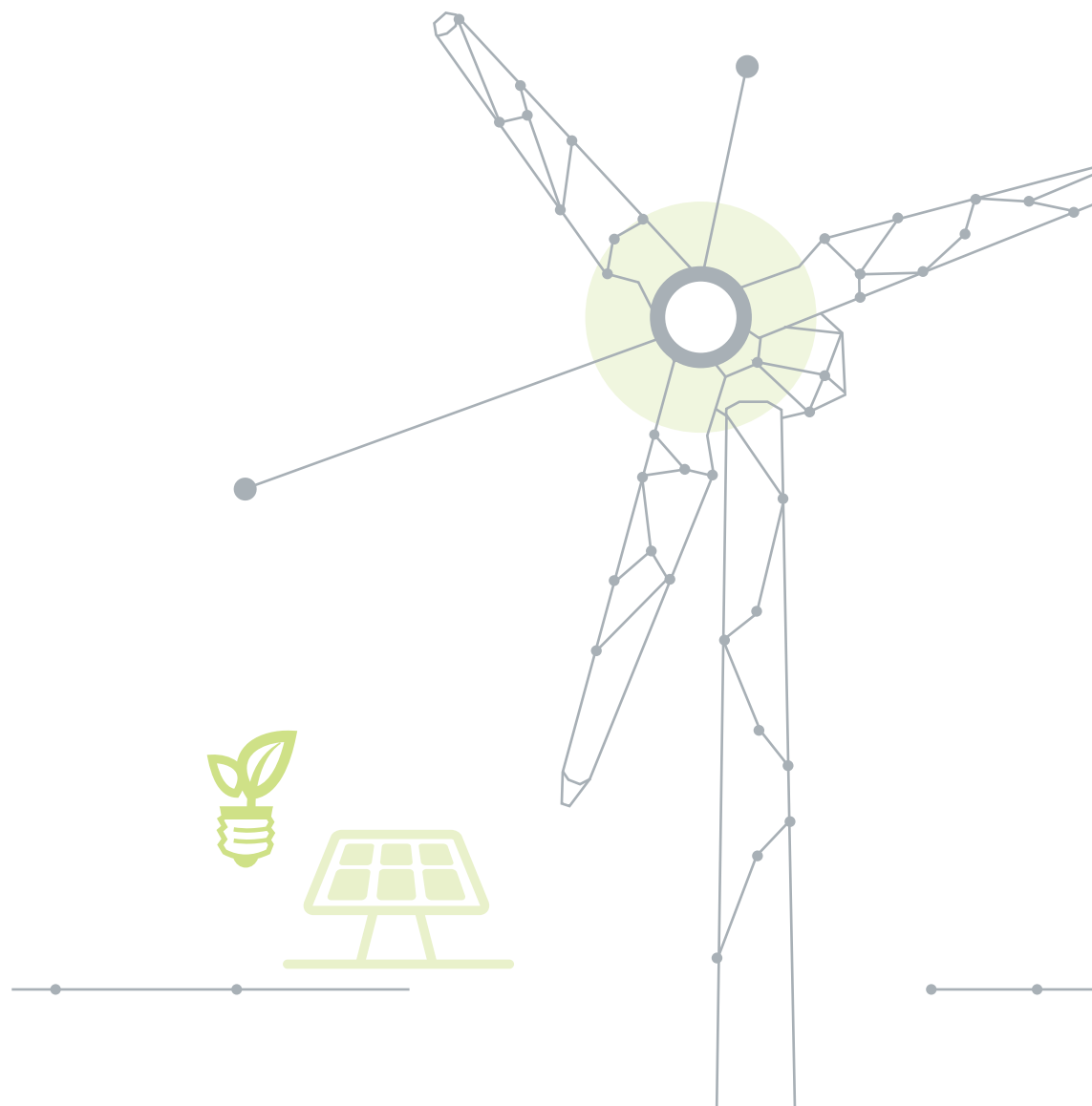


INVESTMENT  
OPPORTUNITIES  
IN KOREA

# NEW & RENEWABLE ENERGY



# NEW & RENEWABLE ENERGY

KOREA,  
Where **Success** Knows No Limits

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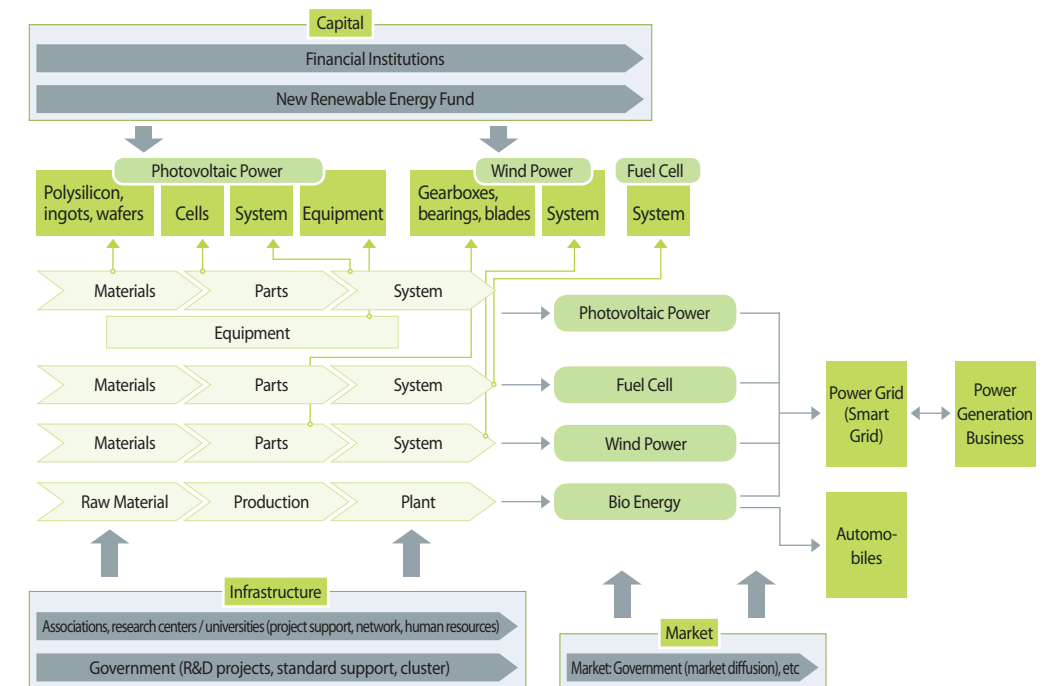
## 01

INDUSTRY  
OVERVIEWDefinition of  
the industry  
and ecosystem  
structure

New & renewable energy is defined, according to Article 2 of the Act on the Promotion of the Development, Use and Diffusion of New and Renewable Energy, as “an energy transformed from existing fossil fuels or a renewable source, including sunlight, water, geothermal heat, a river and bio-organisms.” It is divided into 11 categories.

New energy includes three items: hydrogen and fuel cells and the gasification of coal and heavy residual oil. Renewable energy includes photovoltaics, solar heat, bio, wind power, hydraulic power, marine, waste and thermal heat.

## Concept map of the ecosystem of the new &amp; renewable energy industry

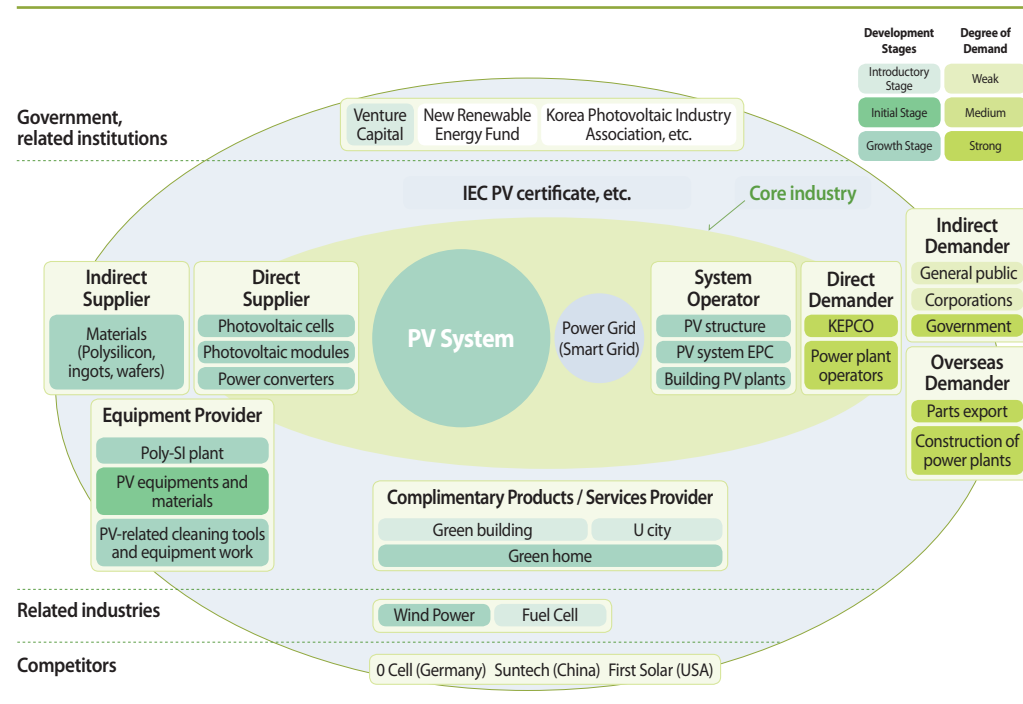


\* Source: Research on New Growth Engines and Ways to Promote Them, 2010, Korea Institute for Industrial Economics and Trade (2010)

For photovoltaics, the core business area is a photovoltaic power system. The structure of the system connects a system operator and a domestic demand group, which consists of direct consumers including the Korea Electric Power Corporation and indirect consumers, including the public, through power grids.

This system forms a business ecosystem, in a broad sense, where there is an overseas consumer group for the export of each parts and materials unit and system; suppliers of related equipment for demand purposes; green buildings for complementary goods and relevant industries; and certificate authorities including the IEC.

### The value chains and ecosystem of the photovoltaic business

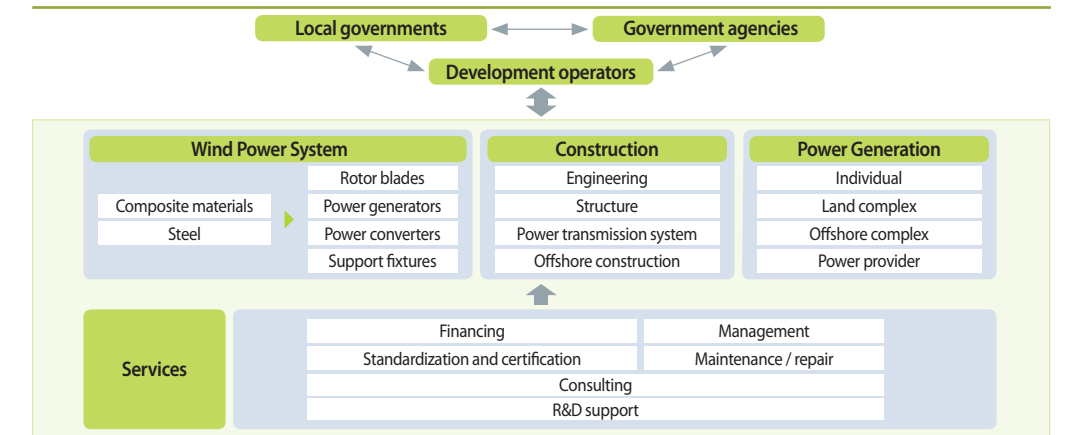


\* Source: Research on the Promotion of the Industrial Ecosystem of New Growth Engines, December, 2011, Korea Institute for Industrial Economics and Trade (2011)

The wind power industry, which is related to the construction industry that builds the wind power system and development projects, has a business ecosystem where private developers, local governments and government institutions order projects with the support of external service providers that handle the industry's financial, authentication, consulting, research and development (R&D) affairs, operation and maintenance.

Major corporate members of the wind power industry in Korea have mostly advanced into the wind power business as part of their investments in emerging businesses, doing related businesses (e.g., shipbuilding, heavy industry). Most of them have secured the required technological prowess and production capacity through mergers and acquisitions (M&A) of foreign enterprises and production lines. When it comes to small- and medium-sized enterprises (SME), those belonging to the construction, metal forge welding and metal assembly parts manufacturing, ship engine parts and machinery manufacturing industries are expanding their business range into the wind power equipment area.

### Value chains and ecosystem of the wind power industry

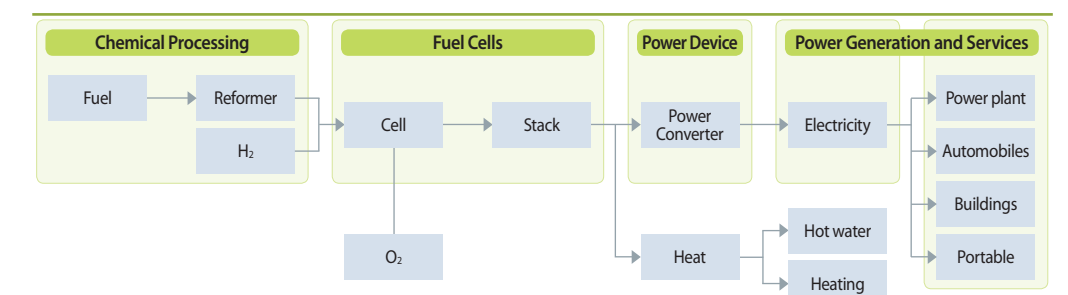


\* Source: Approaches to the Creation of an Industrial Ecosystem for the Co-survival and Development of Large / Small / Medium Enterprises in the New & Renewable Energy Industry, April, 2012, Korea Institute for Industrial Economics and Trade

In the case of fuel cells whose release on the market is relatively slow compared to photovoltaics and wind power, heat and electricity are produced through a fuel battery system composed of cells and stacks. The heat is supplied to consumers as energy for hot water and air / floor heating and electricity is supplied to power generation plants, automobiles, buildings and mobile devices, all of which constitute the value chain.

As for fuel cells, the most challenging area in terms of technologies on the value chain is fuel cell materials. The number of enterprises participating in the fuel cells business, at a stage prior to full-fledged commercialization, remains small and corporate interest in the area is lower than it is for photovoltaics and wind power. Currently, most of the projects being carried forward are in the power generation area, with the focus on R&D and pilot projects. However, in the future, more R&D and commercializing activities are expected in various sectors, including the automobile, shipbuilding and mobile arenas. Enterprises participating in the fuel cell business are mostly tech-intensive companies in their industrial nature that have been participating in a number of government-run pilot projects.

### Structure of the value chain of the fuel cell business



\* Source: Approaches to the Creation of an Industrial Ecosystem for the Co-survival and Development of Large / Small / Medium Enterprises in the New & Renewable Energy Industry, April, 2012, Korea Institute for Industrial Economics and Trade (2012)



## Status of demand

### Overseas

Recently, global demand for new & renewable energy has shrunk a little due to unfavorable situations, such as the curtailment of subsidies in many of the EU market leaders that are suffering economic recessions. The specific reasons for this slashing of support are below.

First, the significant decline in costs for photovoltaic modules, etc., has sparked a downward adjustment in the amount of support. Second, as seen in the example of Australia, there are local governments that are not favorable to the new & renewable energy business. Third, as proven by the example of the EU and the United States, local governments that are in financial trouble are trying to constrain their overall government budgets. This results in the scaling down of related support. Fourth, there is concern that Chinese corporations are very likely to monopolize the global new & renewable energy market, based on their cost competitiveness and ability to supply on a large scale, with the support of the Chinese government. In addition, the EU and United States have decided to impose anti-dumping and countervailing duties on imports, which is fueling the competition between China and other global powers. Last but not least, it appears the global economic recession will last for a while, and shale gas reform in the United States continues to drop global oil prices, which has negative effects on the possibility of a hike in demand.

According to The Export-Import Bank of Korea (Korea Eximbank), the amount of money invested in the global clean energy industry (including new & renewable energy efficiency and energy storage and conversion) in 2013 was USD 255 billion, which was an 11% drop from the previous year. This resulted in this industry posting a consecutive 2-year decline. The amount of money drawn into the global clean energy industry is on the decline, falling from its peak of USD 332.8 billion in 2011. This decline is attributed to a drop in product prices and shrinking demand by EU nations. The amount of investment in EU nations nosedived to USD 68 billion in 2013 from USD 127 billion in 2011, which can be explained by the increase of supply of new & renewable energy around consumer nations in Europe, including Germany. This resulted from the financial crisis in the EU, which drastically dragged down the need for investments.

Until recently, Germany, Spain and Italy have led market demand for new & renewable energy, and demand has been concentrated in Japan and China. However, it is somewhat positive that the demand is now being distributed around the Middle East, Southeast Asia and South America. Furthermore, it is noteworthy that the demand pattern for photovoltaics is changing, as market interest is moving from large facilities to small, practical items for households. This is due to the curtailment of government subsidies. For example, the advanced world, which includes the United States, Australia and the EU, has introduced business models that will meet small-scale demand, such as leases, thereby expanding the related market. Also, in Korea, some corporations, including Hanwha, have already advanced into the global photovoltaics lease business. In line with this, Japan, Germany and other major countries are proactively working to improve unstable aspects in the power supply chain, which is one of the underlying issues regarding the source of

new & renewable energy. They are doing so by incorporating an energy-saving system (ESS) into the chain that may help develop required technologies and radically save costs, which will have positive effects on promoting demand.

### Domestic

The supply rate of new & renewable energy in Korea is 3.18% for the primary energy group as of 2012, which accounts for 3.7% of the country's entire power generation. For five years, from 2008 to 2012, the supply of new & renewable energy increased 10.9% a year on average; specifically for each power source, the increase was 80% for wastes / bio and 5% for photovoltaics / wind power, which is nearly three times the 3.7% increase of the supply of primary energy for the same period.

Compared with major countries in the advanced world, the proportion of new & renewable energy to primary energy (3.2%) is much lower than that of Germany (12%), Denmark (26.8%), Spain (12.1%), Germany (12%), France (8.4%), the United States (6.5%) and Japan (4.6%).

However, the supply rate has continued to grow thanks to aggressive investments by the government and interventions by the private sector to respond to external influences, including the enforcements made by the Climate Change Convention and skyrocketing oil prices. The government budget spent on related projects was merely KRW 118 billion (USD 107.7 million)\* in 2003 but rose to KRW 288.1 billion in 2005, KRW 414.1 billion in 2007 and to KRW 876.6 billion in 2010, following government initiatives taken in 2008 for "green growth and green industries." In 2011, the budget reached KRW 1.0035 trillion and KRW 998.2 billion in 2012.

The expanded housing supply project (to supply 1 million houses) and other initiatives drove up the supply of geothermal heat, fuel cells and photovoltaics. The per-month increase in 2012 as compared with 2011 posted the highest increase, with 38.5% for bio energy, followed by 36.4% for geothermal heat, 20.4% for photovoltaics, 3.8% for wind power and 17.1% for wastes. The supply of marine energy registered an unbreakable record increase of 874.2% year-on-year, but the absolute amount of supply is still far from enough.

When it comes to the monthly proportions of each category of new & renewable energy, as of 2012, waste energy took up 2/3, or 67.7%; bio energy 15.1%; and hydropower 9.2%, followed by the core members of the new & renewable energy group – photovoltaics with 2.7%, wind power with 2.2% and fuel cells with 0.9% – at a lower level all in all. Others include geothermal heat with 0.7%, solar heat with 0.3% and maritime energy with 1.1%.

\* Currency conversion based on February, 10, 2015 rate.



## 02

INDUSTRY  
STATUS – SUPPLY**Conditions  
and trends in  
on / offshore  
supplies****Conditions of the global supply**

Compared to the demand for new & renewable energy in the global market, whose growth is shrinking, the supply of new & renewable energy, especially photovoltaics, is active thanks to lower access barriers in almost all processes, except for some of the materials and parts that are required. Chinese corporations are leading the price decline and are taking up nearly 70% of the intermediate market, including cells and modules, based on larger capacities and lower costs. In contrast, players in the advanced world are bellying up one after another, which is accelerating price competition in the global supply market rather than competition for technologies. Meanwhile, trade barriers, including anti-dumping duties, are fueling the increase of costs that mostly result from the overseas relocation of factories.

**Sales, employment, export and investment trends in Korea**

From 2007 to 2012, the number of new & renewable energy providers in Korea increased two-fold; employment by 3.35 times, sales by 5.24 times, export by 3.4 times and investment by 2.22 times, which means there was rapid quantitative growth of Korea's new & renewable energy industry. However, the global new & renewable energy industry is going through a restructuring process due to global economic contraction and oversupply, which has, in turn, significantly withered Korea's new & renewable energy industry.

This industry has primarily been developed with the growth of photovoltaics and wind power, with a higher effect of stimulating other industries. Photovoltaics and wind power account for 91% of investment in the industry, 85% of its sales and 97% of its export.

**Major indicators of Korea's new & renewable energy industry**

	2007	2008	2009	2010	2011	2012	'07 - '12 CAGR
No. of companies	100	134	187	209	225	200	14.9
Employment (People)	3,532	6,496	10,000	13,149	14,563	11,836	27.4
Sales (KRW 1 bil.)	1,233	3,268	4,463	7,663	9,357	6,467	39.3
Exports (KRW 100 mil.)	7.4	17.1	21.3	39.3	47.7	25.2	27.8
Investments (KRW 1 bil.)	623	1,901	2,955	3,537	4,584	1,385	17.3

\* Source: New & Renewable Energy Center, Korea Energy Management Corp.



## Sales

From 2008 to 2012, the total sales of all corporations in Korea's new & renewable energy industry increased by 18.6% on average, annually. Sales rose from KRW 3.268 trillion in 2008 to KRW 6.467 trillion in 2012. Particularly, in 2011, Korea's new & renewable energy industry posted sales of KRW 9.357 trillion, which was a 22.1% year-on-year increase that was supported by the continuous growth of the photovoltaics industry and the recovery of overseas wind power markets. However, this is estimated to have rapidly dropped all the way down to KRW 6.467 billion in 2012, which was a 30.9% year-on-year decrease.

The posted proportion of sales in 2012 for Korea's photovoltaics and wind power industries was KRW 4.208 trillion and 1.276 trillion, respectively; each of which accounts for 65.0% and 20% of the total sales of the new & renewable energy industry. On a monthly basis, the wind power industry accounted for more than 50% of the total sales of the new & renewable energy industry until 2007. The industry's growth started to accelerate in 2008. It has led Korea's new & renewable energy industry with a 60 - 80% share of total sales since 2009. When it comes to proportions of domestic demand and the exports of Korea's new & renewable energy industry, its exports have continued to increase, thereby enhancing the industry's standing as one of the nation's export leaders, especially as the photovoltaics and wind power industries rely heavily on exports rather than domestic demand.

### Sales trends per category of new & renewable energy sources in Korea (2008 - 2012)

(Unit: KRW 1 billion, %)

	2008	2009	2010	2011	2012	'08 - '12 CAGR
Photovoltaics	1,577 (48.0)	2,719 (61.0)	5,859 (76.0)	7,420 (79.0)	4,208 (65.0)	27.8
Wind power	1,293 (40.0)	1,073 (24.0)	972 (13.0)	1,008 (11.0)	1,276 (20.0)	-0.3
Fuel cells	34 (1.0)	78 (2.0)	128 (2.0)	105 (1.0)	117 (2.0)	36.2
Bio	311 (9.0)	499 (11.0)	602 (8.0)	745 (8.0)	813 (13.0)	27.2
Solar heat	33 (1.0)	62 (1.0)	65 (1.0)	36 (-)	13 (-)	-20.8
Geothermal heat	20 (1.0)	33 (1.0)	37 (-)	43 (-)	38 (1.0)	17.4
<b>Total</b>	<b>3,268</b>	<b>4,463</b>	<b>7,663</b>	<b>9,357</b>	<b>6,467</b>	<b>18.6</b>

\* Source: New &amp; Renewable Energy Center Website, The Korea Energy Management Corp.

## No. of corporations

From 2008 to 2012, the number of Korean new & renewable energy manufacturers, including for photovoltaics, wind power, fuel cells and bio, increased an average of 10.5% each year, from 134 corporations in 2008 to 200 in 2012. As of 2012, companies per power source included 83 (42%) for photovoltaics, 38 (19%) for wind power, 9 (5%) for fuel cells and 46 (23%) for bio. In particular, the proportion of photovoltaics in the entire new & renewable energy industry has increased significantly, which has captured the industry's attention since 2007. Furthermore, a large number of SMEs have joined related businesses to contribute to the creation of an environment that allows for the co-survival of large-scale companies and SMEs.

### The number of corporations per new & renewable energy source in Korea (2008 - 2012)

(Unit: Company)

	2008	2009	2010	2011	2012	'08 - '12 CAGR
Photovoltaics	54 (40.0)	79 (42.0)	92 (44.0)	99 (44.0)	83 (42.0)	11.3
Wind power	26 (20.0)	29 (16.0)	30 (14.0)	38 (17.0)	38 (19.0)	10.0
Fuel cells	4 (3.0)	10 (5.0)	10 (5.0)	10 (4.0)	9 (5.0)	22.5
Bio	25 (19.0)	41 (22.0)	49 (23.0)	48 (21.0)	46 (23.0)	16.5
Solar heat	18 (13.0)	18 (10.0)	18 (9.0)	18 (8.0)	12 (6.0)	-9.6
Geothermal heat	7 (5.0)	10 (5.0)	10 (5.0)	12 (5.0)	12 (6.0)	14.4
<b>Total</b>	<b>134</b>	<b>187</b>	<b>209</b>	<b>225</b>	<b>200</b>	<b>10.5</b>

\* Source: New &amp; Renewable Energy Center Website, The Korea Energy Management Corp.

## Employment

From 2008 to 2012, the number of employees in Korea's new & renewable energy industry increased by an annual average of 16.2%, from 6,500 employees in 2008 to 11,836 in 2012. The number of employees in the photovoltaics and wind power industries in 2012 were 8,302 and 2,030, respectively, where each made up 70% and 17% of all of the employees in the new & renewable energy industry. The rapid growth of the photovoltaics and wind power industries has created jobs in other relevant industries.

Employee numbers in the wind power sector exceeded those in the photovoltaics arena until 2007. However, the increase has been sluggish due to market contraction and investments withheld since 2008. In terms of employment per duty, the photovoltaics and wind power sectors, which have grown rapidly, include the highest proportion of production line workers (about 60% for photovoltaics and 40% for wind power). Areas where R&D is stressed, including fuel cells, have a high number of research staff members (about 65%).

### Employment trends per new & renewable energy source in Korea (2008 - 2012)

(Unit: People, %)

	2008	2009	2010	2011	2012	'08 - CAGR '12
Photovoltaics	3,650 (56.0)	6,285 (63.0)	8,906 (68.0)	10,660 (73.0)	8,302 (70.0)	22.8
Wind power	1,860 (29.0)	2,332 (23.0)	2,554 (19.0)	2,456 (17.0)	2,030 (17.0)	2.2
Fuel cells	161 (2.0)	272 (3.0)	364 (3.0)	338 (2.0)	442 (4.0)	28.7
Bio	453 (7.0)	712 (7.0)	850 (6.0)	722 (5.0)	735 (6.0)	12.9
Solar heat	211 (3.0)	213 (2.0)	235 (2.0)	184 (1.0)	156 (1.0)	-7.3
Geothermal heat	165 (3.0)	186 (2.0)	240 (1.0)	203 (1.0)	171 (1.0)	0.9
<b>Total</b>	<b>6,496</b>	<b>10,000</b>	<b>13,149</b>	<b>14,563</b>	<b>11,836</b>	<b>16.2</b>

\* Source: New &amp; Renewable Energy Center Website, The Korea Energy Management Corp.

## Exports

From 2008 to 2012, the exports of Korea's new & renewable energy industry grew 10.3% on average annually. It increased from USD 1.7 billion in 2008 to USD 2.523 billion in 2012, driven by an accelerated business expansion to overseas markets. In 2012, the export of photovoltaics and wind power posted USD 1.968 billion and USD 487 million, respectively, each accounting for 78% and 19% of all of the exports of Korea's new & renewable energy industry. The photovoltaics and wind power industries seek offshore markets abroad, rather than domestically, so they rely heavily on exports (70% or more for photovoltaics and 80% for wind power).

### Export trends per new & renewable energy source in Korea (2008 - 2012)

(Unit: USD 1 million, %)

	2008	2009	2010	2011	2012	'08 - '12 CAGR
Photovoltaics	860 (51.0)	1,561 (73.0)	3,506 (89.0)	4,259 (89.0)	1,968 (78.0)	23
Wind power	827 (48.0)	556 (26.0)	421 (11.0)	488 (10.0)	487 (19.0)	-12.4
Fuel cells	- (-)	- (-)	- (-)	1.2 (-)	2 (-)	-
Bio	19 (1.0)	14 (1.0)	1 (-)	22 (-)	67 (3.0)	37
Solar heat	- (-)	1 (-)	2 (-)	- (-)	- (-)	-
Geothermal heat	- (-)	- (-)	- (-)	- (-)	- (-)	-
<b>Total</b>	<b>1,706</b>	<b>2,131</b>	<b>3,929</b>	<b>4,770</b>	<b>2,523</b>	<b>10.3</b>

\* Source: New &amp; Renewable Energy Center Website, The Korea Energy Management Corp.

## Investments

Investments made by companies in Korea's new & renewable energy industry from 2008 to 2012 increased a high average of 34% annually until 2011. This was driven by the continuous growth of the global photovoltaics and wind power markets and the government's reinforced policies on supporting the new & renewable energy industry. However, things nosedived to KRW 1.385 trillion in 2012. As of 2012, the photovoltaics sector accounts for 78% of all investments in the new & renewable energy industry and wind power accounts for 13%.

### Investment trends per new & renewable energy source in Korea (2008 - 2012)

(Unit: KRW 1 billion, %)

	2008	2009	2010	2011	2012	'08 - '12 CAGR
Photovoltaics	1,386 (73.0)	2,263 (77.0)	2,872 (81.0)	4,205 (92.0)	1,082 (78.0)	-6
Wind power	465 (24.0)	564 (19.0)	508 (14.0)	281 (6.0)	181 (13.0)	-21
Fuel cells	41 (2.0)	64 (2.0)	117 (3.0)	31 (1.0)	94 (7.0)	23.1
Bio	7 (-)	62 (2.0)	35 (1.0)	62 (1.0)	25 (2.0)	37.5
Solar heat	1 (-)	1 (-)	3 (-)	2 (-)	2 (-)	18.9
Geothermal heat	0.2 (-)	1 (-)	2 (-)	2 (-)	1 (-)	49.5
<b>Total</b>	<b>1,901</b>	<b>2,955</b>	<b>3,537</b>	<b>4,584</b>	<b>1,385</b>	<b>-7.6</b>

\* Source: The Korea Energy Management Corp.'s New &amp; Renewable Energy Center Website

## Generation cost

According to data from Korea Eximbank, the new & renewable energy generation cost of major locations in the first quarter of 2014 was USD 60 - 120/MWh for coal, USD 70 - 100/MWh for gas and USD 30 - 140/MWh for nuclear generation. Compared with this, the average unit price of wind power is USD 80/MWh and USD 150/MWh for photovoltaics. These power sources are still expensive but, at the same time, the prices are dropping the fastest among all the other power sources. This is thanks to the evolution of technologies and the industry, as well as the rising price of electricity.

In less than two years, the unit price for generating photovoltaics fell to half of the previous USD 300/MWh in 2012. The price has continued to fall and is expected to drop to a level similar, to that of coal generation in five years. This is due to the mass-production of it and the development of related technologies.

Globally, policies to support the new & renewable energy industry are rapidly progressing because the economic feasibility of new & renewable energy is improving. In particular, the cost of gas generation in the United States is lower than that of coal, which is a result of decreased gas prices thanks to the development of shale gas.

The average unit price of wind power generation is USD 80/MWh, which is a level similar to that of coal generation in the United States. The price of wind power generation is equivalent to the level of fossil fuel generation. However, a drawback of wind power generation is that the generating equipment is usually run at night.

New & renewable energy is advantageous in terms of maintenance and eco-friendliness, but it involves a higher initial investment and lower use of equipment. In other words, higher capacity factors are found in nuclear power generation (92%), coal generation (85%) and gas generation (60%). However, new & renewable energy sources, which are represented by wind power with a capacity factor of 32% and photovoltaics with 20%, cannot guarantee a large amount of power generation. Thermal power generation is sensitive to the volatility of fuel prices, as the cost of raw materials (i.e., coal or gas) accounts for nearly 80% of the entire power generation cost. Nonetheless, it is highly profitable in that it involves almost no cost for materials, except for fuel cells that use the reformed gases of new & renewable energy sources.

Globally, regions receiving power from photovoltaic generation cheaper than the normal source has been rapidly increasing since 2013. This increase will continue to accelerate in 2014.



## Cost of equipment and production

Throughout the world, the cost of producing modules for photovoltaic generation systems is on a sharp decline. The cost in 2011, which was at USD 1.31/W, dropped to USD 0.53/W in the fourth quarter of 2013. The fall was seen as inevitable due to the oversupply of energy and, most practically, thanks to the continuous efforts of many companies to reduce costs. The primary contributor to the fall in unit price was the efforts of module manufacturers to expand their equipment, seeking economy of scale, in addition to being able to cut back on costs through new technologies.

While the cost of materials for generating other energy groups keeps rising, the price of photovoltaic modules continues to drop, so as to keep the cost of generating it down. In other words, it is likely that the current cost of photovoltaic power generation, which is currently at 12 - 18 cents (KRW 123 - 184) per kWh, may drop to less than 10 cents (KRW 102). As for wind power, the generation cost has been lower than the cost of generating power with fossil fuels.

As of now, the manufacturing cost of leading module producers is estimated at USD 0.53/W, and the cost gap with later starters is getting bigger and bigger. Currently, the market price of a silicon module is usually USD 0.8/W and the leading module producers are expected to have a price competitiveness of more than 30% in the market. Given that they have to pay the same manufacturing cost of USD 0.8/W, small and medium module providers are behind the leading module manufacturers in price competitiveness.

When it comes to the unit price of conventional power plants in Korea, including nuclear, the unit price of nuclear power plants operators is KRW 48.8/kWh, the unit price combined with social expenses is KRW 54.2 - 254.3/kWh and the average unit price is estimated to be KRW 154.3/kWh. Under the premise that other expenses are not reflected, bituminous coal has the lowest cost (KRW 62.25/kWh), which is followed by liquefied natural gas generation (KRW 119.6/kWh), combined cycle generation (KRW 168.1/kWh), hydraulic generation (KRW 180.86/kWh), heavy oil generation (KRW 250.72/kWh) and pumping up generation (KRW 213.93/kWh). This shows that generating nuclear power involves higher external expenses. However, an exact comparison with other types of generation will be possible only when the unit prices of other types of generation reflect external expenses. The status of new & renewable energy generation costs in Korea indicates that the total cost per kWh in the first quarter of 2014 was KRW 230 - 270, which was a dramatic fall from KRW 711 in the same period in 2009.

## Status of foreign direct investment (FDI)

Not many foreign companies invest in new & renewable energy equipment in Korea. The Korean government took aggressive initiatives to invite foreign investment in 2009, following their announcement for the promotion of "green growth and green industry" in 2008. Successful cases include that of Vestas, a Danish wind power operator. The company installed 104 wind power generators around Taebaek and Woengseong in Gangwon Province and Jeju Island. It reached an investment agreement with South Jeolla Province for wind power generation in April of 2014. Currently, the company is reportedly reviewing key agendas in detail, including investment timing and whether to set up a manufacturing line.

SSF in Austria announced in 2010 that it is going to invest KRW 109.2 billion in photovoltaic module manufacturing facilities between 2011 and 2012 and a total of KRW 138 billion by 2015, including KRW 28.8 billion between 2012 and 2015. These investments are expected to have a direct effect on creating 500 jobs.

Solvay SA has introduced a global center within the Ewha Womans University campus that deals with special chemicals. This facility was completely set up in December of 2013 and started operations in May of 2014. The center is also accompanied by Solvay's Korean RDT Center. Solvay SA has invested a total of 13 million EUR in this R&D and technology center, in addition to another 3.8 million EUR under a 5-year research cooperation agreement with the university. One of the reasons Solvay SA chose to invest in Korea is that the country offers a lot of opportunities via its advanced business ecosystem, which has been prepared since the 1970s. The RDT Center will focus on markets that have high growth potential, including electronic components, solar batteries and lithium ion cells.

In the meantime, Samsung Fine Chemicals Co., Ltd. (hereinafter "SFC") entered into an agreement with SunEdison last March. It has promised to sell 35% of its shares in SMP\* to SunEdison and to invest a portion of the earnings in buying the equity of SSL.

Sumitomo Corp. Korea, a Japanese corporation whose business profile includes metal, mineral resources, energy, chemicals, machinery, communications and infrastructure, is headquartered in Jongno-gu, Seoul. The Busan branch, which opened in 2009, aims to expand their business to plate works, which are widely used in shipbuilding, wind power and nuclear power generation. Bosch Rexroth Korea, another company in Busan, is an affiliate of Bosch Group in Germany. Bosch Rexroth Korea is currently producing not only hydraulic systems for vehicles and industrial automation devices, but also transmission systems used in wind power turbines.

The Ministry of Trade, Industry and Energy (MOTIE) dispatched a task force in December of 2014 to invite investment in new & renewable energy from Europe as part of their strategic investment promotion for the first half of 2014. In May of 2014, the ministry enacted a revision of the guideline for the operation of foreign investment zones in connection with energy equipment. The government did this to allow for the installment of a photovoltaic power generation facility in such areas. Thus, any company in the industry can save energy costs by better using new & renewable energy.

\*SMP was jointly established by SFC and SunEdison, an American company, in 2011 with a 50:50 share. SMP will build a plant with an annual production capacity of 10,000-tons at its Ulsan operations. It plans to complete construction in the first half of 2014 and begin operations in the second half of the year.

# 03

## LOCATIONAL STATUS OF KOREA'S NEW & RENEWABLE ENERGY INDUSTRY

### Locational status

#### Distribution of Korea's new & renewable energy operations

In Korea, photovoltaic producers are located mainly around South Chungcheong Province, North Gyeongsang Province and North Chungcheong Province. The total capacity of Korea to produce polysilicon is 70,000 tons and the total module production capacity is about 3,500 MW, which, as of 2013, can cover 28% of the global demand for polysilicon. The total module production capacity of Korea accounts for 7% of the global module production capacity. The combined ingot and wafer production capacity of five companies in Korea is 3,350 MW and 2,430 MW, respectively. Korea's total capacity for producing solar batteries is 1,820 MW, which can cover 4% of the global demand.

#### Distribution status of major solar light providers in Korea (as of June 2014)

Region	No. of companies	Polysilicon	Ingots	Wafers	Cells	Modules
Gyeonggi Province	1	-	-	-	-	30 (1)
Incheon	1	-	-	-	-	20 (1)
Gwangju	1	-	-	-	-	100 (1)
Daegu	4	-	1,000 (1)	500 (1)	-	370 (2)
Gyeonggi Province	4	-	250 (2)	230 (2)	-	-
North Chungcheong Province	6	-	-	-	950 (2)	1,090 (4)
South Chungcheong Province	7	3,000 (1)	350 (1)	350 (1)	100 (1)	300 (3)
North Jeolla Province	4	42,000 (1)	1,750 (1)	1,350 (1)	-	600 (1)
South Jeolla Province	3	25,000 (2)	-	-	-	250 (1)
North Gyeongsang Province	7	-	-	-	680 (2)	770 (5)
South Gyeongsang Province	1	-	-	-	90 (1)	-
<b>Total</b>	<b>39</b>	<b>70,000 (4)</b>	<b>3,350 (5)</b>	<b>2,430 (5)</b>	<b>1,820 (6)</b>	<b>3,530 (19)</b>

\* Source: Korea Photovoltaic Society

\* Note: ( ) is the number of companies; the unit of polysilicon is 1 ton and MW for the other items





### Status of new & renewable energy clusters in Korea

In Korea, new and renewable energy clusters have been formed around the regions of Daegu-North Gyeongsang Province, North Chungcheong Province and North Jeolla Province. In 2011, North Gyeongsang Province was selected through public offerings as a proper region for two of six projects planned by the central government (three for photovoltaics, two for wind power and one for fuel batteries). The province completed the establishment of a new & renewable energy test bed by the end of June, 2014. This will promote the export of local industries by verifying their technologies and the parts used for the production of new & renewable energy and will wrap up all of the steps preceding the birth of a new & renewable energy cluster.

These new & renewable energy test bed projects, which have been actively promoted by the Korean government for the new & renewable energy industry, offer a verification / certification tool for local SMEs, to help them secure confidence in their technologies and parts. Accordingly, they also support the creation of supply chains to systematically drive the growth of Korea's new & renewable energy industry.

Responsibilities for these test bed projects are divided between the Gumi Electronics & Information Technology Research Institute (GEITRI) and Pohang University of Science and Technology (POSTECH). The test beds in Gumi help 240 photovoltaic manufacturers in Daegu and North Gyeongsang Province nurture custom-tailored experts and support the R&D of SMEs to develop new parts and commercialize their products.

The test bed for fuel cells that has been set up in POSTECH's new & renewable energy lab supports qualified enterprises regarding the analysis of hydraulic fuel cell performance and product commercialization. The world's largest fuel cell plant, to be built at POSCO Energy, and a number of original technologies pertained by POSTECH will help the nation become more competitive in the global market.

Chungbuk Innovation City, in North Chungcheong Province, is going to have a photovoltaic R&D cluster that will act as an outpost to promote the nation's photovoltaics industry. In the cluster, a photovoltaics tech support center on an area that is approximately 4,900 m<sup>2</sup> will be responsible for photovoltaics-related research and technology development, certification testing and manpower training. A building-energy tech support center on about 3,400 m<sup>2</sup> will handle the certification and estimation of buildings / structures and construction materials related to photovoltaics.

The new & renewable energy cluster in North Jeolla Province aims to lead Korea's new & renewable energy industry by establishing a power generation hub for photovoltaics, wind power and fuel cells. As part of this, an RNE complex in Buan, which sits on a 355 m<sup>2</sup> sized area, is the only comprehensive complex in Korea for empirical research, industries and PR. It is occupied by OCI, Nexolon, Solarpark Korea, Hyundai Heavy Industries and Quartz Tech, which are all part of the photovoltaics sector; Hyundai Heavy Industries and DACC-Aerospace, which are part of the wind power sector; and Propower in the fuel cell sector.

Furthermore, Buan has the Korea Testing Laboratory, which is responsible for demonstrations and performance testing for photovoltaics, a materials development center within Chonbuk National University responsible for the R&D of photovoltaic sources, a nano IC center under the Korea Electronics Technology Institute and the Jeonju Center of Korea Basic Science Institute, which is dedicated to the R&D of next-generation solar cell materials. For the wind power sector, Buan has the Korea Institute of Machinery & Materials, a performance rating institution for wind power blades and speed boosters, the Korea Institute of Energy Research and a hydraulic fuel cell performance assessment and R&D organization.

Meanwhile, North Jeolla Province plans to attract photovoltaics-related companies and research institutions to the Saemangeum Solar Power Cluster (area: 2.237 million m<sup>2</sup>); the world famous photovoltaics specialist OCI will invest KRW 10 trillion in a 1.55 million m<sup>2</sup> site. The Jeonbuk Wind Power Industrial Cluster will build a 20 MW capacity monitoring block (with an investment of KRW 82.7 billion) at a pilot complex for wind power generation in Saemangeum and plans to invest about KRW 10 trillion in a 2.5GW-class maritime wind power generation complex that is to be introduced along Wido Island to Anmado Island in Yeonggwang.

A new & renewable energy project site in Saemangeum, on a 20.3 km<sup>2</sup> site, will, as its first step, accommodate a 4.3 km<sup>2</sup> research and test center as well as a 4.0 km<sup>2</sup> pilot bio crop complex. In the second step, a photovoltaic generation complex and bio crop harvest complex (11.5 km<sup>2</sup>) will be built there. In particular, the Composite Green Energy Industrial Complex, in which Samsung is scheduled to invest, will receive a total investment of KRW 120 trillion from 2021 to 2040 to accommodate solar cell, wind power generation, bio fuel, fuel cell and R&D centers.

## Context of competitiveness

According to the Korea Energy Economics Institute, the overall technical level of Korea's new & renewable energy industry is 81.7% on average, which is about 10 percentage points less compared to that of the advanced world, including the EU, the United States and Japan. However, it is about 5 percentage points higher than that of rival China. In 11 areas, the technical capacity of Korea's new & renewable energy industry is generally 10 – 17 percentage points behind that of the advanced world and 0 – 7 percentage points ahead of that of China.

For each energy source, the technological capacity in photovoltaics, hydraulic and bio is close to that of advanced countries, but is substantially behind in wind power and thermo heat. As for the top technologies in 11 new & renewable energy sources, Europe has 10 of them and Japan has one in the fuel cell area.

### Technical capacity of Korea's new & renewable energy industry as compared with the advanced world

(Unit: %)

Items	U.S.	Japan	EU	China	Korea
Photovoltaics	92.2	93.1	95.7	81.2	85.1
Wind power	91.0	90.3	96.1	77.2	80.0
Hydrogen	93.7	92.0	94.4	77.6	80.8
Fuel cells	92.5	92.8	92.3	71.4	78.7
Coal gasification / liquidation	92.5	90.0	94.1	80.3	80.4
Hydraulic power	93.1	93.6	96.8	82.1	84.7
Maritime	91.8	90.1	94.4	76.6	81.1
Bio	92.6	91.9	95.9	80.4	83.9
Geothermal heat	92.6	91.9	95.1	77.5	78.3
Solar heat	92.1	90.6	96.2	79.7	82.0
Wastes	89.9	92.5	96.2	76.9	82.4
All new & renewable energy	92.0	91.8	95.1	77.8	81.7

\* Source: Plans for the analysis and expansion of tech achievements of new & renewable energy, June, 2013, Korea Energy Economics Institute (2013)



The localization rate of new & renewable energy in Korea is 76.9% and 68.4% in terms of technologies and markets, respectively. The localization rate of photovoltaics and bio is high but very low in fuel cells. The gap between the localization rate for technologies and markets in hydraulic, wind, fuel cell, thermo heat and waste energy is wide. In this regard, technological prowess is secure but the latter is insufficient.

### Tech localization rate of each new & renewable energy type in Korea

(Unit: %)

Item	Tech level [A]	Market [B]	Average [C]	A-B
Photovoltaics	79.4	71.8	75.6	7.5
Wind power	75.9	66.4	71.2	9.5
Hydrogen	76.2	68.8	72.5	7.3
Fuel cells	73.4	63.7	68.6	9.7
Coal gasification / liquidation	75.0	68.4	71.7	6.6
Hydraulic power	80.5	68.4	74.5	12.1
Maritime	75.6	70.4	73.0	5.2
Bio	78.7	70.6	74.7	8.0
Geothermal heat	75.0	65.2	70.1	9.7
Solar heat	77.6	70.0	73.8	7.6
Waste	78.3	68.7	73.5	9.5
All new & renewable energy	76.9	68.4	72.6	8.5

\* Source: Plans for the analysis and expansion of tech achievements of new & renewable energy, June, 2013, Korea Energy Economics Institute (2013)





## 04

GOVERNMENT  
POLICIES AND  
GOVERNING  
LAWS**The Fourth  
New &  
Renewable  
Energy  
Development  
Framework  
(09 / 2014)**

With the goal of replacing 11% of the primary energy supplied with new & renewable energy by 2035, the Korean government finalized The Fourth New & Renewable Energy Development Framework in September of 2014. For the annual objectives for proportions in major periods, the government aims to fulfill the goal toward 11% by 2035. It will do so by gradually upgrading the proportion from 3.2% in 2012 to 3.6% in 2014, 5% in 2020, 7.7% in 2025 and 9.7% in 2030. According to the schedule, the year-on-year supply increase of new & renewable energy from 2014 - 2035 may reach 6.2%, which is a relatively high increase given the goal of a 0.7% supply increase for the primary energy group.

In addition, the government plans to reduce the amount of waste energy, which accounts for 2/3 of the entire new & renewable energy supply, and intends to focus on promoting the supply of photovoltaics and wind power energy. With respect to monthly proportions, the proportion of waste energy in 2012 was 68.4%, and this will be raised to 29.2% by 2035. The government plans to upgrade the proportion of wind power from 2.2% in 2012 to 18.2% in 2035, and photovoltaics from 2.7% to 14.1%.

**Goals for each source of the primary energy group in proportion to the supply**

(Unit: %)

Items	2012	2014	2025	2035	Average annual % increase
Solar heat	0.3	0.5	3.7	7.9	21.2
Photovoltaics	2.7	4.9	12.9	14.1	11.7
Wind power	2.2	2.6	15.6	18.2	16.5
Bio	15.2	13.3	19.0	18.0	7.7
Hydraulic power	9.3	9.7	4.1	2.9	0.3
Geothermal heat	0.7	0.9	4.4	8.5	18.0
Maritime	1.1	1.1	1.6	1.3	6.7
Waste	68.4	67.0	38.8	29.2	2.0

\* Source: Ministry of Trade, Industry &amp; Energy (MOTIE) (2014)

According to related plans, 13.4% of the entire amount of power to be used in 2035 is supposed to be replaced by new and renewable energy. As such, the government plans to implement their policies by focusing on the creation of a business ecosystem for the new & renewable energy market, which will shift from government-oriented to public-private partnership. On top of this, the Korean government will be committed to inviting the private sector to make voluntary investments through finding appropriate business model types for the effective supply of new & renewable energy, designing market-friendly systems, suggesting profitable business models and promoting deregulation.



### New support policies for improving RPS and energy supplies

Prior to The Fourth New & Renewable Energy Development Framework plan, the Korean government prepared a new & renewable energy promotion plan in 2013 for each month and sub-category. The plan is divided into the improvement of a system related to mandatory supply and the adoption and expansion of new & renewable energy supply systems. This required the completion and improvement of RPS, to switch from supporting the generation amount gap (FIT: Feed-in Tariff) to the supply obligation of generation operators (RPS: Renewable Portfolio Standard). This was initiated by the need to improve the system promoting the existing demand for new & renewable energy.

For photovoltaics, the government is trying to expand the domestic market by raising the mandatory supply amount and promoting the credit given by local residents by giving preference to the weighted value of power generation plants that engage local residents. The government also seeks to heighten the lower preference limit for weighted values, as well as preferentially allot 30% of the given volume to small business operators, to facilitate user convenience and boost the lease business.

To improve issues related to the intense support for photovoltaics, the government seeks to raise the initial weighted value, including maritime wind and tide power, and raise the price of LNG fuel for cells. The government also plans to promote the implementation of the mandatory supply rule by allowing the fulfillment of the rule any time within three years.

#### Details of the RPS system improvement plans

	Current support systems and issues	Improvement measures	Anticipated effects
	<ul style="list-style-type: none"> <li>Mandatory amount of supply: 1.2 GW until 2015</li> </ul>	1.5GW (+300 MW) until 2015	Expand the domestic photovoltaics market
	Conflicts intensified on energy facility sites	Give preference to the weighted value of plants that engage local residents	Promote the acceptance of local residents
Photovoltaics	<ul style="list-style-type: none"> <li>Markets selected by sellers: 100 MW/year</li> <li>Entered into a long-term agreement with power generation operators at a fixed price</li> <li>Benefits for small businesses: 1.0 → 1.2 for 30kW or below</li> </ul>	<ul style="list-style-type: none"> <li>Raise to 150 MW</li> <li>Allot 30% of the given volume to small-scale operators</li> <li>Extend the preference for weighted value to 100 kW or below</li> </ul>	Reinforce support for small businesses
	Installation support: There remains an initial cost burden (KRW 5 million) and difficulties with maintenance.	Introduce PV rental service providers (pay only the rent and receive maintenance service free of charge)	Improve user convenience
Non-photovoltaics	<ul style="list-style-type: none"> <li>Investments are sluggish from uniform weighted values</li> <li>Maritime wind and tide power → a burden of large-scale initial investment</li> <li>Fuel cell → Increase in fuel costs</li> </ul>	<ul style="list-style-type: none"> <li>Maritime wind and tide power: Given a higher initial weighted value</li> <li>Fuel cells: Reflect the increment of LNG price</li> </ul>	Expand investments in non-photovoltaic areas
Improve government policies	Postponement of fulfillment: Fulfilled in the first place during the next year	Allowed to fulfill over a 3-year period	Promote % compliance with obligations and convenience thereof

\* Source: Ministry of Trade, Industry & Energy (MOTIE) (2013)

When it comes to the supply of new & renewable energy, the government plans to: adopt a system to meet the supply of thermal heat energy to reduce power waste; encourage operations that consume a higher volume of power to install an internal new & renewable energy supply system; remove the exclusive partitions between different energy sources; and promote convergence projects to improve the synergy effect between new and different renewable energy. Combined with this, the government will expel insolvent enterprises and improve consumer satisfaction by letting industry members renew their declaration of business every three years and will obligate manufacturers to buy insurance and join cooperatives.

#### The adoption and expansion of new systems for the supply of new & renewable energy

	Current support systems and issues	Improvement measures	Anticipated effects
Thermal energy	Decrease in growth of the new & renewable energy industry, including photovoltaics and geothermal heat, due to the government's concentration on existing power energy sources	Adoption of a geothermal energy supply obligation system	The supply of new and renewable thermal energy will reduce the wasting of power for generating heat
Large-scale operations	Poor incentives for power use are resulting in weak motivation to promote the installation of new & renewable energy systems and the saving of power	Encourage operations that consume a higher volume of power to install an internal new & renewable energy supply system	Expand the supply of new & renewable energy and reduce the demand for electric power
Supply projects	Invest 50% or more of government subsidies in solar light energy	Remove the partitions between different energy sources and move to convergence projects	Improve the synergy effect of New & Renewable Energy
Management of providers	Increase in enterprises with poor capacities due to the new business declaration system, etc	<ul style="list-style-type: none"> <li>Dedicated corporations are required to declare every three years</li> <li>Manufacturers are required to buy insurance or join cooperatives</li> </ul>	Expel insolvent enterprises and improve consumer satisfaction

\* Source: Ministry of Trade, Industry & Energy (MOTIE) (2013)





## Loans for the new & renewable energy business and general support for the promotion of new & renewable energy

The Korean government runs a loan support program for the new & renewable energy industry. The program is designed to offer long-term, low-interest rate loans to new & renewable energy system installers and producers so that they can cut back on their initial investment costs and secure economic efficiency, eventually to promote not only the new & renewable energy equipment business but also other related industries.

This program allows business owners to apply for loans to secure operating funds or smooth capital liquidity when these business owners are those who wish to establish facilities for new & renewable energy including photovoltaics, wind power or geothermal heat; to install processing lines for the parts or assembled products used in new & renewable energy equipment, including photovoltaic modules and wind turbines; and to run businesses related to new & renewable energy.

Meanwhile, general support for the promotion of new & renewable energy is about the government supporting a certain portion of the installation costs for new & renewable energy equipment free of charge, to promote the commercialization of products developed in Korea and to create and boost the initial market. Support is provided for any ordinary, internal new & renewable energy supply system that is commercialized for up to 60% of the equipment cost. Up to 50% of the equipment cost for photovoltaics, geothermal heat and bio is provided; up to 60% for photovoltaics, wind power and hydraulic equipment is provided; and up to 30% for waste power equipment is provided.

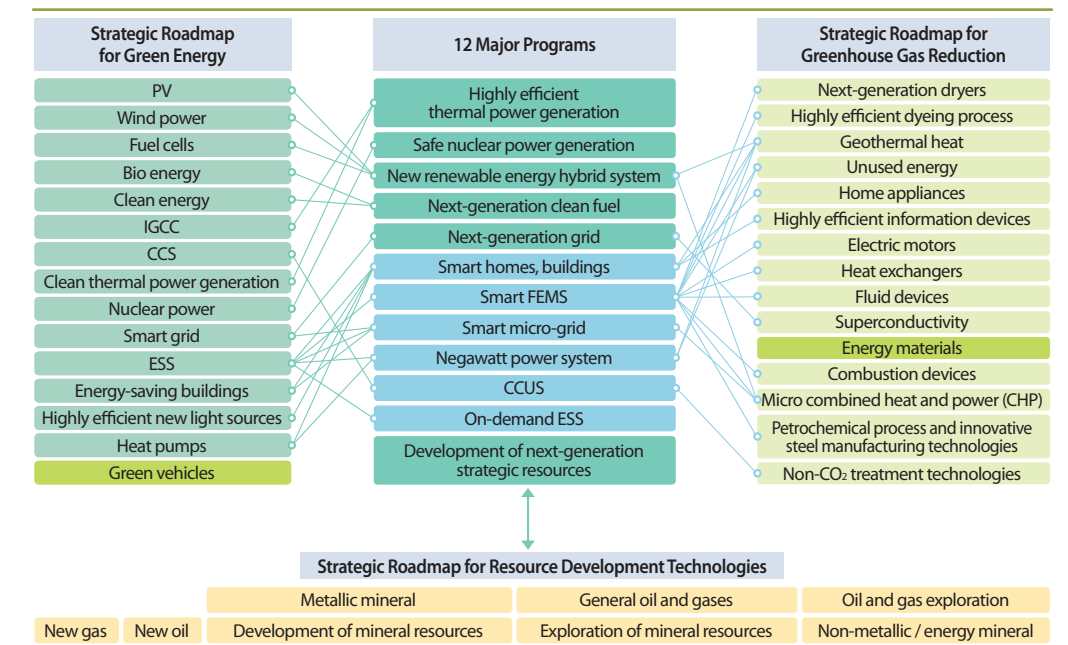
To support pilot supply equipment for the commercialization of new & renewable energy technologies (on the condition of using the government's R&D system), the government offers coverage of up to 80% of the equipment cost (limited to the internal system). It also supports a business coordinated through the deliberation of the Appraisal Board as being part of a support program, in association with local governments or other public organizations.

As part of its effort to have public organizations lead the way in the use of new & renewable energy, the government has been implementing a system to require the use of new & renewable energy by public institutions. In order to create 1 million green homes by 2020, the government covers a certain portion of the cost of power generation equipment for houses that install new & renewable energy, including photovoltaics and solar heat, geothermal heat, small wind power and bio sources.

In October of 2014, the Korean government established a road map for innovating energy solutions in relation to energy technology R&D, in order to connect the existing green energy strategy road map and the strategic road map for the reduction of greenhouse gases. It also established Top-12 energy source development programs. The specific context of the connection is as shown in Figure.

## Development of technologies

Relations Between the Top-12 Energy Source Development Program and the Strategic Road Map



\* Source: Ministry of Trade, Industry and Energy (MOTIE) · KETEP(2014), Energy Tech Innovation Roadmap Energy Innovation Architecture 2025, October 8, 2014

MOTIE confirmed a KRW 806.3 billion energy R&D support project to help develop a photovoltaic generation system with the goal of achieving a generation cost of KRW 180/kWh in early 2014, by reflecting the ongoing decline of the cost of photovoltaic generation, around the globe. The plan includes the development of and demonstrative research on a large ESS and a 100 MW marine substation.

Regarding technological development in the new & renewable energy industry, when it comes to the size of government support for each ministry, the biggest portion (about 60%) of the budget is allotted to the Ministry of Trade, Industry and Energy (MOTIE); 15% to the Ministry of Science, ICT and Future Planning (MSIP); 6% to the Small and Medium Business Administration (SMBA); and 5.5% to the Ministry of Environment (MOE). MOTIE mainly supports the photovoltaics, wind power and fuel cell areas. The MSIP supports the photovoltaic, hydraulic and bio area and the MOE supports the waste energy arena.

Specifically, the major fields of technologies for each new & renewable energy source include crystalline silicon solar cells, silicon membranes, CIGS and organic solar cells for photovoltaics, and system design, development and demonstrative research for wind power. Flagship areas for fuel cells include systems, core components and peripheral device development and demonstrative research; bio energy, technologies for the production of fuels of transporting equipment and bio-gas transition solutions; waste energy, organic waste and the development of localized technologies for solid fuels; and solar heat, building-integrated solar houses and solar heat developing solutions.



# 05

## STATUS OF MAJOR KOREAN ENTERPRISES

### Photovoltaics

There don't seem to be many success cases in the new & renewable energy area of Korea. The reasons for this can be found, mainly, in the nation's short history in this area. The supply of new & renewable energy in Korea actually began in 2000. However, since 2008, the government's full-fledged investments have been focused on conglomerates, based on their policy stance toward "green growth and green industry." Nevertheless, some large and medium enterprises representing the solar light business in Korea are listed below.

First, in the photovoltaics sector, is OCI ([www.oci.co.kr](http://www.oci.co.kr)), a big company with a 42,000-ton annual production capacity for polysilicon (a photovoltaic material). Polysilicon is a basic, core component that requires a technology dealing with ultra-purity (9-nine), located in the front-most position in the value chain of the solar light industry, including ingot → wafer → solar cell → module → system. OCI succeeded in the commercial production of 9-nine polysilicon in 2008, through continuous R&D and investment. It currently supplies 10-nine and 11-nine ultra-pure polysilicon products to major customers around the world.

Hanwha Chemical Corp. ([hcc.hanwha.co.kr](http://hcc.hanwha.co.kr)) is an enterprise under Hanwha Group, in the basic petrochemical field. At present, its sales in the photovoltaics area account for about 25% of its entire sales, following an announcement about expanding into the photovoltaic business in 2008. In 2010, the company began to produce cells with an annual 30 MW capacity in a solar cell plant in Ulsan. In August of 2008, it acquired Hanwha Solarone (formerly Solarfun Power Holdings), the world's fourth largest module producer. It was listed on the NASDAQ to complete a vertical systemization that encompasses ingots / wafers (production capacity of 400 MW), cells (production capacity - 2.3 GW; sharp increase from acquisition of Q-Cell) and modules (production capacity of 900 MW).

Woongjin Energy ([www.woongjinenergy.com](http://www.woongjinenergy.com)), which is highly appreciated for its exclusive technological prowess in producing the monocrystal ingots / wafers that are required to process highly efficient cells, has been influenced by corporate restructuring and has retreated in its production capacity by cutting back from 1 GW to 500 MW.

S-energy ([www.s-energy.co.kr](http://www.s-energy.co.kr)), a photovoltaic module and development system manufacturer, has 203 employees and posts annual sales of KRW 270 billion. It was founded in 2001 when it branched out from the Samsung Group. It is located in Sampyeong-dong, Bundang-gu, Seongnam-si, Gyeonggi Province and is the first company in Korea to successfully commercialize the Building-integrated Photovoltaic (BIPV) module.



## Wind power

Hyundai Heavy Industries ([www.hhi.co.kr](http://www.hhi.co.kr)) is a Korean conglomerate that produces 1.65 MW, 2 MW, 2.5 MW and 5.5 MW-class land turbines and towers, main frames, blades and connection hubs. In Korea, the company runs its operations based on production lines built in 2010 in Gunsan Industrial Complex. The company co-established a wind power production facility with an annual capacity of 600 MW with Datang Shandong Development Ltd of China in May of 2011. It produces 300 sets of 2 MW turbines for wind power generation, each year. The corporation's total production capacity is at 1.2 GW. It has also been preparing for the development and commercialization of a 5.5 MW maritime wind power generator.

DSME Co., Ltd. ([www.dsme.co.kr](http://www.dsme.co.kr)) bought Dewind Inc., an affiliate of CTC in the United States, for KRW 50 million. It did so in order to advance into the wind power generation market, with the goal of becoming the world's 10<sup>th</sup> wind power equipment manufacturer by 2015 and, by 2010, the world's third, with a global market share of at least 15%, based on its North American production base. This company also has wind power generation tower and blade factories in Canada.

In 2009, Samsung Heavy Industries ([www.shi.samsung.co.kr](http://www.shi.samsung.co.kr)) manufactured the 2.5 MW wind power generation facility unit #1 in its shipbuilding plant in Geoje Island and handed it over to CLO, in the United States. It has emerged as Korea's first exporter of wind power generation equipment. The company aims to become the world's third-largest wind power producer by 2020. Its annual wind power equipment manufacturing capacity is at the 500 MW level.

Hyosung Heavy Industries ([www.hyosungpni.co.kr](http://www.hyosungpni.co.kr)) is a producer of core parts for wind power generators, including speed accelerators, generators, controllers and towers, which are all based on internal technologies. It is now building a 5 MW-class line-up and aims to become the world's 10<sup>th</sup> wind power generation corporation by 2018.



Unison ([www.unison.co.kr](http://www.unison.co.kr)), a medium-size wind power generator manufacturer, recently won a bid for a large-scale project. In June of 2014, the company coordinated and launched an EPC (engineering, procurement and construction) project in the Yeonggwang Wind Power Complex. This complex is 40 MW in size and where Unison is responsible for manufacturing, supplying and building a wind power generator. From the total project cost of KRW 100 billion, Unison expects to make a profit of KRW 70 billion. The company, which is responsible for EPC, also obtained an equity in a Special Purpose Corporation (SPC) of the Yeonggwang Wind Power Complex to anticipate earnings from the sales of power / new & renewable energy supply certificates (REC). As new projects become available in the Uiryeong and Hwasun wind power complexes, under an agreement between MOTIE and the MOE, the company has also recently entered into an agreement with the Uiryeong Wind Power Plant for a KRW 43 billion project where it will provide wind power generators and construction work, which is of the same scale as its sales in 2013. More recently, when the wind power project in Yeonggwang resumed, which had been withheld from the delay of permission, the company's orders exceeded 60 MW.

## Fuel cells

POSCO Energy ([www.poscoenergy.com](http://www.poscoenergy.com)), an affiliate of POSCO, is one of the world's leading steel manufacturers. It is a comprehensive energy corporation that deals with power generation, fuel cells and new & renewable energy. Since 2007, it has continued to conduct R&D and make other relevant investments in the fuel cell area to become the world's largest fuel cell business operator. It has done so by actively participating in various new & renewable energy businesses, including resource circulation, photovoltaics and wind power. POSTECH, which is under POSCO, possesses many original technologies in the fuel cell area.





# 06

## RELEVANT PUBLIC ORGANIZATIONS, ASSOCIATIONS AND INSTITUTES

### Relevant public organizations and associations

The New & Renewable Energy Center of the Korea Energy Management Corp ([www.knrec.or.kr](http://www.knrec.or.kr)) is a public institution under MOTIE. It provides a wide range of services, including performance appraisal and certification; housing support; support for gaps in generation; mandatory public projects; propagation / promotion / education projects, such as PRS; international cooperation; and policy research. It does so, in order that the use and supply of new & renewable energy and the promotion of the industry are implemented in a professional and efficient manner.

The Korea New & Renewable Energy Association ([www.knrea.or.kr](http://www.knrea.or.kr)) was established to promote the technological development of Korea's new & renewable energy industry, nurture it, contribute to the sound growth of the Korean economy and to protect and promote the common interests of the new & renewable energy industry.

The Korea Photovoltaic Industry Association ([www.kopia.asia](http://www.kopia.asia)) is a business association in the photovoltaics industry. It undertakes a pivotal role in developing the industry. This association is committed to information exchanges and mutual cooperation between solar light operators, technological innovation, balanced growth for each value chain and the early achievement of grid parity.

The Korea Wind Energy Industry Association ([www.kweia.or.kr](http://www.kweia.or.kr)) is a wind power business association established to promote ties between industry members, information exchanges and the identification of issues, in order to facilitate the development of all aspects of Korea's wind power industry.

The Korea Hydrogen Industry Association ([www.h2.or.kr](http://www.h2.or.kr)) was established to contribute to the adoption and propagation of hydraulic energy and to introduce mutual support systems between overseas groups and societies, in order to promote Korea's hydraulic industry.

### Relevant institutes

The Korea Institute of Energy Research ([www.kier.re.kr](http://www.kier.re.kr)) is a national research center under the Ministry of Science, ICT and Future Planning (MSIP). Its goal is to contribute to the development and diffusion of industrial and original technologies in Korea's energy technology areas and, eventually, to the creation of growth engines and national economic growth.

The Korea Institute of Energy Technology Evaluation and Planning ([www.ketep.re.kr](http://www.ketep.re.kr)) is a pseudo-government organization that supervises national R&D projects related to the innovation of energy technology solutions.

The Korea Energy Economics Institute ([www.keei.re.kr](http://www.keei.re.kr)) is a government-funded economic research center under the Prime Minister's Office. It was established to collect, survey and study all types of data and trends related to energies and resources in and outside of the nation and to propagate and utilize these items in order to help establish sound energy and resource maintenance policies and to contribute to the improvement of the nation's economy.



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