm = parts per million.
[5] Marginal cost of avoiding emissions of 1 ton of CO_2 equivalents in each abatement demand scenario.

Source: Vattenfall (2006).

APPENDIX 2. SHARES OF WORLD GHG EMISSIONS, PER CAPITA EMISSIONS AND GHG INTENSITY IN G8+5 COUNTRIES

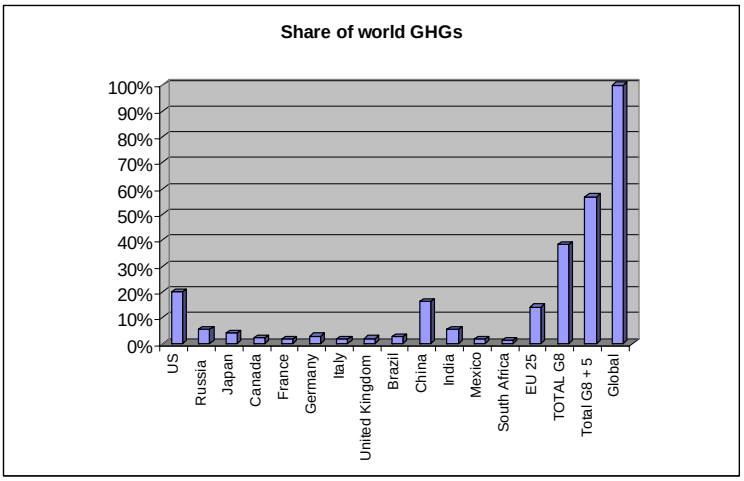
Figure A2.1 Shares of world GHG emissions: EU-25, G8 and G8+5



Note: Based on data from 2003, the year for which the most recent data were available at the time of collection in August 2007.

Sources: Greenhouse Gas Inventory Data, UNFCCC; US EPA 2006 Global Anthropogenic Non-CO2 greenhouse gas emissions 1990-2020; OECD Environmental Data Compendium; and EDGAR 3.2 database, Netherlands Environmental Assessment Agency.

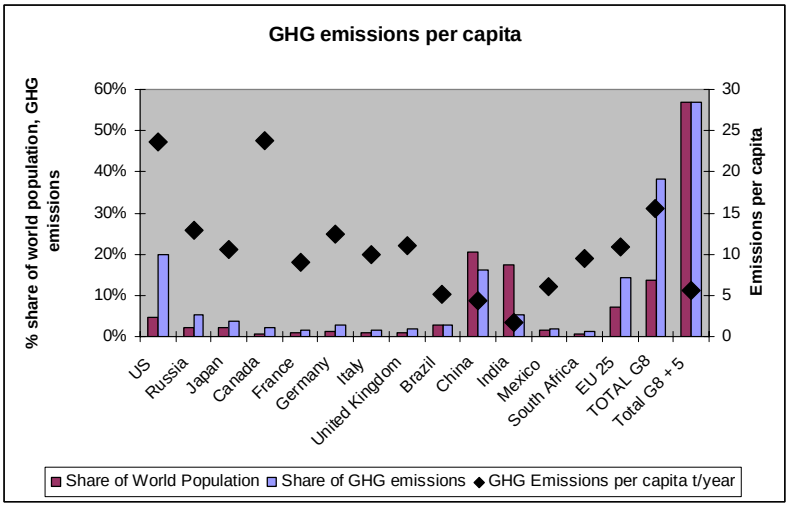
Figure A2.2 Shares of world GHG emissions by country/grouping



Note: Based on data from 2003, the year for which the most recent data were available at the time of collection in August 2007.

Sources: Greenhouse Gas Inventory Data, UNFCCC; US EPA 2006 Global Anthropogenic Non-CO2 greenhouse gas emissions 1990-2020; OECD Environmental Data Compendium; and EDGAR 3.2 database, Netherlands Environmental Assessment Agency.

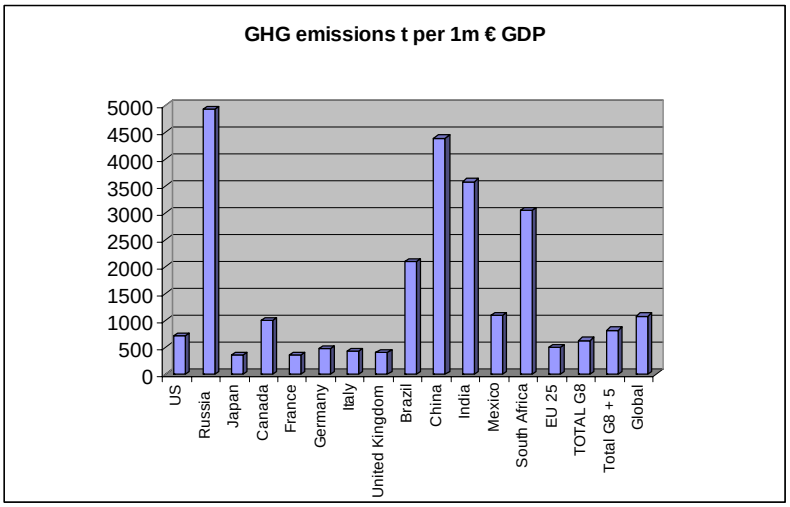
Figure A2.3 GHG emissions per capita by country/grouping



Note: Based on data from 2003, the year for which the most recent data were available at the time of collection in August 2007.

Sources: Greenhouse Gas Inventory Data, UNFCCC; US EPA 2006 Global Anthropogenic Non-CO2 greenhouse gas emissions 1990-2020; OECD Environmental Data Compendium; and EDGAR 3.2 database, Netherlands Environmental Assessment Agency.

Figure A2.4 GHG emissions by tonne per €1 million GDP by country/grouping



Note: Based on data from 2003, the year for which the most recent data were available at the time of collection in August 2007.

Sources: Greenhouse Gas Inventory Data, UNFCCC; US EPA 2006 Global Anthropogenic Non-CO2 greenhouse gas emissions 1990-2020; OECD Environmental Data Compendium; and EDGAR 3.2 database, Netherlands Environmental Assessment Agency.

APPENDIX 3. MAJOR GLOBAL PARTNERSHIPS ON ENERGY AND CLIMATE CHANGE

Table A3.1 Major multilateral global partnerships on energy and climate change

Partnerships	Description
Global Gas Flaring Reduction (GGFR)	The GGFR is a World Bank-led initiative launched at the 2002 World Summit on Sustainable Development (WSSD). It is a *public–private partnership*, which facilitates and supports national efforts to use currently flared gas by promoting effective regulatory frameworks and tackling the constraints on gas utilisation. Poverty reduction is also an integral part of the programme (see http://www.cslforum.org/).
Partnership for Clean Fuels and Vehicles (PCFV)	The PCFV was also launched at the 2002 WSSD as a *public–private partnership*. It seeks to reduce vehicular air pollution in developing countries through the promotion of clean fuels and vehicles. It has focused initially on the elimination of lead in gasoline and the phase-down of sulphur in diesel and gasoline fuels concurrent with the adoption of cleaner vehicle technologies (see http://www.unep.org/pcfv/).
Johannesburg Renewable Energy Coalition (JREC)	The JREC was launched following the Johannesburg Plan of Implementation agreed at the 2002 WSSD. Ministers and senior officials identified a large range of policy objectives that can be addressed through increased renewable energy policies and measures including objectives related to the environment, energy and development (see http://ec.europa.eu/environment/jrec/index_en.htm).
Carbon Sequestration Leadership Forum (CSLF)	The CSLF focuses on the development of improved, cost-effective technologies for the separation and capture of CO_2 for its transport and long-term safe storage. Launched in 2003, its purpose is to make these technologies broadly available internationally and to identify and address wider issues relating to carbon capture and storage (see http://www.cslforum.org/).

Table A3.1 continued

Partnerships	Description
International Partnership for the Hydrogen Economy (IPHE)	Launched in 2003, the IPHE aims at accelerating the transition to a hydrogen economy. It serves as a mechanism to organise effective, efficient and focused international research, development, demonstration and commercial utilisation activities related to hydrogen and fuel cell technologies (see http://www.iphe.net/).
Methane to Markets Partnership (MMP)	The Partnership is an initiative taken in 2004 to advance cost-effective, near-term methane recovery and use as a clean energy source. Its goal is to reduce global methane emissions in order to enhance economic growth, strengthen energy security, improve air quality, improve industrial safety and reduce GHG emissions (see http://www.methanetomarkets.org/).
FutureGen	FutureGen is a *public–private partnership* formed in 2005 to build a first-of-its-kind coal-fuelled, near-zero emissions power plant (see http://www.futuregenalliance.org/about.stm).
Renewable Energy and Energy Efficiency Partnership (REEEP)	The REEEP was conceived at the 2002 WSSD and established in 2004. This *public–private partnership* organises policy and regulatory initiatives for clean energy and facilitates financing for energy projects. Its aim is to accelerate the integration of renewables into the energy mix and to advocate energy efficiency as a path to improved energy security and reduced carbon emissions, ensuring socio-economic benefits (see http://www.reeep.org/).
Generation-IV International Forum (GIF)	In the GIF, countries work together to lay the groundwork for the 4th generation nuclear reactor, Generation IV (see http://gif.inel.gov/).
Global Nuclear Energy Partnership (GNEP)	First announced in 2006, the GNEP seeks to develop a worldwide consensus on enabling the expanded use of clean, safe and affordable nuclear energy to meet growing electricity demand. It proposes a nuclear fuel cycle that enhances energy security (see http://www.gnep.gov/).

Source: Fujiwara (2007).

Table A3.2 Major bilateral global partnerships on energy and climate change

Partnership	Description
US Fossil Energy Bilateral Agreements	The formats and goals for these agreements are set bilaterally (http://fossil.energy.gov/international/International_Partners/International_Partners.html).
US ENERGY STAR agreements	There are international agreements to promote certain ENERGY STAR-qualified products. These aim at unifying voluntary energy-efficiency labelling programmes in major global markets and making it easier for partners to participate by providing a single set of energy-efficiency qualifications (see http://www.energystar.gov/index.cfm?c=partners.intl_implementation).
International Nuclear Energy Research Initiative (I-NERI)	The US I-NERI programme is designed to foster collaborative R&D with international partners in advanced nuclear energy systems. It has implemented bilateral collaborative agreements (see http://www.energetics.com/ineri_client/index.aspx).
EU bilateral cooperation initiatives	The formats and goals for these initiatives are set bilaterally (see http://ec.europa.eu/dgs/energy_transport/international/index_en.htm).

Source: Fujiwara (2007).

Table A3.3 Multilateral global partnerships and their main participants

	G8	G8	G8	G8	G8	G8	G8	G8	+5	+5	+5	+5	+5	
	CA	**FR**	**DE**	**IT**	**JA**	**RU**	**UK**	**US**	**BR**	**CH**	**IN**	**ME**	**SA**	**EU**
GGFR	○	○				●	○	○						○
PCFV	●									●		●		
JREC		●	●	●			●		●				●	●
CSLF	●	●	●	●	●	●	●	●	●	●	●	●	●	●
IPHE	●	●	●	●	●	●	●	●	●	●	●			●
MMP	●		●	●	●	●	●	●	●	●	●	●		

Table A3.3 continued

	G8	G8	G8	G8	G8	G8	G8	G8	+5	+5	+5	+5	+5	
	CA	**FR**	**DE**	**IT**	**JA**	**RU**	**UK**	**US**	**BR**	**CH**	**IN**	**ME**	**SA**	**EU**
REEEP	○	●	○	○	●		○	○	●			●	●	○
GIF	●	●			●		●	●	●				●	
GNEP		●			●	●	◘	●		●				

Legend: ○ Member and donor ● Member ◘ Observer

Notes: The EU is represented at G8 summits but is not counted as one of the eight members. The EU is a donor to the GGFR, and it led the launch of the JREC. The European Commission is a member of the CSLF, the IPHE and the REEEP. EURATOM is a member of the GIF. The non-G8+5 participants are not listed.

Source: Modified from Table 3, Appendix 3, Fujiwara (2007).

Table A3.4 Bilateral global partnerships and their main participants

	CA	**FR**	**DE**	**IT**	**JA**	**RU**	**UK**	**US**	**BR**	**CH**	**IN**	**ME**	**SA**	**EU**
Fossil Fuel	●			●		●	●	○	●	●[a)]	●[b)]			
ENERGY STAR	●				●			○						●
I-NERI	●	●			●			○	●					
EU Cooper-ation						●		●	●[c)]	●[d)]	●[e)]			○

[a)] The bilateral Fossil Energy Protocol has been extended to 2010. There is also a public–private partnership, the US–China Oil and Gas Industry Forum.

[b)] A US–India Energy Dialogue was launched in May 2005.

[c)] A new Energy Policy Dialogue was launched in July 2007.

[d)] The EU–China Partnership on Climate Change was agreed in September 2005.

[e)] The EU–India Initiative on Clean Development and Climate Change was agreed in September 2005.

Legend: ○ Host country ● Its partners

Note: The non-G8+5 participants are not listed.

Source: Modified from Table 4, Appendix 3, Fujiwara (2007).

APPENDIX 4. REPORT OF THE TRANSPORT SUB-GROUP, MAY 2007

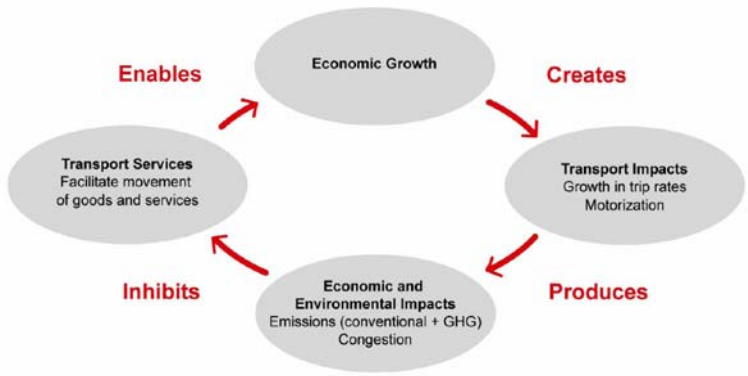
CEPS G8+5 Climate Change Task Force – An Integrated Approach

The mobility dilemma

Transport services facilitate the movement of goods and services, enabling economic growth and improving human welfare. These same transport services also create more demand for the mobility of products and hence, more trips and vehicles.

The environmental and safety impacts of increased levels of mobility can include greenhouse gas (GHG) and conventional emissions, congestion, accidents and noise. These are to be addressed by industrial and political activities in order to ensure sustainability and enable continued economic growth.

Figure A4.1 The mobility dilemma



Background – Where does transport fit in?

Transport makes a considerable contribution to GHG emissions. In the year 2000, transport contributed worldwide about 14% of global GHG emissions, representing roughly 21% of energy emissions (mainly CO_2 – see Stern, 2007). The transport proportion is somewhat higher in North America, which itself represents about 25% of global GHG emissions. Light vehicle transport (passenger cars and vans) represent less than half of transport emissions.

Figure A4.2 GHG contributing sectors

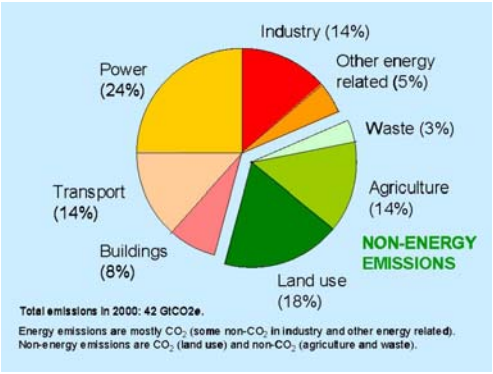
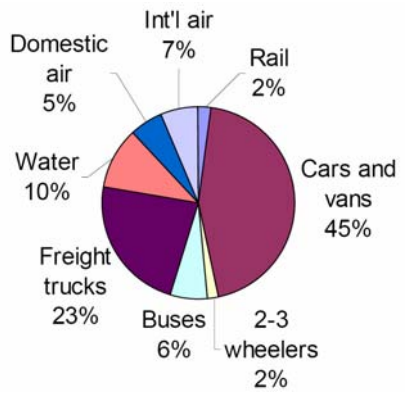


Figure A4.2 Transport split



Source: Stern (2007).

According to the Stern report (2007), transport's contribution is likely to remain at 14% of total GHG emissions by 2050, even as total emissions double between 2000 and 2050. Most of the growth in transport emissions will come from China, Asia, Latin America and North America.

Principles for reducing global transportation GHG emissions

Since global transportation is a contributor to GHG emissions (mainly CO_2 and NO_x), it is reasonable for this sector to contribute to a reduction in GHG emissions. It is also important to note that transport GHG emissions are indistinguishable from GHG emissions from other sources or with respect to country of origin. Policies on reducing emissions from transport should recognise it as part of an economy-wide and global issue. The following principles should be applied when considering policy and technology options for this sector:

- Transport GHG contributions should be seen as one part of an entire system, in conjunction with all the other sectors.
- Ultimately, GHG emission reduction measures should be global in nature, with regional measures to be viewed as a stage on the way to global agreements.
- The target for policy measures is to limit or reduce total GHG emissions and thereby assist in limiting atmospheric GHG concentration.

- Measures should be non-discriminatory. There should be no 'picking technology winners'.
- Against the background of the enormous efforts that are necessary to mitigate climate change, measures and technology must achieve cost-effectiveness.
- In developing regulations, comprehensive and independent impact assessments, including all relevant sectors, are essential.
- Many stakeholders contribute to the CO_2 emissions of vehicles in transport; therefore, all these stakeholders should be involved in reducing CO_2 emissions in order to realise the most cost-effective solutions.

Adhering to the above principles, abatement costs should ideally be the same throughout the entire economy, preferably globally. In this study, we concentrate on transport-specific measures, taking into account the economy-wide and global nature of GHG emissions in developing policy options.

For the transportation sector, the last principle mentioned above, referring to the contributions of many stakeholders, leads to the policy foundation of an integrated approach, as described below.

Rationale, measures and stakeholders for an integrated approach

An integrated approach involves all the stakeholders in securing solutions to meet policy objectives, in contrast to concentrating on only one aspect, e.g. technology. The contributions from technology should be complemented by those from other stakeholders, including users, government and associated industries. To work well, the principle of cost-effectiveness should be applied to any integrated approach to achieve the greatest benefit at the least cost.

The relevant stakeholders can be summarised into four groups: the automotive industry, the fuel industry, government and drivers/consumers. Similarly, measures can be grouped into four areas: automotive technology, fuels, infrastructure and driver behaviour.

Table A4.1 indicates the measures that are available to affect change by each of these four groups in each of the four areas. In addition, the influence of policy on each of the areas is shown in the final column. The lightly shaded fields represent those that are appropriate for inclusion in an integrated approach.

Table A4.1 Measures for an integrated approach

	Responsible stakeholders				Policy levers
Areas of responsibility	**Automotive industry**	**Fuel industry**	**Drivers/ consumers**	**Government agencies**	
Auto technology	Automotive technology Marketing	Fuel quality	Vehicle purchasing decision	R&D support Commercialisation support	CO_2 labelling standards Tax/incentive policy R&D support
Fuels	Technology to enable alternative fuels	Low-CO_2 fuels (especially biofuels)	Fuel purchasing decision	R&D support Commercialisation support	Fuel quality standards Well-to-wheel standards for fuels Tax/incentive policies
Infrastructure & transport policy	ITS technologies Use of alternative transit	-	ITS access and use Use of alternative transit	ITS support Infrastructure construction and management	Resources for infrastructure Standards for ITS Availability of alternative transit
Driving behaviour	GSI Eco-driving information	Fuel availability information Eco-driving information	Driving style Vehicle usage Maintenance	Information on driving style & car usage Education on eco-driving	Tax/incentive policies

Selected measures/responsibilities in focus for an integrated approach on CO_2; Potential policy levers

ITS: Intelligent transport systems

GSI: Gear shift indicator

Source: Authors' compilation.

Tasks for each stakeholder in an integrated approach

Automotive industry

Below is a list of the main categories of measures available for implementation by the automobile industry and more detailed examples of the elements at which measures can be targeted. The industry itself is in the best position to determine which technical measures are most cost-effective in meeting targets. Policies for regulating emissions should recognise the cost implications of the measures available. Thus, the selection of emissions limits in this and other markets, if applied, should be decided based on independent impact assessments, which should help to determine the cost-effectiveness of all available measures within an integrated approach.

- Automotive technology options
  - Increased engine efficiency
  - Weight reduction
  - Higher-efficiency components and appliances
  - Improved aerodynamics & mechanical friction
- Behavioural technology options
  - Gear shift indicator
  - Develop and install intelligent transport system accessories
- Consumer information
  - Promote eco-driving
  - Support transparency in consumer/driver information on CO_2 emissions (e.g. labelling)

Fuel supply and delivery industry

Below is a list of the main categories of measures available for the implementation of fuels to reduce GHG emissions. As with automotive technology, it is appropriate for cost-effective solutions to be identified and for policy and regulation to reflect this. Again, this approach requires independent impact assessments to determine the optimum stringency of policy measures in comparison with measures in other areas.

- Increase the market penetration of alternative fuels with low CO_2 intensity, in particular biofuels.
- Improve the CO_2 intensity of conventional fuels.

- Provide the infrastructure for alternative fuels.
- Provide the infrastructure for tyre inflation.
- Provide low-viscosity oil.

Drivers/consumers

Drivers of cars and trucks are the direct link in the chain to actual CO_2 emissions. Their behaviour leads straight to the consumption of fuel and emissions of CO_2. Their behaviour is difficult to mandate or regulate, and hence measures in this category mainly relate to the adaptation of behaviour through information and training. The following behavioural measures can be employed by individuals, and are highly cost-effective since behavioural changes do not involve a financial outlay. Similarly, consumers (i.e. the person who purchases the vehicle, who may be distinct from the driver) have an influence through their decisions on vehicle purchase.

- Employ eco-driving.
- Complete regular maintenance.
- Adapt behaviour by reducing unnecessary trips, by telecommuting, etc.
- Consider alternative modes of transport according to the available infrastructure.
- Consider CO_2 emissions as a factor in the initial vehicle purchase.

Government agencies

Specific substantive measures can be employed by governments that have a direct effect on consumption and CO_2 emissions:

- Improve road traffic management through the intelligent design of roads and support for intelligent transport systems.
- Improve and build the infrastructure to reduce congestion and facilitate traffic flow.
- Financially support R&D and commercialisation for vehicle and fuel technologies.
- Support eco-driving programmes by offering training and implementing a validation scheme.
- Manage the public procurement of vehicles and fuels with consideration for environmental criteria.

Actions by policy-makers

These actions refer to the measures that will in the medium and long term influence the decision-making of other stakeholders and thereby encourage the shift towards technologies and activities that reduce GHG emissions (as distinct from specific substantive measures implemented by government agencies). In this context, the most useful measures that can be implemented by policy-makers are the employment of stringent, independent and objective impact assessments to determine the cost-effectiveness and affordability of all the available technical and non-technical options. This step will facilitate the setting of regulatory standards at the appropriate level and will lend support to those actions that will help to reduce CO_2 emissions but cannot be regulated directly.

In addition, the following measures can be applied by governments:

- Shift taxation towards a proportional CO_2 basis (and by implication away from existing tax bases), increasingly harmonised within and between regions. This approach ensures a clear and consistent signal among markets through a consistent or harmonised price of CO_2 emissions and therefore a uniform incentive to reduce emissions.
- Promote other incentives for the purchase of vehicles and fuels according to their CO_2 reduction performance. In particular, under circumstances in which tax treatment is not an option, incentives can be designed to achieve similar results as shifts in taxation.
- The level of CO_2 taxation (or other incentives) will determine how producers and consumers value CO_2 and thus the amount of CO_2 reduction that can be achieved in the transportation sector.
- Implement programmes to increase the transparency of information on the CO_2 performance of cars and fuels, driver behaviour and financial incentives, including the standardisation of labelling and other information sources.
- Support and implement the commonality of relevant technology standards, in particular for fuel quality, well-to-wheel GHG balance of fuels, vehicle regulations and intelligent transport systems. These standards assist in ensuring that the market signals through a global price on CO_2 are efficiently transmitted throughout the economy.
- Make long-term resources available to support policy, in particular for infrastructure development and support for R&D and commercialisation of technologies.

Summary – Achieving an integrated approach effectively and efficiently

Actions by policy-makers are fundamental to progress in implementing an integrated approach in the transportation sector, according to the general policy measures above.

Independently and in response to policy signals, other stakeholders – including businesses and consumers – should implement measures that reduce overall CO_2 emissions, consistent with economic effectiveness and good (corporate) citizenship, in addition to adhering to technical regulations.

An ideal national, regional or even global policy would be one that puts a price on GHG emissions, so that consumers and businesses are encouraged through their financial interests to reduce emissions. Actions in this direction include GHG taxation and other fiscal measures, which, to work well, should yield the same value for CO_2 economy-wide. Within such a framework, policies can be applied to reach the high-level GHG reduction targets determined by policy-makers. The lever to achieve the reductions is therefore the value given to CO_2, and thus the reductions in emissions that are necessary to reach the targets are attained where they make the greatest economic sense. This is the ultimate integrated approach.

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