# KOREA ENERGY

## MASTER PLAN

outlook & policies to 2035

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MOTIE
MINISTRY OF
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# Contents

KOREA ENERGY MASTER PLAN

# CHAPTER I

## Outline of the Energy Master Plan and Assessment of the First Energy Master Plan

# 1. Outline of the Energy Master Plan

## A. Legal Basis

◎ Article 41 of the Basic Law on Low Carbon Green Growth and Clause 1 of Article 10 of the Energy Law

## B. Period and Cycle

◎ Revised and re-implemented every five years over a period of twenty years. The First Energy Master Plan was introduced in 2008.

## C. Procedure for Establishment

◎ Reviewed and approved by three separate entities in a three-step process:

- National Energy Committee → Presidential Committee on Green Growth → State Council

## D. Key Features (Under Clause 3 of Article 41 of the Basic Law on Low Carbon Green Growth)

1. Matters concerning trends and prospects of domestic and overseas demand and supply of energy
2. Matters concerning measures for stable import, supply, and management of energy
3. Matters concerning the targets for demand of energy, the composition of energy source, the saving of energy, and the improvement of efficiency in the use of energy
4. Matters concerning the supply and use of environmentally friendly energy, such as new and renewable energy
5. Matters concerning measures for the safety control of energy; and
6. Matters concerning the development and diffusion of technology related to energy, the training of professional human resources, international cooperation, the development and use of natural resources of energy, and welfare in energy.

## E. Related Plans

◎ Supply side plans: power, gas, renewable energy, integrated energy, etc.

◎ Demand management and other low carbon-related plans: rational use of energy, energy technology development, climate change response, etc.

# 2. Purpose and Features of the Energy Master Plan

## A. Scope and Purpose

◎ The Energy Master Plan is a comprehensive plan that covers all energy sectors, and systematically links and coordinates energy related plans from a macro perspective.

* As an overarching plan, it presents principles and directions for energy-related plans source-by-source and sector-by-sector.

◎ The main purpose of the plan is to provide a fundamental philosophy and vision for mid- to long-term energy policy while suggesting major targets to help realize these ends.

## B. Relation to Sub-Plans

◎ As a master plan, it contains a long-term perspective rather than detailed objectives. It is also scheduled to apply for a relatively long period of time (five years), and hence it cannot easily be adjusted in response to changes in the policy environment.

- As a result, excessive restrictions on sub-plans could worsen distortions caused by energy policies.

◎ Sub-plans will therefore be independently designed to reflect changing conditions and the particular needs and objectives of each plan while complying with the Master Plan's fundamental philosophy and principles.

◎ Additionally, compatibility will be ensured as much as possible both between individual sub-plans and between sub-plans and the Master Plan.

## C. Process for Establishment

◎ Due to the increasing complexity of energy policies and growing conflicts among stakeholders, it is essential to actively involve the private sector in the establishment of the Master Plan.

◎ A channel is needed for civic groups and experts to participate from the initial stage. The plan must be confirmed by the National Energy Committee and Committee on Green Growth, which are composed of the public and private sector.

# 3. Changing Direction of Energy Policy

### Until the 1990s

◎ The major policy objective was to secure a stable and affordable supply of energy needed for economic growth, daily life, and industrial production.

- The energy sector was dominated by public monopolies, and energy prices* were directly regulated by the government, with a priority on achieving rapid economic growth.

* In the case of petroleum products, oil prices were liberalized in 1997. However, prices continued to be regulated for electricity, gas, heat, etc.

### In the Early 2000s

◎ The government promoted competition in the energy industry through measures such as structural reform of the power industry.

- The government allowed the market to decide energy supply and demand and energy prices, with a focus on keeping both government intervention and market failures to a minimum.

### Until the First Energy Master Plan (2008)

◎ The main objective of mid- to long-term energy policy was to achieve sustainable development, simultaneously considering energy security, economic growth, and environmental impact.

* "3 Es" of Energy Policy: Energy Security, Efficiency, and Environment

- Amid world-wide efforts to respond to climate change, greenhouse gas emissions reduction emerged as a major issue for energy policy.

# 4. Assessment of the First Energy Master Plan (2008)

## A. Five Visions

| Vision | Indicator | 2007 | 2030 |
|---|---|---|---|
| Realizing an energy self-sufficient society | Self-development rate | 3.2% | 40% |
| | Renewable energy deployment rate | 2.2% | 11% |
| | Share of nuclear installed capacity | 27% | 41% |
| Moving toward a non-oil-based society | Oil dependence | 43.6% | 33% |
| Moving toward a low energy consumption society | Energy intensity | 0.347 | 0.185 |
| Creating new growth engines and job opportunities through green energy and green technology | Energy technology level | 60% of developed nations | World leader |
| Realizing a socie ty of shared energy prosperity | Energy poverty rate | 7.8% | 0% |

## B. Overall Assessment

◎ The core policy objective in the First Energy Master Plan was "Low-Carbon Green Growth."

- The plan was aimed at maximizing the use of nuclear and renewable energy and dramatically reducing energy intensity by curbing demand, while at the same time creating a new growth engine by developing green technologies.
- The First Energy Master Plan has provided the basis for a variety of measures aimed at achieving green growth since 2008, including enacting basic laws, establishing committees, and setting a national greenhouse gas (GHG) reduction target.*

* GHG reduction target of 30% from business-as-usual (BAU) by 2020

◎ Previous energy policies focused on one primary purpose, the affordable and stable supply of power, to support economic growth and industrialization.

- The First Energy Master Plan pursued sustainability in the energy industry and presented a new and advanced paradigm for creating a new growth engine through green technologies.

◎ Significant growth in the size of the renewable and nuclear industries brought about a green industry renaissance.

* For renewables, between 2007 and 2011, the number of enterprises in the market increased two times, the number of employees four times, the volume of sales eight times, and the volume of exports and amount of private investment seven times.

◎ In 2012, the final energy consumption growth rate surpassed the projection of the First Energy Master Plan by 3.3%.
(If the trend continues, the gap between the actual growth rate and the projection will reach 13.3% by 2030.)

◎ The electrification of energy consumption, in which demand is focused on electricity due to low electricity rates, destabilized the power supply-demand balance.

- More and more generation facilities have been constructed to meet growing demand, but this resulted in negative effects, such as increased GHG emissions, an overloaded transmission network and opposition from local residents.

◎ Overseas resources development, which was led mainly by public enterprises with a narrow focus on quantitative growth, resulted in increased debt without sufficiently improving development capability.

* "3 Es" of Energy Policy: Energy Security, Efficiency, and Environment

## C. Assessment of Main Tasks

### Energy Mix

◎ Key points: Maximize* the use of nuclear energy, which has both environmental benefits, such as $CO_2$ reduction, and economic benefits.

* Targeting 41% of total installed capacity and 59% of total power generation by 2030.

- Expand renewable energy to 11% of primary energy consumption by 2030 through various measures, including the Renewable Portfolio Standard (RPS) and the One Million Green Home project.

◎ Areas for improvement: The energy mix proposed in the plan emphasized both GHG reduction and economic efficiency. However, it was insufficiently comprehensive in terms of considering such factors as feasibility*, public acceptance, power grid conditions, and safety.

* Renewable energy: potential after considering geographical/technological conditions, environmental regulations, etc.; nuclear energy: load-following capacity, etc.

## Demand Management

◎ Key points: Reduce energy intensity by 46% by 2030

* Energy intensity (TOE/1,000$): 0.347 in 2006 → 0.233 in 2020 → 0.185 in 2030

◎ Forecast vs actual consumption: Total energy consumption in Korea has increased faster than forecasted in the First Energy Master Plan for last five years (2007~2012).

◎ Energy consumption in the industrial sector has been increasing faster than forecasted, while the trend is less pronounced in the transportation, household and commercial sectors.

* Whereas the First Energy Master Plan forecasted that energy consumption in the industrial sector would decrease from 57.5% of final energy consumption in 2007 to 56.1% in 2012, actual consumption increased to 61.4%.

[ Forecast vs Actual Consumption ]

| Category | | 2012 Forecast vs Actual | | Annual Growth Rate (2007~2012, %) | Margin of Error(%) |
|---|---|---|---|---|---|
| Energy Consumption | Total energy consumption (1,000 toe) | Forecast | 268,190 | 2.6 | 3.5 |
| | | Actual | 277,621 | 3.3 | |
| | Final energy consumption (1,000 toe) | Forecast | 199,607 | 1.9 | 3.8 |
| | | Actual | 207,262 | 2.7 | |
| | Energy Intensity (TOE/1 mil won) | Forecast | 0.222 | - 2.1 | 13 |
| | | Actual | 0.251 | - 0.3 | |
| Sector | Industry | Forecast | 112,015 | 1.4 | 13.5 |
| | | Actual | 127,213 | 4.0 | |
| | Transportation | Forecast | 40,473 | 1.8 | 3.8 |
| | | Actual | 37,176 | 0.1 | |
| | Household & Commerce | Forecast | 42,458 | 3.4 | - 8.1 |
| | | Actual | 38,084 | 1.2 | |
| | Public & Others | Forecast | 4,663 | 2.4 | 2.7 |
| | | Actual | 4,790 | 2.9 | |

◎ Areas for improvement:  Precise demand forecasting, effective demand management, and policies for pricing and technology development/deployment are needed.

### Power Supply and Demand

◎ Key points: Reduce electricity demand by 7.6% by 2020 and 12.4% by 2030.

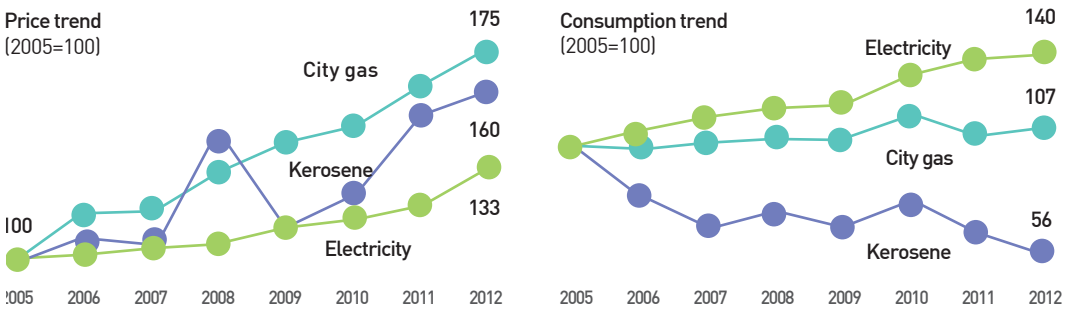
◎ Forecast vs actual consumption: Electricity demand as of 2012 was over 9% higher than forecasted, accounting for almost 20% of final energy consumption.

* Share of electricity in final energy consumption: 17.5% in 2007 → 19.3% in 2012

- Low electricity prices resulted in increased consumption as people switched to electricity from other energy sources.

* Following price liberalization, the price of petroleum products soared due to high oil prices. However, the increase in electricity rates was kept to a minimum out of consideration for consumer prices.

[ Forecast vs Actual Consumption ]

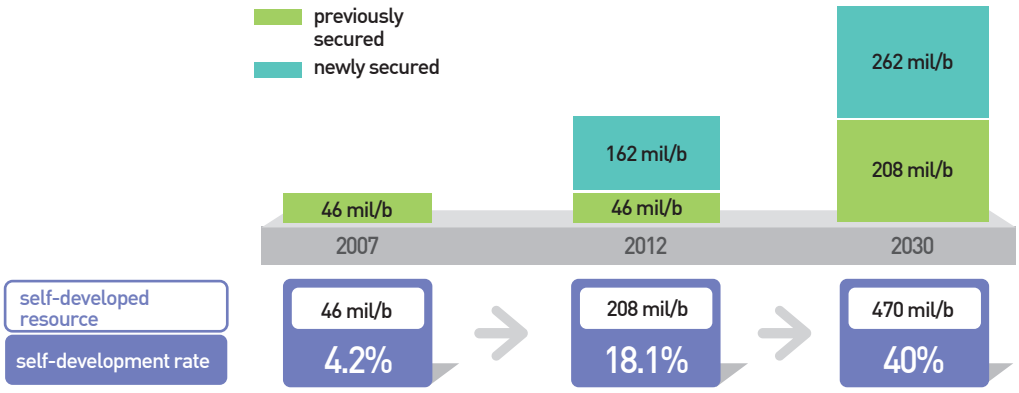



◎ Areas for improvement: Rational reform of the energy pricing mechanism is needed in order to fundamentally reduce electricity demand and peak load.

### Overseas Resource Development

◎ Key points: In view of Korea's high dependence on energy imports (96%), innovative efforts are needed to raise the self-development rate for overseas resources.

* Target: 40% by 2030.

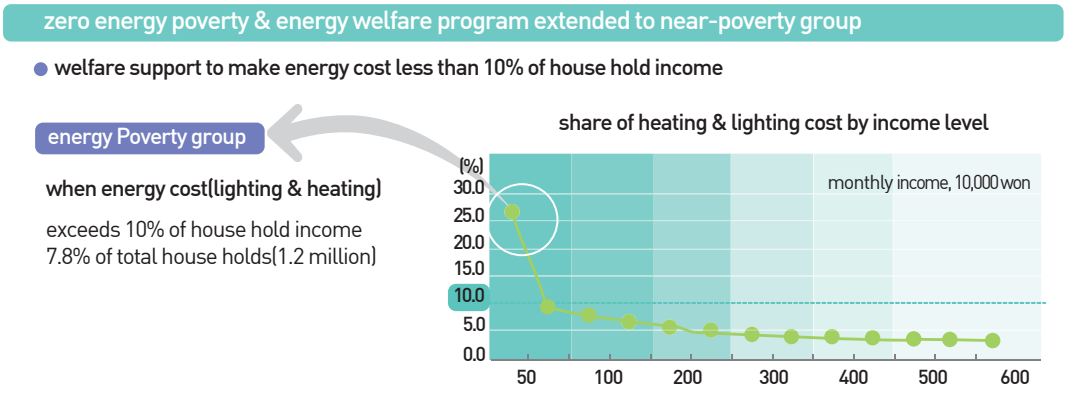



◎ Areas for improvement: The focus should be shifted from quantitative growth to qualitative growth, such as securing exploration and operation rights, and inclusive growth should be sought through public-private coordination.

* Projects with operation rights: 77 out of 205 (37.6%), Korea National Oil Corporation 55.6%, Korea Gas Corporation 14%, private companies 26.2%

## Energy Welfare

◎ Key points : Eradicate energy poverty affecting 1.2 million households by 2016 (phase 1); reduce energy costs for near-poverty group by 2030 (phase 2)




◎ Areas for improvement: The support system needs to be fundamentally improved to help the energy poor, who continue to suffer as energy rates rise due to high oil prices while receiving only short-term and sporadic support from the current system.

KOREA ENERGY MASTER PLAN

# CHAPTER II

## Background to the Implementation of the Second Energy Master Plan

# 1. Current Energy Consumption

## A. Consumption by Sector

◎ The average annual growth rate (AAGR) of final energy consumption from 2000 to 2012 was 2.8%.

* The AAGR, which was 7.2% in the 1990s, slowed considerably after the Asian financial crisis.

◎ The share of energy consumed in the industrial sector has been steadily increasing and currently exceeds 60% of final energy consumption.

* The shares of the household, commercial, public and transportation sectors have steadily decreased.

◎ Feedstock, such as naphtha and coking coal, accounts for more than half of energy consumption in the industrial sector and more than 35% of total final energy consumption.

* If consumption of feedstock is excluded, the AAGR of final energy consumption decreases by 0.6% percentage points to 2.2%.
Energy used as feedstock was the largest contributor to the increase in energy consumption.
Industrial energy consumption soared throughout the recovery from the 2010 financial crisis.

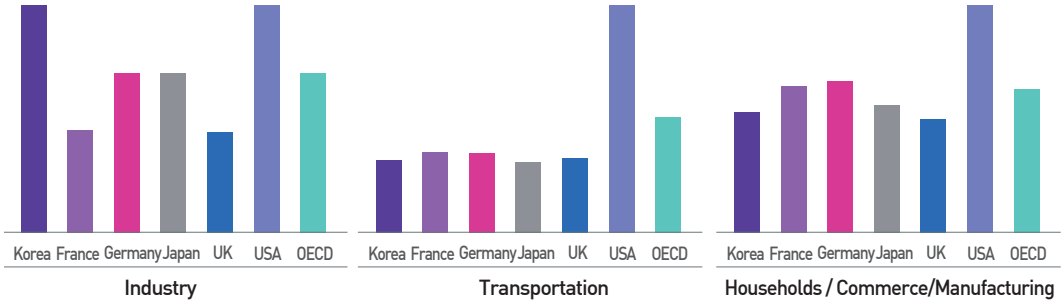
[ Energy Consumption Trend by Sector (Unit: million TOE) ]

| Sector | 2000 | 2008 | 2009 | 2010 | 2011 | 2012 | AAGR (%) |
|---|---|---|---|---|---|---|---|
| Industry (excluding feedstock) | 83.9 (42.0) | 106.5 (50.1) | 106.1 (50.3) | 116.9 (51.1) | 126.9 (54.3) | 127.3 (54.5) | 3.5 (2.2) |
| Transportation | 30.9 | 35.8 | 35.9 | 36.9 | 36.9 | 37.1 | 1.5 |
| Household/ Commerce | 32.4 | 36.2 | 35.7 | 37.3 | 37.5 | 38.0 | 1.3 |
| Public/Others | 2.6 | 4.1 | 4.3 | 4.5 | 4.6 | 4.4 | 4.5 |
| Total | 149.9 | 182.6 | 182.1 | 195.6 | 205.9 | 207.8 | 2.8 |

◎ The energy intensity (energy used per unit of GDP) of the Korean economy is relatively high due to a large proportion of energy-intensive industries compared to other countries.

* Share of energy consumed in the industrial sector (2011): Korea 53%, Japan 37%, US 25%, OECD 30%

[ Per Capita Energy Consumption (TOE/person) (Source: IEA, 2011) ]




## B. Consumption by Energy Source

[ Final Energy Consumption Trend By Source ]


◎ Oil: The share of oil in final energy consumption reached a record high of 68.2% in 1994 before steadily decreasing to 48.9% in 2012.

* AAGR: Reached 8.0% in the 1990s before decreasing to 1.0% from 2000
- By oil product: gasoline 1.2%, diesel for transportation 1.4%, kerosene/light oil -2.9%, heavy oil -8.2%, naphtha 4.4%

* Share by sector: Industry 55.6%, transportation 36.3%, household/commerce 6.9%
- Excluding feedstock: Industry 14.5%, transportation 70.2%, household/commerce 13.1%

◎ Electricity: The share of electricity increased from 10.8% in 1990 to 19.3% in 2012, and electricity consumption increased rapidly at an AAGR of 5.7% from 2000.

- Low electricity prices compared to other energy sources, along with convenience of use, accelerated the electrification of energy consumption.

◎ City Gas: Consumption of city gas increased very rapidly at an AAGR of 30.5% in the 1990s, but this increase slowed to an AAGR of 5.9% after 2000 due to saturation of infrastructure.

* AAGR by sector (from 2000): industry 9.3%, household/commerce 3.6%

◎ Coal: The share of coal remained in the 13% range in the 2000s before increasing to 15.4% in 2012 due to recent rise in industrial consumption.

* The share of bituminous coal in total coal consumption, which was 50.4% in 1990, increased sharply to 91.8% in 2012 due to a decrease in anthracite coal consumption and an increase in the use of bituminous coal for power generation.

## 2. Global Conditions

### A. Global Energy Demand Forecast

◎ Global energy demand is forecasted to increase by 48.3% between 2010 and 2035 on the back of economic and population growth in developing countries, and GHG emissions are expected to increase by 40.2%.

- Total energy demand will increase by 0.5% annually on average in OECD countries and 2.3% in non-OECD countries.

◎ By energy source, nuclear and renewable energy will experience the fastest growth with an AAGR of 2.7%.

* Among fossil fuels, natural gas will see the largest increase as a result of the distribution and expanded production of shale gas.

[ Demand Forecast by Region & Energy Source 2010~2030 (Unit: 1000 Trillion Btu) ]

| By Region / By Source | 2010 | 2015 | 2020 | 2035 | CAGR (10~35) |
|---|---|---|---|---|---|
| **OECD** | | | | | |
| Oil | 92.8 | 90.6 | 91.4 | 91.4 | - 0.1% |
| Natural Gas | 57.5 | 60.1 | 63.4 | 74.2 | 1.0% |
| Coal | 44.8 | 42.2 | 42.3 | 42.8 | - 0.2% |
| Nuclear | 22.6 | 22.0 | 24.4 | 27.6 | 0.8% |
| Renewable & Others | 24.6 | 29.2 | 33.0 | 40.1 | 2.0% |
| **Subtotal** | 242.3 | 244.1 | 254.6 | 276.1 | 0.5% |
| **Non-OECD** | | | | | |
| Oil | 83.3 | 94.9 | 103.3 | 129.7 | 1.8% |
| Natural Gas | 59.3 | 64.1 | 72.6 | 103.2 | 2.2% |
| Coal | 102.6 | 122.4 | 138.0 | 173.9 | 2.1% |
| Nuclear | 4.7 | 8.4 | 13.5 | 25.9 | 7.0% |
| Renewable & Others | 31.7 | 38.1 | 48.0 | 68.4 | 3.1% |
| **Subtotal** | 281.7 | 327.9 | 375.3 | 501.0 | 2.3% |
| **World** | | | | | |
| Oil | 176.1 | 185.5 | 194.7 | 221.1 | 0.9% |
| Natural Gas | 116.8 | 124.2 | 136.0 | 177.4 | 1.7% |
| Coal | 147.4 | 164.6 | 180.3 | 216.7 | 1.6% |
| Nuclear | 27.3 | 30.4 | 37.9 | 53.5 | 2.7% |
| Renewable & Others | 56.2 | 67.3 | 81.0 | 108.5 | 2.7% |
| **Total** | 523.9 | 572.0 | 629.8 | 777.1 | 1.6% |

■ Non-OECD countries will lead the growth in global energy demand. The share of fossil fuels in energy demand will decrease from 84% in 2010 to 79% in 2035 despite increased use of unconventional resources, such as shale gas.

## B. Continued High Oil Prices

◎ Global oil prices, which averaged $94.3/bbl* in 2008, fell in 2009 following the financial crisis before rebounding to a record high of $124/bbl in 2012.

* Dubai crude oil

◎ Oil prices are expected to remain high, reaching $140/bbl by 2035 according to the IEA (WEO 2012).

* EIA's projection: $145/bbl by 2035

| | Past | New Era of High Oil Prices |
|---|---|---|
| Cause | · Supply-side instability in the Middle East and other regions | · Demand growth from emerging countries<br>· Increasing marginal cost of production |
| Price Recovery | · Prices return to previous levels when conditions normalize | · Oil prices remain high |

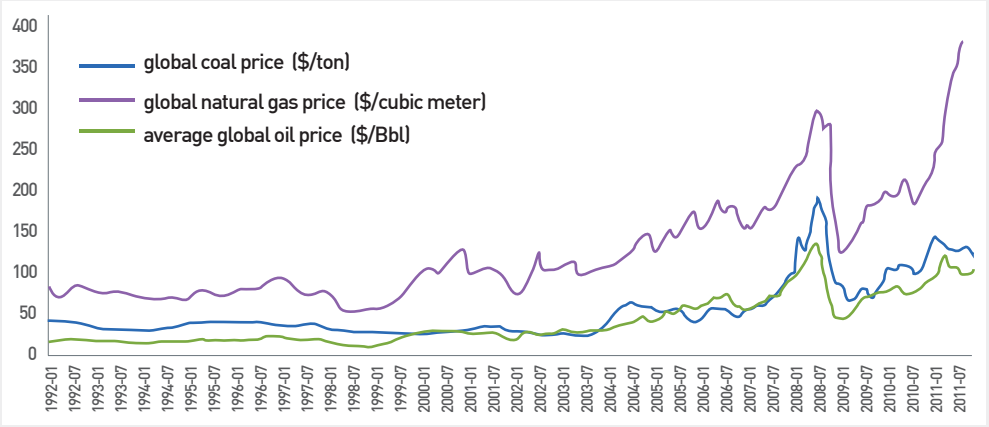
- A steady increase in fossil fuel prices will have a large negative impact on the entire Korean economy, which is highly dependent on imports.
- However, continued high oil prices will accelerate the development of alternative energy and improvements in energy efficiency.

## C. Expanded Development of Unconventional Energy Sources

◎ The development of unconventional energy sources, such as shale gas and tight oil, will change the landscape of the energy market.

* Unconventional gas will account for 48% of the growth in gas production by 2035. The US, which currently imports 20% of its energy, will achieve energy self-sufficiency by 2020.

- Regions with shale gas resources, such as China, Europe, and the US, will replace the Middle East and Russia, which are the largest exporters of traditional gas, as the dominant players in the natural gas market.
- The markets for natural gas substitutes, such as coal and oil, are also highly likely to be affected.



## D. Changes in Nuclear Energy Policy After the Fukushima Nuclear Accident

◎ In the aftermath of the Fukushima nuclear accident on March 11, 2011, several countries, including Germany and Switzerland, announced plans to shut down their nuclear power plants in operation.

◎ Japan decided to phase out nuclear energy by 2030 after soliciting public comments on three scenarios for nuclear energy use.

* The decision was later put on hold in the face of opposition from the industry and allies, such as the US, and it was effectively reversed after the new government took office.

◎ Some countries are turning back to nuclear energy, including the UK, which announced plans to construct a new nuclear power plant for the first time in 20 years.

- The Nuclear Regulatory Authority of Japan announced new safety regulations on July 8, 2013, and plans to restart the operation of nuclear power plants after confirming their safety under the new regulations.

* Hokkaido Electric Power Co., Kansai Electric Power Co., Shikoku Electric Power Co., and Kyushu Electric Power Co. applied for safety tests on twelve reactors in five nuclear power plants.

◎ Many countries have not significantly changed their positions on nuclear energy and are maintaining their previous nuclear energy policies with the addition of new measures, such as stronger safety standards.

[ World-wide Nuclear Power Plants Before and After the Fukushima Accident (Source: World Nuclear Association) ]

| Period | In Operation (capacity) | Under Construction (capacity) | Planned (capacity) | Total (capacity) |
|---|---|---|---|---|
| Before Accident | 437 (373,966 MW) | 60 (61,759 MW) | 158 (176,773 MW) | 655 (981,643 MW) |
| After Accident (as of July 1, 2013) | 432 (371,870 MW) | 68 (71,226 MW) | 162 (183,025 MW) | 662 (984,87 1MW) |
| Difference | -5 (-2,096 MW) | +8 (9,467 MW) | +4 (6,252 MW) | +7 (3,228 MW) |

■ Although some countries have announced plans to shut down nuclear power plants, world-wide reliance on nuclear energy has not changed significantly since the Fukushima accident.

## E. Negotiations on New Post-2020 Climate Regime

◎ The Ad Hoc Working Group on the Durban Platform for Advanced Action (ADP) aims to conclude negotiations on a new post-2020 global climate framework that is applicable to all nations by the end of 2015.

* Whereas the Kyoto Protocol of 2008 to 2020 called for mandatory GHG reduction by developed nations and voluntary GHG reduction efforts by developing nations, the new post-2020 climate regime will be a single climate regime applicable to all participating nations.

◎ The recent 19th session of the Conference of Parties (COP 19) developed a concrete work plan for conducting negotiations on the new post-2020 climate regime through the end of 2015.

- The parties agreed to come forward with their intended national contributions to post-2020 global GHG emissions reduction by 2015.

■ Persistent disagreements between developed and developing countries as well as global economic uncertainty have weakened the momentum for negotiations compared to the period of the First Energy Master Plan.

■ The establishment of a new post-2020 climate regime applicable to both developed and developing nations is likely to put increased pressure on Korea.

## F. Restructuring of the Renewable Energy Industry

◎ The renewable energy industry is going through a period of rapid restructuring due to a sluggish global economy and an overabundance of solar PV and wind power manufacturers.

* Reduction of the number of solar PV companies and production capacity between 2011 and 2013: Europe (25 companies, 2,400 MW), US (15 companies, 1,200 MW), Korea & China (200 companies, 3,200 MW).

◎ Accelerated technology development has continually driven down the generation costs of renewable energy.

* Unit costs of generation: (wind power) $200/MWh in 2010 → $100/MWh by the end of 2012; (solar PV) $315/MWh in 2010 → $166/MWh by the end of 2012

■ Although the renewable energy industry is going through period of stagnation and restructuring in the short-term, technology competition is likely to lead to considerable growth in the mid- to long-term.

## Energy Mix Forecast for Major Countries (Source: IEA)

◎ Current status by country

[ Energy Mix in Major Countries (%, 2011) ]

| | Coal | Oil | Gas | Nuclear | Hydro | Renewable | Total |
|---|---|---|---|---|---|---|---|
| US | 43.3 | 0.9 | 24.2 | 19.0 | 7.4 | 5.2 | 100.0 |
| Germany | 45.1 | 1.1 | 13.9 | 17.9 | 2.9 | 19.1 | 100.0 |
| France | 3.1 | 0.6 | 4.8 | 79.4 | 8.0 | 4.0 | 100.0 |
| Japan | 27.0 | 14.7 | 35.9 | 9.8 | 8.0 | 4.7 | 100.0 |
| China | 78.9 | 0.2 | 2.0 | 1.8 | 14.7 | 2.4 | 100.0 |

- US: Coal is the largest source of power generation in the US (43.3%), followed by gas (24.2%) and nuclear energy (19.0%).
- Germany: Germany's energy mix is similar to that of the US, except for a higher share of renewable energy.
- France: France is highly dependent on nuclear power, which supplies 79.4% of its electricity.
- Japan: Following the shutdown of nuclear power plants, fossil fuels increased from 62.4% of Japan's energy mix in 2010 to 77.5% in 2011. The share of gas (36.0%) was especially high.
- China: Coal currently accounts for 79% of power generation in China. However, the government plans to expand nuclear power capacity to 80 GW by 2020, which will supply 5% of China's power.

◎ Energy mix forecast

- The shares of coal and oil in the energy mix of major countries will decrease, while those of gas, nuclear and renewable energy will increase.

[ Primary Energy Consumption Forecast in Major Countries (%) ]

| | US | | Japan | | China | | OECD Europe | |
|---|---|---|---|---|---|---|---|---|
| | 2011 | 2035 | 2011 | 2035 | 2011 | 2035 | 2011 | 2035 |
| Coal | 22 | 18 | 23 | 22 | 68 | 53 | 18 | 10 |
| Oil | 36 | 27 | 45 | 30 | 16 | 18 | 33 | 25 |
| Gas | 26 | 29 | 22 | 23 | 4 | 11 | 24 | 29 |
| Nuclear | 10 | 11 | 6 | 10 | 1 | 6 | 13 | 12 |
| Hydro | 1 | 1 | 2 | 2 | 2 | 3 | 2 | 3 |
| Renewable | 5 | 13 | 3 | 13 | 9 | 10 | 9 | 21 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

## 3. Domestic Conditions

### A. Deteriorating Conditions for Power Supply & Demand

◎ Low electricity prices have led to a sharp increase in the electricity demand of the industrial sector and in demand for cooling and heating.

* From 2008 to 2012, electricity consumption in the industrial sector grew by 6.4% annually on average, making it the largest contributor to the increase in total electricity consumption. Due to a decrease in the relative price of electricity, electricity used for heating accounted for 25% of peak demand.

[ Shares of Electricity Used for Heating During Peak Demand (%) ]

| '05~'06 | '06~'07 | '07~'08 | '08~'09 | '09~'10 | '10~'11 |
|---|---|---|---|---|---|
| 18.6 | 19.8 | 22.0 | 22.6 | 24.1 | 25.4 |

◎ The issue of electricity demand and supply should be addressed by controlling industrial demand, spreading an energy saving culture, and using decentralized generation.

### B. Growing Demand for Nuclear Safety

◎ The Fukushima nuclear accident has heightened public concerns about nuclear safety.

- Despite moves to strengthen nuclear safety standards, including the establishment of a Nuclear Safety and Security Commission, corruption scandals involving suppliers have led to increased calls for reform of the safety management and overall culture of the nuclear industry.

◎ Plans for the construction of new nuclear power plants were put on hold in the 6$^{th}$ Basic Plan for Long-term Electricity Supply and Demand.

### C. Deteriorating Power Transmission Conditions

◎ Although the transmission network was expanded to prepare for the construction of new power plants, the difference between the location of generation sites and areas of high demand has caused transmission lines to the Seoul metropolitan area to be become overloaded.

◎ The centralized power system is facing limitations due to local opposition to the construction of ultra-high-voltage transmission lines.

## D. Emergence of Various Controversial Issues

◎ Various controversies have arisen surrounding energy policy, including nuclear energy policy, spent nuclear fuel issues, and the construction of transmission lines.

◎ Unilateral policy making by the central government has a limited capacity to effectively address such issues.

## E. Changing Conditions for GHG Emission Reduction

◎ Since the establishment of the First Energy Master Plan, policy efforts to reduce $CO_2$ emissions have been strengthened.

- In 2009, the government set a national GHG emissions reduction target of 30% below BAU levels by 2020.

  * An emissions trading system (ETS) will be introduced as part of efforts to achieve the GHG emissions reduction target.

◎ However, conditions have become less favorable for GHG emissions reduction policies.

  * Supply: Limitations to renewable energy deployment, increased use of coal-fired power plants, etc.

  * Demand: Increased production in energy-intensive industries, including steel and petrochemicals

KOREA ENERGY MASTER PLAN

# CHAPTER III

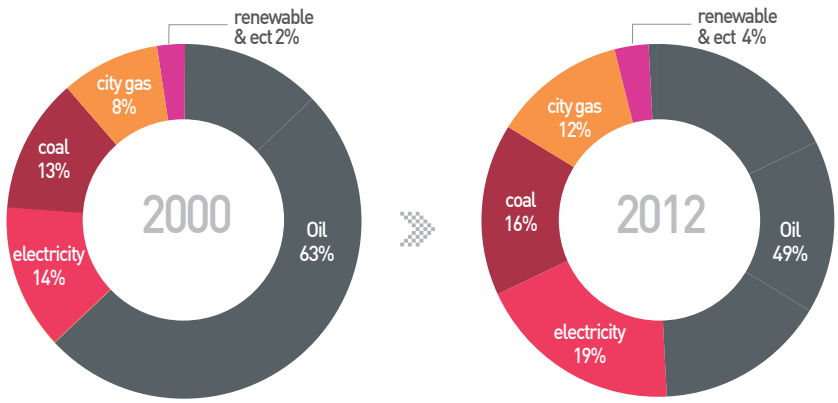
## Basic Direction of the Second Energy Master Plan

## 1. Drawbacks of the Current Energy Policy

### A. Inefficient Resource Distribution

◎ A low-price policy motivated by social and economic concerns has reinforced energy overconsumption patterns and accelerated the trend toward disproportionate use of certain types of energy, such as electricity.

[ Change in Energy Mix (2000 → 2012) ]




- In particular, the electrification of energy consumption is causing serious problems.

  - Significant energy loss (63%) takes place during the production process (generation, transmission, etc.).
    * 2.74 TOE of energy input is needed to produce 1 TOE of electricity.
  - While a stable supply of other energy sources can be maintained by stockpiling and imports, a sudden increase in demand for electricity may result in a supply-demand imbalance if the supply infrastructure is insufficient.
  - An expansion of generation facilities could cause environmental degradation, overload the transmission network, and provoke a backlash from local residents.

- Low electricity prices are also a significant obstacle to the creation of new markets in less economical areas, such as renewable energy and smart grid.

◎ The current energy mix is based on economic feasibility without giving sufficient consideration to external effects.

- There should be a reassessment of external effects, such as environmental pollution caused by nuclear and coal-fired plants, public safety concerns, opposition from local residents, etc.

## B. Policies Centered on Supply and Quantitative Growth

◎ In place of aggressive measures to curb demand, large-scale, centralized supply infrastructure (the unified power grid) was expanded to meet growing demand.

- An expanded power grid, larger power generating complexes, and supply-demand imbalance in the Seoul metropolitan area have led to deteriorating operating conditions in the power grid and transmission network.

◎ A narrow focus on efficiency during the rapid growth of the nuclear industry had unintended consequences:

- The goal of achieving rapid "nuclear self-sufficiency*" resulted in decreased transparency within the industry, while little attention was given to investment in safety and improving the safety regulation system.**

* (1978) Kori #1 → (1999) Uljin #3·4 (OPR1000) → (2014) Shin Kori #3·4 (APR1400)

**The Ministry of Education and Science and Technology was previously in charge of nuclear safety regulation. An independent regulatory body, the Nuclear Safety and Security Committee, was established in October 2011 following the Fukushima accident.

## C. Result-Oriented Policy Goals

◎ New power plant construction was kept to a minimum while ambitious demand management targets were set to achieve the policy goal of sustainable development.

* The 3rd Basic Plan for Long-term Electricity Supply and Demand attracted criticism about over-investment in generation facilities due to the high power reserve ratio (18.4% in 2003).

◎ Overseas resources development, which was led mainly by public enterprises with a narrow focus on quantitative growth, resulted in increased debt without sufficiently improving development capability.

◎ As the current deployment rate of renewable energy is a mere 2.75% (85% of the target of the first plan), reconsideration of the deployment target and detailed measures to achieve the target are needed.

* It has been pointed out that the First Energy Master Plan did not include practical measures, such as funding mechanisms, to achieve the deployment target of 11%.

## 2. Basic Direction of the Second Energy Master Plan

### Six Major Tasks

#### 1. Transition to energy policies focused on demand management

◎ Objective: Reduce electricity demand by 15% by 2035
◎ Main tasks: Adjust energy tax rates, improve the electricity rate system, establish a demand management system based on ICT, etc.

#### 2. Build a distributed generation system

◎ Objective: Supply more than 15% of power from distributed generation by 2035
◎ Main tasks: Detect transmission constraints in advance, expand distributed generation, etc.

#### 3. Strike a balance with environmental and safety concerns

◎ Objective: Apply the latest GHG reduction technology to new power plants
◎ Main tasks: Strengthen climate change response, enhance nuclear safety, etc.

#### 4. Enhance energy security and energy supply stability

◎ Objective: Build overseas resource development capacity and achieve a renewable energy deployment rate of 11%
◎ Main tasks: Reinforce public resource development enterprises, expand renewable energy deployment, enhance international cooperation, etc.

#### 5. Establish a stable supply system for each energy source

◎ Objective: Secure a stable supply of conventional energy sources, such as oil and gas
◎ Main tasks: Diversify supply routes, expand domestic stockpiling capacity, etc.

#### 6. Shape energy policy to reflect public opinion

◎ Objective: Introduce an "Energy Voucher System" in 2015
◎ Main tasks: Improve energy welfare, respond pro-actively to energy- related controversies, etc.

## 3. Policy Objectives and Major Tasks

### A. Transition to Energy Policies Focused on Demand Management

◎ Policy objectives: 13% reduction in energy demand and 15% reduction in electricity demand by 2035

◎ Tax reform: Adjust energy tax rates to reduce the imbalance between the consumption of electricity and other energy sources (Impose a tax on bituminous coal used for generation, offer tax incentives for LNG, etc).

◎ Rate revision: Revise the rate system to reflect environmental and social costs (e.g., refurbishment of nuclear facilities and the transmission network), apply different pricing for different types of use (e.g., progressive rate relief, pricing based on voltage), expand critical-peak pricing, etc.

◎ ICT-based demand management: Deploy smart grid (incentives for ESS installation, etc.) and energy management systems (revising standards for building design, etc.), invigorate the demand management market, etc.

◎ Reinforcement of systems for each sector: Improve average car mileage to the level of developed nations by 2020, zero-energy for new buildings by 2025, eliminate low-efficiency products from the market, etc.

### B. Build a Distributed Generation System

◎ Construct power plants in areas with sufficient transmission capacity: Provide information on available sites for new plants in advance to minimize construction of ultra-high voltage transmission lines

◎ Expand distributed generation: Supply more than 15% of power from distributed sources, such as integrated energy systems, renewable energy, and in-house generators by 2035 (current contribution rate: 5%)

◎ Operate transmission network operation: Develop integrated plans for generation and transmission, raise public acceptance through a review of ultra-high-voltage transmission lines, and establish an independent body* to manage and supervise the power grid

* Responsible for monitoring and analyzing power grid operation, applying reliability standards, investigating and managing grid malfunctions, etc.

## C. Enhance Sustainability (Environmental Protection, Improved Safety, and Technology Development)

◎ Strengthen climate change response: Apply GHG reduction technologies, such as USC and CCS, to thermal power plants as soon as they are available

* Applying USC to an aged power plant decreases GHG emissions by approximately 10% and raises efficiency approximately 4 percentage points.

◎ Improve safety: Prioritize safety in the operation of nuclear power plants by expanding investment, improving management of aged plants, and fostering planned and preventive inspections to enhance nuclear safety on a large scale

* Continuous development of nuclear safety technologies to improve nuclear safety, stress tests for plants with extended lives, proactive maintenance of equipment in use for long periods of time, and extension of preventive inspection periods and its application

◎ Promote innovation in the nuclear industry: Revise relevant systems and consolidate operational systems to introduce observation, monitoring, openness, and competition into the value chain of the nuclear industry

* Enact laws on nuclear regulation and supervision and form a government panel for the integrated administration of public nuclear facilities

◎ Develop energy technology: Promote the development of key technologies to support stronger demand management, the expansion of distributed generation, etc.

## D. Enhance Energy Security to Escape From Energy Isolation

◎ Build capacity for overseas resource development: Reorient public enterprises toward high-risk areas and long-term investment, while private enterprises focus on areas with high market potential.

* Shift the focus of public enterprises from M&As and share purchases to exploration and development activities and operating rights, expand support to encourage private investment and entrance into related industries, such as plant construction.

◎ Renewable energy deployment: Raise the renewable energy deployment rate to 11% by 2035 by extending deployment policies currently applied to electricity* to heat and transportation and by implementing a private sector-driven deployment system**.

* The RHO and the RFS systems, which are similar to the RPS in the electricity sector, will be introduced in the heat and transportation sectors respectively.

** Introduce a photovoltaic rental business; provide incentives for projects invested in by local residents and with benefit-sharing mechanisms; etc.

## E. Establish a Stable Supply System for Each Energy Source

◎ Oil: Reduce dependence on certain oil exporting countries by diversifying oil import routes and improve the industrial structure by establishing a Northeast Asia oil hub

◎ Gas: Respond aggressively to changes in the global market, such as the emergence of shale gas, and expand the supply infrastructure for domestic stockpiling

◎ Integrated energy: Expand facilities and improve relevant systems to expand the role of integrated energy as distributed power and make an effort to convert to a low-cost structure

◎ Electricity: Construct of power plants in a timely manner, maximize the use of available generation resources to secure a stable supply capacity at times of supply-demand imbalance, etc.

## F. Shape Energy Policy to Reflect Public Opinion

◎ Respond proactively to energy-related conflicts: Improve transparency throughout the process of establishing and implementing policies on the transmission network, spent fuel management, nuclear energy, etc.

◎ Improve energy welfare: Introduce an energy voucher system in 2015, expand energy efficiency projects for vulnerable households, and eradicate welfare blind spots by expanding infrastructure, such as system revision

◎ Strengthen cooperation with local governments: Conduct an assessment of the "Regional Energy Plan" for distributed generation and energy saving and incorporate the plan into the budget

* Consolidate the institutional base: Improve the establishment process for regional energy plans; enact ordinances related to regional energy policy; establish local government energy commissions; etc.

KOREA ENERGY MASTER PLAN

# CHAPTER IV

## Establishment Process for the Second Energy Master Plan

# 1. Public-Private Working Groups

## A. Background

◎ During the drafting of the First Energy Master Plan, the National Energy Committee was formed as a deliberative and decision-making body by representatives of the public and private sectors. The opinions of interested parties were collected through public hearings and discussions.

* National Energy Committee: (8 members including the president, the prime minister, and heads of related institutions) + (11 members including industrial, academic and research professionals), (5 members recommended by civic groups) - total 24 members.

◎ Since that time, increasing energy-related controversies have made it all the more crucial to reach reasonable and amicable agreement during the establishment and implementation of energy policies.

◎ Therefore, whereas the collection of public opinion on the First Energy Master Plan took place in the final stages of planning as a matter of formality, the Second Energy Master Plan was designed to reflect the views of the public from the very beginning through the formation of public-private working groups.

- Five working groups were formed from the draft plan stage by 60 interested participants from industry, academia and civic groups.

[ Main Discussion Topics of Working Groups ]

| | |
|---|---|
| **Coordinating WG** | • Direction and coordination of four working groups on demand/electricity/nuclear energy/ renewable energy; setting the basic direction for the Energy Master Plan and reviewing the energy mix |
| **Demand WG** | • Demand forecast; target demand based on demand management effects; energy pricing policy; etc. |
| **Electricity WG** | • Review of constraints on transmission; measures to promote distributed generation and reduce GHG emissions; etc. |
| **Nuclear WG** | • Analysis of economic feasibility of nuclear power plants; review of nuclear scenarios; mid- to long-term nuclear policies, including strengthening nuclear safety |
| **Renewable WG** | • Setting mid- to long-term deployment targets for renewable energy; improving deployment policy; etc. |

## B. Discussion Process

◎ In-depth discussions on various energy policy issues have taken place at more than 50 meetings since May 2013.

◎ Seven major tasks for the Second Energy Master Plan were introduced in August 2013. The Master Plan was written based on reports prepared by the five working groups.

### Seven Major Tasks

① Energy pricing system revision: Correct imbalance in the consumption of electricity and other energy sources

② Sustainable energy mix: Give comprehensive consideration to economic feasibility, public acceptance, the environment, grid conditions, etc.

③ Distributed generation system: Expand distributed generation, rationalize the transmission network

④ Stronger demand management: Manage demand in a forward-looking manner using pricing schemes, technology and policies

⑤ Balance with environmental policies: Strengthen GHG reduction efforts in each sector

⑥ Improved transparency and acceptability in the energy industry: Improve the industrial ecosystem, respond actively to energy related conflicts

⑦ Creation of new growth engine: Promote new businesses in areas such as renewable energy and smart grid

◎ In October 2013, the public-private working groups announced their recommendations for the Second Energy Master Plan based on the seven major tasks and discussions.

### Key Recommendations

- The Second Energy Master Plan should establish a consensus on the energy mix, including the share of nuclear energy, and present future policy directions on restoring the market function of energy prices, improving power grid stability, and other areas.
  - Nuclear energy share: A share of 22%~29% for nuclear energy was recommended in view of changed conditions since the First Energy Master Plan.
  - Renewable energy share: A share of 11% for renewable energy was recommended after considering analysis of the deployment potential of each energy source.

## 2. Process and Results of Gathering and Considering Opinions on the Working Group Recommendations

### A. National Assembly Hearing

#### Summary and Assessment

◎ Summary: On November 7, 2013, the Trade, Industry & Energy Committee hosted a public hearing on the recommendations of the working groups.

◎ Assessment: The policy recommendations, including transitioning to demand management and facilitating distributed generation, were reflected in the Energy Master Plan.

- The open discussion process was considered an improvement, while opinions differed about the items below.

#### Following Consideration of the Recommendations

◎ Energy demand forecast: Lively discussion took place on the soaring demand for electricity.

→ Action: Detailed documents will be submitted to the National Assembly with additional information on electricity demand.

◎ Conventional energy sources: In view of the high share of electricity, more consideration should be given to alternative energy sources, such as oil, gas, and heat.

→ Action: Plans for each energy source will be included in the report.

◎ Energy mix: Different opinions were raised about nuclear and renewable energy targets.

→ Action: The nuclear and renewable energy targets must be adequately explained.

◎ Demand management: More concrete and practical plans were requested.

→ Action: Detailed demand management plans for each sector, including building and transportation, are to be included.

### B. Discussion With Industry

#### Summary and Assessment

◎ Summary: From October to November, discussions were held with energy suppliers

(public enterprises, oil/gas/renewable energy companies), large energy consumers (steel/petrochemical/electronics companies), and economic research institutes.

◎ Assessment: Compared to the discussions for the First Energy Master Plan, the discussions for the present plan were positively received as they suggested practical policy directions, including a revision of the energy pricing system and an expansion of distributed generation.

- Energy-intensive companies and economic research institutes expressed concern about the declining competitiveness of the nuclear industry due to the decreased share of nuclear energy (41% → 22%~29%).
- Suggestions varied according to positions of the different industries.

* Some of the participants requested that the plan include detailed policy proposals in addition to mid- to long-term policy directions.

### Following Consideration of the Recommendations

◎ Energy tax reform: The LPG tax rate should be lowered to ensure the fair treatment of resources.

➔ Action: Tax rates for LNG, kerosene, and propane gas are to be lowered to correct the imbalance in the consumption of electricity and other sources.

◎ Oil and gas: The role of oil and gas as bridging energy sources paving the way for the expanded use of future energy sources, such as renewable energy, should be emphasized.

➔ Action: The plan will include a role for conventional energy sources such as oil and gas.

◎ R&D: Government-led technology development and governmental support are important for the promotion of demand management, distributed generation, and GHG reduction.

➔ Action: Energy R&D strategies will be included in the plan.

## C. Discussion Among Relevant Ministries

◎ Energy demand forecast: Joint working groups formed by specialized bodies under relevant ministries held discussions in order to maintain the coherence of the national energy plans and objectivity and transparency in the demand forecast.

* Greenhouse Gas Inventory and Research Center of Korea (controlling role), Korea Energy Economics Institute (responsible for energy transition · the energy industry), Korea Transport Institute (responsible for transportation), etc.

- The joint working groups discussed and reviewed the coherence of the demand forecast

model created by KEEI as well as key preconditions and active variables for each sector.

- KEEI produced a forecast for energy demand on the basis of these discussions, which the working groups then discussed and reviewed.
- Relevant entities, including Office for Government Policy Coordination, discussed and reviewed the coherence of the demand forecast models and preconditions.

◎ Main topics of discussion: In-depth discussions were held on GHG reduction measures and the appropriateness of demand management policy and the shares of nuclear and renewable energy in the energy mix.

# CHAPTER IV

## Energy Demand Forecast, Targets, and the Energy Mix

## 1. Main Factors in the 2035 Forecast

### A. Economic Growth Rate

◎ Figure: The economy is expected to grow by 2.8% annually on average from 2011 to 2035.

* * Annual average growth rate: 6.5% from 1990 to 2000, 4.2% from 2000 to 2011

◎ Method: The Korea Development Institute (KDI) produced the long-term economic forecast using the production function approach*.

* To calculate projected GDP growth, past GDP growth is divided into contributions from production factors, including labor, capital and total factor productivity. Forecasts for each factor are then added up to predict future economic growth.

### B. Population and Households

◎ Figure: The population will grow by 0.17% annually on average from 2011 to 2035 and is likely to decrease after 2030. The number of households will increase by 0.96% annually on average during the same period due to a larger share of single-person households.

- Increasing energy consumption in the residential sector is partly attributable to the rising number of single-person households.

* Single-person households: 24.7% in 2011 → 29.6% in 2020 → 32.7% in 2030 → 34.3% in 2035

◎ Method: Statistics Korea (KOSTAT) forecasted growth in population and households on the basis of the results of its population and household forecasts, which reflect the 2010 Population and Housing Census.

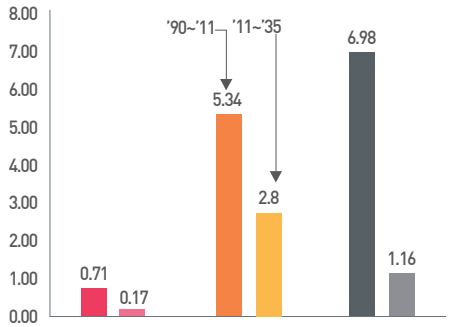
### C. Global Oil Prices

◎ Figure: The price of Dubai crude oil will rise by 1.2% annually on average from 2011 to 2035, reaching $140/bbl by 2035.

◎ Method: The International Energy Agency (IEA) forecasted the oil price growth rate using the average growth rate of imported oil prices as published in its World Energy Outlook 2012.

[ Key Conditions ]

| Items | 2011 | 2035 | Average Annual Growth Rate (%) |
|---|---|---|---|
| GDP (Trillion won) | 1,082 | 2,101 | 2.80 |
| Population (Million) | 49.8 | 51.9 | 0.17 |
| Oil Price (Dubai, $/bbl) | 106.0 | 139.8 | 1.16 |



Average annual growth rate

## D. Industrial Structure

◎ Figure: As the growth of energy-intensive sectors slows, it is likely that economic growth will be led by assembly and metal businesses (general machine/automobile/shipbuilding/communications devices/semi-conductor, etc.).

* (Unit : trillion won, 2005 constant prices)

| Sector | 2011 | 2025 | 2030 | 2035 | Average Annual Growth Rate (%) |
|---|---|---|---|---|---|
| Agriculture, forestry & fishing, mining & quarrying | 31.3 | 32.1 | 31.0 | 29.3 | -0.27 |
| Manufacturing | 351.6 | 600.0 | 685.1 | 761.9 | 3.28 |
| -Petrochemical, Non-metallic mineral, Iron and steel | 87.1 | 112.7 | 117.5 | 118.8 | 1.30 |
| - Fabricated metal products | 221.2 | 440.7 | 522.2 | 600.5 | 4.25 |
| SOC (construction, etc.) | 87.6 | 115.8 | 122.5 | 127.0 | 1.56 |
| Service* | 610.0 | 929.7 | 1,057.9 | 1,182.0 | 2.79 |

* The service industry is composed of wholesale/retail, restaurants/accommodations, transport/storage, communications, financial intermediation, real estate/business services, education, health/social work, and other service activities.

◎ Method: The Korea Institute for Industrial Economics & Trade (KIET) forecasted value added of each type of business as well as industrial structure on the basis of national accounts of the Bank of Korea and the "KIET-DIMM12" model developed by the KIET.

## 2. 2035 Energy Demand Forecast (BAU)

### A. Key Indicators

◎ Total primary energy demand: Total primary energy demand will increase by 1.3% annually on average from 2011 to 2035.

◎ Final energy consumption: Final energy consumption will increase by 0.9% from 2011 to 2035 due to slowing economic and population growth.

◎ Energy intensity: Energy intensity will improve 30% from 0.255 (toe/million won) in 2011 to 0.180 (toe/million won) in 2035 (1.4% annually on average).

| Item | 2011 | 2025 | 2030 | 2035 | Average Annual Growth Rate (%) |
|---|---|---|---|---|---|
| Total Primary Energy Demand (million TOE) | 275.7 | 354.1 | 369.9 | 377.9 | 1.32 |
| Final Energy (million TOE) | 205.9 | 248.7 | 254.3 | 254.1 | 0.88 |
| Energy Intensity (TOE/million won) | 0.255 | 0.211 | 0.195 | 0.180 | -1.44 |

### B. Forecast By Source: Total Primary Energy Demand

* (Unit: million toe)

| Source | 2011 | 2025 | 2030 | 2035 | Average Annual Growth Rate (%) |
|---|---|---|---|---|---|
| Coal (share %) | 83.6 (30.3) | 100.2 (28.3) | 107.7 (29.1) | 112.4 (29.7) | 1.24 |
| Oil | 105.1 (38.1) | 111.0 (31.3) | 107.1 (29.0) | 101.5 (26.9) | - 0.15 |
| Natural Gas | 46.3 (16.8) | 64.8 (18.3) | 69.8 (18.9) | 73.3 (19.4) | 1.93 |
| Hydro | 1.7 (0.6) | 1.7 (0.5) | 1.9 (0.5) | 2.0 (0.5) | 0.70 |
| Nuclear | 32.3 (11.7) | 59.6 (16.8) | 65.3 (17.7) | 70.0 (18.5) | 3.28 |
| Renewable & Others | 6.6 (2.4) | 16.8 (4.7) | 18.0 (4.9) | 18.8 (5.0) | 4.44 |
| Total | 275.7 (100.0) | 354.1 (100.0) | 369.9 (100.0) | 377.9 (100.0) | 1.32 |

## C. Forecast By Source: Final Energy Consumption

* (Unit: million toe)

| Source | 2011 | 2025 | 2030 | 2035 | Average Annual Growth Rate (%) |
|---|---|---|---|---|---|
| Coal (share %) | 33.5 (16.3) | 37.4 (15.0) | 38.8 (15.3) | 38.6 (15.2) | 0.58 |
| Oil | 102.0 (49.5) | 109.1 (43.9) | 105.1 (41.3) | 99.3 (39.1) | -0.11 |
| City Gas | 23.7 (11.5) | 32.5 (13.1) | 34.4 (13.5) | 35.3 (13.9) | 1.68 |
| Electricity | 39.1 (19.0) | 59.7 (24.0) | 65.6 (25.8) | 70.2 (27.6) | 2.47 |
| Heat energy | 1.7 (0.8) | 2.9 (1.2) | 3.1 (1.2) | 3.3 (1.3) | 2.82 |
| Renewable (non-electricity) | 5.8 (2.8) | 7.1 (2.9) | 7.4 (2.9) | 7.4 (2.9) | 1.01 |
| Total | 205.9 (100.0) | 248.7 (100.0) | 254.3 (100.0) | 254.1 (100.0) | 0.88 |

## D. Forecast By Sector

* (Unit: million toe)

| Sector | 2011 | 2025 | 2030 | 2035 | Average Annual Growth Rate (%) |
|---|---|---|---|---|---|
| Industry (share %) | 126.9 (61.6) | 151.6 (60.9) | 152.3 (59.9) | 148.4 (58.4) | 0.66 |
| Transport | 36.9 (17.9) | 44.0 (17.7) | 45.5 (17.9) | 46.5 (18.3) | 0.97 |
| Residential | 21.6 (10.5) | 24.2 (9.7) | 24.6 (9.7) | 24.9 (9.8) | 0.59 |
| Commercial | 15.9 (7.7) | 23.6 (9.5) | 26.0 (10.2) | 28.1 (11.0) | 2.39 |
| Public Service & Others | 4.6 (2.2) | 5.4 (2.2) | 5.8 (2.3) | 6.2 (2.5) | 1.31 |
| Total | 205.9 (100.0) | 248.7 (100.0) | 254.3 (100.0) | 254.1 (100.0) | 0.88 |

## 3. 2035 Electricity Demand Forecast (BAU)

### A. Comparison With the First Energy Master Plan

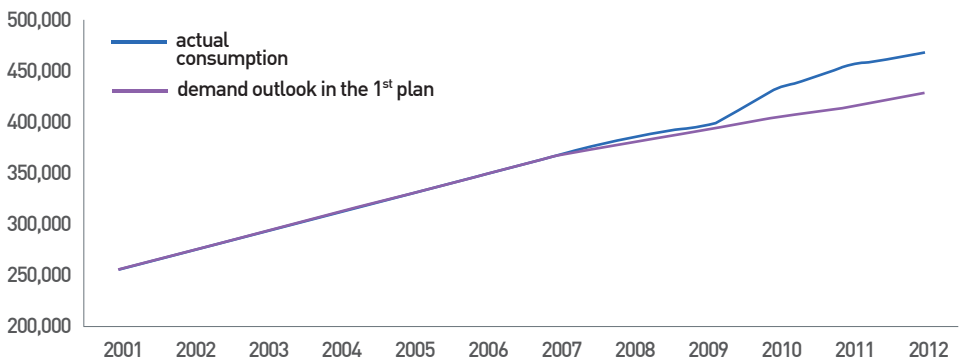
| | 2006 | 2010 | 2020 | 2030 | 2035 |
|---|---|---|---|---|---|
| First Plan (TWh) | 349 | 404 | 510 | 585 | - |
| Second Plan (TWh) | 349 | 434 | 610 | 762 | 816 |

### B. Factors in the Increase in the Demand Forecast

◎ Electricity consumption has increased more sharply in recent years than forecasted in the First Energy Master Plan.

◎ Electricity consumption stood at 465 TWh in 2012, which is 9% higher than the 428 TWh demand forecast in the First Plan.

[ Actual Consumption vs Demand Forecast in the First Plan ]




- Electricity demand growth is mainly attributable to increased investment in infrastructure as well as increased production by iron and steel manufacturers, petrochemical businesses, and fabricated metal product businesses whose global competitiveness increased during the recovery from the international financial crisis.
- Low electricity prices have encouraged fuel switching from energy sources, such as oil and gas, to electricity.

### Actual Consumption and Demand Forecasting (BAU)

- How is the business-as-usual (BAU) demand forecast calculated?
  - The BAU demand forecast is based on the assumption that government policy and the energy consumption trends of economic players will remain constant at current economic growth rates.
  - In other words, BAU outlook is the forecast with the highest probability, based on assumption that the current policy conditions and consumption pattern will be maintained. This process is applied to all countries.
- Should demand-management effects be reflected in the demand outlook?
  - Any expected effect from normalized electricity rates and improved demand management will be reflected in the target demand, not the BAU demand.
  - [ (BAU demand: 816 TWh)-(Demand reduction target: 15%)=(Target demand: 696 TWh) ]

## C. Comparison With Other Countries

◎ According to the IEA's forecast, the share of electricity in Korea's final energy consumption will be lower than that of Japan and similar to that of the US in 2035.

[ 2035 Share of Electricity in Final Energy Consumption (%) ]

| OECD Average | US | Japan | Korea |
|---|---|---|---|
| 26.2 | 27.2 | 30.4 | 27.6 |

* * IEA, World Energy Outlook 2012 (November 2012) The demand forecast for Korea is from the Second Energy Master Plan.

◎ The BAU projection for electricity demand in 2035 is 816 TWh. After taking into account the target demand reduction of 15%, electricity demand falls to 696 TWh, with a GDP elasticity of only 0.6.

* The economy is expected to grow by 2.8% annually on average until 2035, and target electricity demand is predicted to increase by 1.8% annually on average.

• The electricity consumption of major countries has historically risen in proportion to economic growth. When per capita income is less than $30,000, the GDP elasticity of electricity demand is higher than 1.0.

[ GDP Elasticity in Per Capita Income Bracket of $20,000~$30,000 ]

| | US | Japan | Germany | France |
|---|---|---|---|---|
| GDP (%) | 2.1 | 3.0 | 2.3 | 1.7 |
| Electricity Demand (%) | 4.7 | 3.7 | 2.0 | 3.6 |
| GDP Elasticity | 2.2 | 1.2 | 0.9 | 2.1 |

## 4. 2035 Demand Target

■ (Improved demand management) + (Price/tax adjustment) + (R&D expansion) = 13% reduction in energy consumption by 2035

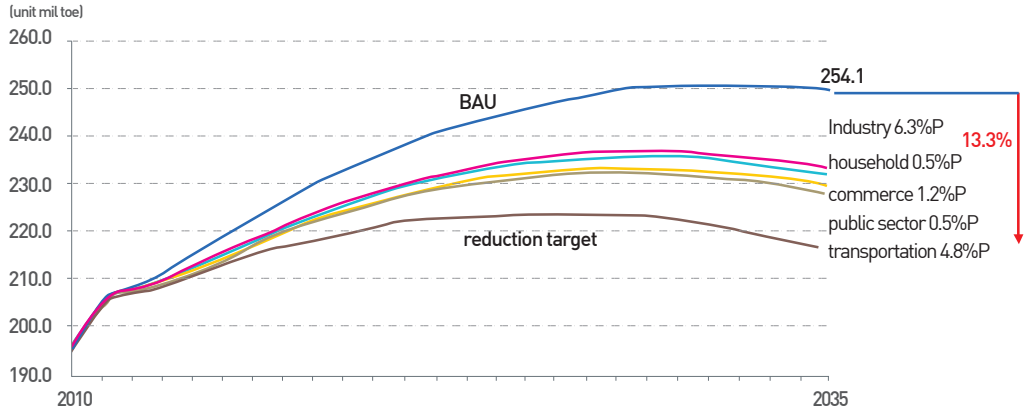
### A. Final Energy Consumption

◎ Final energy consumption and electricity demand will be reduced by 13% and 15% respectively relative to the BAU scenario by 2035.

| Items | 2011 | 2025 | 2030 | 2035 | Average Annual Growth Rate |
|---|---|---|---|---|---|
| BAU demand (million toe) | 205.9 | 248.7 | 254.3 | 254.1 | 0.88% |
| Target demand (million toe) | 205.9 | 226.7 | 226.0 | 220.5 | 0.29% |
| Reduction rate | - | -8.9% | -11.1% | -13.3% | - |
| **Final Energy Consumption** | **2011** | **2025** | **2030** | **2035** | **Average Annual Growth Rate** |
| Coal (Share %) | 33.5 (16.3) | 34.7 (15.3) | 35.3 (15.6) | 34.4 (15.6) | 0.10% |
| Oil | 102.0 (49.5) | 96.2 (42.4) | 88.8 (39.3) | 80.3 (36.4) | - 0.99% |
| City gas | 23.7 (11.5) | 31.4 (13.8) | 33.0 (14.6) | 33.8 (15.4) | 1.50% |
| Electricity | 39.1 (19.0) | 53.3 (23.5) | 57.1 (25.3) | 59.9 (27.2) | 1.79% |
| Heat energy | 1.7 (0.8) | 2.8 (1.2) | 3.0 (1.3) | 3.2 (1.5) | 2.72% |
| Renewable energy (non-electricity) | 5.8 (2.8) | 8.3 (3.7) | 8.7 (3.8) | 8.8 (4.0) | 1.71% |

## B. Reduction Targets By Sector

◎ Industry will account for 47% of total demand reduction, followed by transportation at 36% and commerce at 9%.




# 5. Share of Nuclear Energy in 2035

## A. Working Group Recommendations

◎ After considering changes in electricity demand, transmission network conditions and public acceptance since the First Energy Master Plan, the working group recommended that nuclear energy represent 22% to 29% of the energy mix in 2035.

## B. Considerations When Deciding the Share of Nuclear Energy

### Energy Security

◎ Given Korea's extremely high energy import dependence (96.4%), a balanced energy mix is needed to replace the excessive use of thermal power and other forms of energy.

◎ The decreased use of nuclear energy and the rising share of coal and LNG in the energy mix could bring a risk of greater exposure to global fuel price fluctuations.

### Examples of the Importance of Energy Security

- Case Ⅰ : At the time of the second oil crisis in 1979, 71% of generation facilities used oil as fuel. As oil import prices tripled, electricity rates also rose more than three times from 22 won/kWh to 70 won/kWh.

- Case Ⅱ : Following the shutdown of nuclear power plants in Japan, Japan's LNG imports sharply increased, turning a trade balance into a trade deficit (6.6 trillion yen in 2010 → -7.7 trillion yen in 2013).

## Economic Feasibility

◎ High prices of oil and other fossil fuels place a heavy burden on the entire economy. The generation cost of nuclear energy is lower than other energy sources because it is relatively unaffected by oil prices.

[ Generation Cost by Source (2012) ]

| | Nuclear | Coal | LNG |
|---|---|---|---|
| won/kWh | 39.5 | 66.25 | 168.1 |

* The Working Group on Nuclear Energy concluded that nuclear energy has high economic feasibility even after taking into account decommissioning costs, response costs for potential accidents, policy costs, etc.

### Examples of the Importance of Energy Security

- Nuclear generation cost in the 6th Basic Plan for Long-term Electricity Supply and Demand

| Utilization Rate (%) | Nuclear Energy 1 GW | Nuclear Energy 1.4 GW |
|---|---|---|
| 60 | 68.81 | 61.26 |
| 70 | 59.50 | 53.03 |
| 80 | 52.51 | 46.86 |
| 90 | 47.08 | 42.06 |

▪ Including decommissioning costs

| Utilization Rate (%) | Nuclear Energy 1 GW | Nuclear Energy 1.4 GW |
|---|---|---|
| 60 | 68.81 | 61.26 |
| 70 | 59.50 | 53.03 |
| 80 | 52.51 | 46.86 |
| 90 | 47.08 | 42.06 |

▪ Decommissioning costs + response costs for potential accidents + policy costs + etc.

| Utilization Rate (%) | Nuclear Energy 1 GW | Nuclear Energy 1.4 GW |
|---|---|---|
| 60 | 70.43 (+1.62) | 62.69 (+1.43) |
| 70 | 60.88 (+1.38) | 54.26 (+1.23) |
| 80 | 53.72 (+1.21) | 47.93 (+1.07) |
| 90 | 48.15 (+1.08) | 43.02 (+0.95) |

▪ Conclusions

• The economic feasibility of nuclear energy is maintained with a utilization rate of 80%.

* The economic feasibility of nuclear energy further increases after taking into account the extra costs of coal and gas and other resources, such as GHG reduction.

### GHG Reduction

◎ The use of low carbon energy, such as nuclear energy and renewable energy, should be expanded to reduce GHG emissions.

[ GHG Emission Factor in Power Generation (Unit: kg-$CO_2$e/kWh) ]

| Nuclear | Renewable | LNG | Oil | Coal |
|---|---|---|---|---|
| 0 | 0 (IGCC except fuel cells) | 0.3625 | 0.7018 | 0.8230 |

## C. Global Supply and Demand Conditions

◎ As an energy-poor country with insufficient natural resources, Korea has an energy import dependency ratio of 96% while ranking 10$^{th}$ in the world in energy consumption.

- Consumption of oil, gas, and coal ranks 9th, 16th and 13th in the world respectively, and imports of oil, gas, and coal rank 5th, 6th and 3rd.

◎ Among the ten largest energy-consuming nations in the world, China, the US, India, and Russia (the top 4 energy consumers) have abundant natural resources by comparison.

- Japan, Germany, France, and Korea are categorized as energy poor countries.

[ Fossil Fuel Self-sufficiency Rates of the World's Ten Largest Energy Consumers (2011) ]

| Ranking | Country | Oil | Gas | Coal |
|---|---|---|---|---|
| 1 | China | 0.46 | 0.78 | 0.98 |
| 2 | U.S. | 0.46 | 0.93 | 1.12 |
| 3 | India | 0.26 | 0.76 | 0.77 |
| 4 | Russia | 3.25 | 1.41 | 1.55 |
| 5 | Japan | 0.00 | 0.03 | 0.00 |
| 6 | Germany | 0.03 | 0.16 | 0.60 |
| 7 | France | 0.01 | 0.01 | 0.01 |
| 8 | Canada | 2.12 | 1.58 | 1.72 |
| 9 | Brazil | 1.03 | 0.62 | 0.14 |
| 10 | Korea | 0.01 | 0.01 | 0.01 |

◎ A high share of nuclear energy is a common feature of energy-poor countries.

- Before the Fukushima accident, France supplied 78.7% of its electricity from nuclear energy, while Japan supplied 29%, Germany 29%, and Korea 34%.

◎ There are clear differences between the situation of Korea and that other energy-poor countries.

- In the case of Japan, Germany and France, the need for massive infrastructure investment is lower than Korea as their energy consumption is decreasing or not significantly increasing.
  - Policy change on the energy mix is relatively easier in Japan and Germany since their energy consumption has been steadily decreasing with their reserve ratios reaching 38.5% and 96.4% respectively as of 2010.

[ Energy Consumption Trend of Major Countries (Unit: million TOE) ]

| | 1980 | 1990 | 2000 | 2011 | Average Annual Growth Rate (%) | |
|---|---|---|---|---|---|---|
| | | | | | 1980~2000 | 2000~2011 |
| France | 191.8 | 224.0 | 252.0 | 252.8 | 1.37 | 0.03 |
| Germany | 357.2 | 351.1 | 336.6 | 311.8 | -0.30 | -0.69 |
| Japan | 344.5 | 439.3 | 519.0 | 461.5 | 2.07 | -1.06 |
| Korea | 41.2 | 93.1 | 188.2 | 260.4 | 7.89 | 3.00 |
| OECD | 4,067.6 | 4,522.5 | 5,292.7 | 5,304.8 | 1.33 | 0.02 |

◎ With connected power grids, northern European countries, including France, Germany, the Czech Republic and Austria, are able to secure additional supply capacity by importing and exporting electricity.

◎ Germany, France, and some other countries have high potential for renewable energy deployment, and, as of 2011, the share of renewable energy in their final energy consumption is higher than Korea's 2020 target.

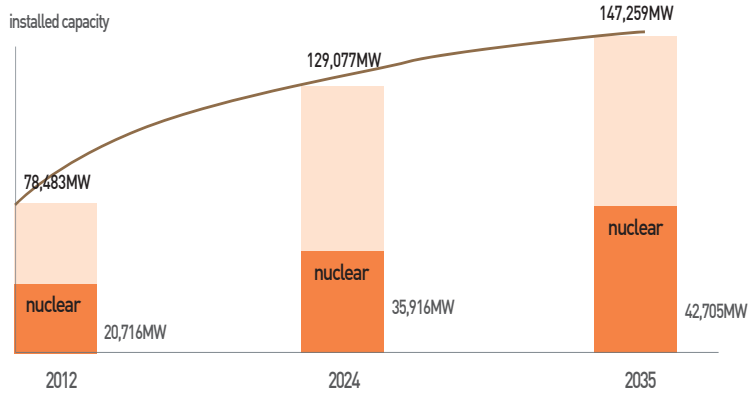
| | Current Rate | 2020 Target |
|---|---|---|
| France | 7.2% | 27% |
| Germany | 10.0% | 20% |
| Korea | 2.8% | 5.9% |

## D. Conclusions on the Share of Nuclear Energy

- The First Energy Master Plan suggested that nuclear power plants should supply energy up to the minimum load point in order to maximize the use of low-carbon nuclear energy (41% of total installed capacity).
- The Working Group on Nuclear Energy recommended a downward revision of the nuclear energy share from 41% in the First Plan to 22%~29% in view of changed conditions in electricity demand, public acceptance and grid stability.
- At the moment, however, there are no energy sources that can replace the role of nuclear energy in terms of energy security, industrial competitiveness and GHG reduction, especially since Korea imports nearly all of its energy.
- As a drastic reduction in the use of nuclear energy is not desirable at this point, a share of 29% was chosen on the basis of the working group' recommendations.

## Nuclear Power Plants

- A total of 43 GW of installed capacity is required to raise the share of nuclear energy to 29% by 2035.
- As the 6th Basic Plan for Long-term Electricity Supply and Demand already confirmed the construction and operation of nuclear power plants with a total capacity of 36 GW by 2024, additional facilities with a capacity of 7 GW should be constructed.




- The number of new nuclear power plants will be decided after consideration of electricity demand, license extensions for retired plants, and construction and operation conditions. It will be disclosed in the Basic Plan for Long-term Electricity Supply and Demand.

# CHAPTER V

## - Six Major Tasks - 1. Transition to Demand Management Policies

# 1. Adjustment of Relative Energy Prices

■ Adjust energy tax rates to prevent an imbalance between electricity consumption and non-electric energy consumption

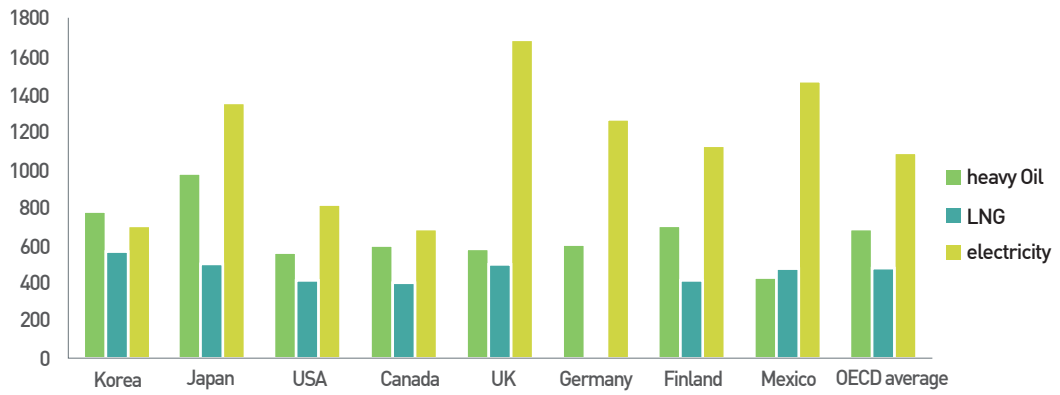
## A. Current Status and Issues

◎ Since price liberalization, the price of electricity has consistently been lower than the price of oil, which is taxed at a rate of up to 50%, worsening distortions in energy consumption.

[ Cost Recovery Ratio (2012) ]

| 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|
| 98.0 | 95.0 | 93.7 | 77.7 | 91.5 | 90.2 | 87.4 | 88.4 |

[ International Prices for Heavy Oil, LNG, and Electricity (IEA, USD/TOE) ]




■ Korea is the only country where heavy oil (blue) is more expensive than electricity (green).

◎ Another source of distortion in energy consumption is that electricity rates do not sufficiently reflect the environmental and social costs of power generation.

- For example, even though bituminous coal used for power generation emits more GHG and pollutants than LNG, LNG is taxed at a rate of 16%, while bituminous coal is not taxed.
- Other costs related to issues such as extra-high voltage transmission lines for large-scale base load power plants and the social controversy surrounding them are also not fully reflected in the price of electricity.

## B. Direction

- Adjust both energy taxes and electricity rates to encourage more rational consumption of energy and electricity.
- Gradually make energy prices reflect social costs, such as nuclear plant safety, transmission line maintenance, and GHG emissions reduction

◎ Taxation adjustment: Impose a consumption tax on bituminous coal* used in power generation, and lower the tax on LNG, which is an alternative to electricity

* Industrial uses, such as steel making and cement production, will be exempted from the tax to avoid hampering industrial competitiveness.

- Lower the tax rate for kerosene and propane to ease the burden on low-income families and adjust the relative prices of energy sources

◎ Electricity rate adjustment: Adjust energy rates to reflect the various social costs of producing, transporting, and distributing power

- Costs related to nuclear power plants: Reassess the costs of nuclear decommissioning and waste disposal through an objective process. Other costs, including increased investment in safety-related facilities and the costs of responding to accidents, will be rationally calculated.
- Transmission costs: Improve power lines, including HVDC, and offer realistic compensation to minimize the impact on local communities.
- Conversion to clean fuel: Take into account the costs of achieving renewable energy deployment and the national GHG emissions reduction target.

◎ Complementary policy to support the underprivileged: Minimize the impact of the energy price adjustment on the vulnerable by offering energy vouchers and increasing investment in energy efficiency.

## 2. Electricity Rate Revision

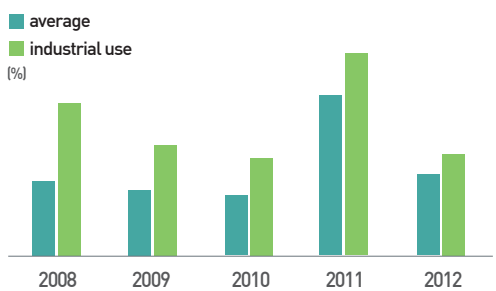
■ Encourage rational use of electricity by moving away from the existing low price policy

| | Existing Policy Paradigm | New Policy Paradigm |
|---|---|---|
| Policy Objective | · Minimize rate increases (minimize possible impacts on consumer price and businesses) | · Encourage rational use of electricity |
| Rate Rationalization | · Rate rationalization is overdue | · Take into account cost-changing factors in a timely manner<br>· Incorporate environmental and social costs |
| Rate Structure | · Differentiate prices for industrial/ general/household use | · Simplify rate structure for each use<br>· Adjust progressive electricity rates for household use<br>· Expand the 'opt-in' rate system |

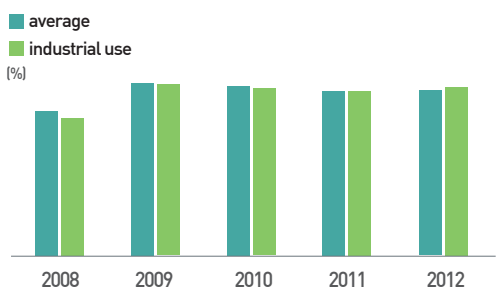
### A. Background

◎ Rate rationalization: Continuous efforts have been made to set electricity rates at realistic levels, particularly for industrial power use as the industrial sector consumes large amounts of power at prices well below production costs.

[ Electricity Rate Adjustment Ratio ]




[ Cost Recovery Ratio ]



◎ Rate reform: The Time of Use (TOU) pricing scheme, which reflects hour-to-hour changes in power generation costs, has been expanded* to encourage rational use of electricity.

* Coverage of TOU:
January 2012 - general use of more than 300 kW, educational use of more than 1,000 kW
May 2013 - all high voltage for general and industrial use

## B. Main Tasks

### ① Rationalization of Electricity Rates

◎ Set electricity rates at realistic levels to encourage reasonable electricity use

- Maintain realistic rates by being more flexible in incorporating cost-changing factors, such as fuel price changes

### ② Improvement of Progressive Scheme for Household

◎ Gradually improve the progressive scheme for households to reflect changes in household power consumption patterns

- Household consumption has increased due to the spread of home appliances, abnormal weather conditions, such as heat and cold waves, etc.

* Households using more than 300 kWh per month (%): (2002) 12.2, (2008) 27.7, (2012) 33.5

◎ Changes in household composition, such as a growing number of one- and two- member families, have reduced the value of the progressive scheme for benefiting energy poor.

* Energy use is related not only to income level but also to household size.

◎ Consider the introduction of Time-of-Use pricing for households on an optional basis following the deployment of smart meters, which enable tiered pricing by hour

### ③ Expansion of Demand Side Management and Opt-In Pricing

◎ Expand seasonally/hourly tiered pricing to all types of power use, including optional coverage for low-voltage power, to accompany the expanded deployment of smart meters

◎ Develop and apply various opt-in pricing schemes to promote reasonable power consumption and reflect power supply and demand, individual consumption patterns, etc.

- Develop a variety of hourly-tiered pricing schemes to encourage users to invest in demand side management for peak reduction using private generators, ESS, etc.

- Instead of forced power savings, apply incentive pricing to add surcharges at certain peak hours in summer and winter and to lower prices at other times

◎ In the mid- to long-term, review a variety of opt-in pricing schemes, including contract pricing between consumers and operators* and tiered pricing based on power supply quality**.

* e.g. Adopt a pricing system based on the introduction of advanced metering infrastructure (AMI), and provide various value-added services such as electricity use tracking, device control, etc.

**e.g. Premium (high price) rates guarantee minimal blackout hours, high-quality voltage, and compensation for damage cause by blackouts

### ④ Improvement of Use-Based Pricing Scheme

◎ Simplify the use-based pricing scheme to minimize pricing differences between different types of use

* Power for homes, street lights, and night-time use has different load characteristics and so should continue to be priced separately.

- Phase in tiered pricing by voltage to reflect different production costs, while using seasonally/hourly tiered tariffs, opt-in tariffs, and others to appropriately reflect differences in load factor (i.e., average load divided by peak load), load patterns, etc.

[ Cost Recovery Ratio by Use (2012) ]

| | Average | Household | General | Industrial | Educational | Agricultural |
|---|---|---|---|---|---|---|
| Cost of sale (won/kWh) | 100.7 | 123.7 | 112.4 | 92.8 | 108.8 | 42.9 |
| Total cost (won/kWh) | 113.9 | 144.9 | 121.3 | 103.8 | 125.1 | 129.2 |
| Cost recovery ratio (%) | 88.4 | 85.4 | 92.7 | 89.5 | 87.0 | 33.2 |

## 3. Creation of a Demand Management Market Based on ICT

■ Systematize energy conservation and develop a demand management market based on ICT infrastructure, such as the internet and smart phones

| | Existing Policy Paradigm | New Policy Paradigm |
|---|---|---|
| Policy Objective | · Focus on supply side management | · Prioritize demand side management |
| Direction | · Reactive demand side management to cope with supply shortages | · Reduce the burden of securing supply through reasonable demand side management |
| | · Sporadic load management such as public campaigns, promotion, indoor temperature limits | · Systematic demand side management using ICT |
| Project Type | · Government support oriented | · Market oriented |

### A. Current Status and Issues

◎ The soaring social costs of energy supply are making it difficult to meet the rapidly increasing energy demand.

- There is a need for conversion from supply side management, in which supply is increased to meet growing demand, to demand side management, in which demand is reduced in advance in a reasonable manner.

◎ Although Korea has world-class ICT infrastructure*, it has not made the most of its ICT infrastructure to improve energy efficiency.

* Ranked 1st in the world: ICT development index (IDC) for 4 consecutive years (ITU), households with an internet connection, smart phone penetration, market share for display, etc.

- ICT has not been fully applied to the energy sector because energy prices have remained low and the efficiency and demand management markets are not fully developed.

* Energy service companies are actively operating in major countries, such as the US and the EU, where load and efficiency management markets are well-developed.

**Case of technology diffusion in the US**

- The US has applied the Energy Efficiency Resource Standard (EERS) to energy suppliers since the 1990s when it hit the limit in expanding supply facilities.
- Energy suppliers have worked with demand management companies to identify demand management resources, resulting in the formation of an ICT-based technology market.

◎ Priority has been placed on load management projects aimed at shifting the time of energy use to off-peak hours in times of supply shortage rather than improving energy efficiency by fundamentally reducing energy demand.

[ Size of Korea's Demand Management Market (2013, hundred million won) ]

| Load Management | Efficiency Gain | Total |
|---|---|---|
| 2,535 | 800 | 3,335 |

## B. Direction

◎ Transition to fundamental and systematic demand side management using ICT, science, and technology rather than temporary consumption regulations, such as indoor temperature limits

- Deploy demand management as a new growth industry by removing regulations and improving systems to enhance the added value of applying ICT, such as ESS and EMS
- Employ integrated resource planning that reflects not only supply resources but also demand management resources when devising supply and demand plans for each energy source

◎ Create a demand management market so that demand side management can be measured and understood as a resource and therefore treated in the same way as supply resources in the energy market

- Improve current systems to allow a choice between demand resources and supply resources based on comparison of their economic values

  * US: demand management (1.7cents/kWh) 〈 supply cost (10cents/kWh), Demand management outweighs supply cost.

◎ Encourage the entrance of various demand management businesses* to the market

* Not only conventional energy companies but also electronic, communications, secondary battery, software companies and others should be nurtured as demand management business.

## C. Plan

### ① Energy Storage System (ESS)

◎ Initial market formation: Strengthen the leading role of plant operators and renewable energy businesses

- Use ESS to fulfill the frequency reserve function currently provided by thermal power generators

* Promote early development of the core technologies for frequency regulation, such as ESS, control systems, and grid control algorithms, and the establishment of operation standards and settlement rules to ensure an initial installation of 200,000~300,000 kW by 2015.

- To control the power quality of renewable energy, treat renewable energy facilities equipped and operated with ESSs as having additional capacity

◎ Investment promotion: Encourage heavy energy consumers and public organizations to make a large investment in ESSs by revising electricity rates and related systems

- Advise heavy consumers with a certain amount of contract demand to install ESSs

* Select heavy power consumers and public buildings as the first targets for the installation of ESSs → Expand opt-in tiered pricing and provide incentives for ESS installation, such as tax credits for investment

- • Use smart ESSs as an emergency power supply in accordance with relevant regulations

* * e.g. Fire safety standards for high-rise buildings, equipment standards for buildings, inspection standards for elevators, etc.

- Regularly monitor ESS performance after installation and, if found to be insufficient, review measures to mandate the phase-in ESS installation

### ② Energy Management System (EMS)

◎ Market expansion: Recommend the introduction of EMSs to large new buildings as well as existing buildings and factories which consume large amounts of energy

* Increase allotted credits for the Energy Performance Index in the Energy Conservation Design Standards for Buildings and revise Energy Management Standards to reflect EMS recommendations.

◎ Incentive: Increase installation cost support and loans* for small and medium-sized companies

* Give additional credits when assessing the eligibility of EMS-based energy conservation projects for financial support

- Provide tax credits for investment in installing EMS and lengthen the diagnosis interval when those subject to the Energy Diagnosis adopt EMS (3-5 years → 10 years maximum, revision of the Energy Use Rationalization Act)

◎ Business support: Develop energy service companies (ESCOs) with EMS technologies as demand side management businesses/aggregators. Moreover, give such companies opportunities to participate in the power market

* Profits can be generated by selling EMS-based demand management resources in the power market, or placing tenders for efficiency improvement performance records in the energy efficiency market.

### ③ ICT-based High-Efficiency Devices

◎ LED: Replace lights in subway stations, tunnels, terminals and other places with large-scale LED lighting using ESCO funds and PF

* 1.36 million lights in subway stations, tunnels, airports, railway stations and highway tunnels will be replaced first.

- Replace all lights used in public buildings with LED by 2020 and obligate the use of LED for mostly-on lights used in private buildings, such as underground parking lot lighting
- Give subsidies for installation to low-income families, welfare facilities, poultry farms, etc.

* In line with phasing out incandescent light bulbs starting in January 2014, jointly conduct the replacement program with local governments

◎ Inverter: Encourage the use of high-efficiency inverters for three-phase induction motors

* Inverters control the motors of production facilities and home appliances, saving energy by up to 30%.

◎ Smart plugs: Add smart functions to the criteria for energy efficiency ratings and efficiently manage the energy consumption of home appliances

* Provide a service which help consumers track the amount of electricity consumed by each product and control power use through a smart phone application

- Promote the mid- to long-term distribution of smart home appliances equipped with intelligent DR functions, such as smart plugs

### ④ Investment by Energy Suppliers in Efficiency Improvement

◎ Increased investment by KEPCO in efficiency improvement: Reinforce KEPCO's efficiency improvement projects starting from 2014

- Set and gradually expand an investment goal for efficiency improvement project compared to total sales.

◎ Expanded targets: Expand targets of energy efficiency improvement to gas and district heating operators based on the progress made by KEPCO

◎ System improvement: Based on the outcome of pilot projects, change the efficiency investment target to the ratio of energy savings to total annual energy sales as is the case in major countries

* The US has set its savings target at 0.8% of annual average consumption.

- Seek measures to minimize the link between sales and profits (decoupling) from investment of energy suppliers in efficiency improvement

### ⑤ Promotion of the Demand Management Market

◎ Demand resources market: Create a demand management resources market to allow demand reduction resources (negawatts) gained from ESS and EMS to be traded the same way as supply generation resources (megawatts)

- Promote profit generation and commercialization for a variety of business models using ESS, EMS, EHP and other demand management resources

◎ Creation of an energy efficiency market: Revise relevant regulations to allow energy saved during peak hours as a result of efficiency projects to be traded in the power market

- Revise regulations to allow energy saved through efficiency improvements to be traded in the power market, taking into consideration the progress in demand-side bidding and the growth of demand management businesses, such as ESCO

## 4. Measures to Improve Demand Management by Sector

■ Shift to a less energy-intensive economy by strengthening energy efficiency standards for transportation, buildings, appliances and other sectors up to the levels of advanced countries.

| | 2012 | 2017 | 2035 |
|---|---|---|---|
| Average fuel efficiency for vehicles (km/l) | 16.9 | 20.3 | 35.0 |
| | advanced countries: (US) 15.3, (Japan) 19.6, (EU) 20.4 | | |
| Insulation standards for new building (reduction rate compared to 2009) | 30% | 60% | (2025) 100% |

■ Reinforce efficiency management for electricity to curb rapidly rising power consumption and encourage the expanded use of other energy sources, such as gas and thermal

### A. Progress

◎ Inter-ministry measures for demand management have brought continuous improvements in energy efficiency.

- Transportation: Average fuel efficiency for passenger cars has been improved by 32% since 2006 when fuel efficiency standards for passenger cars were introduced.

  * Fuel efficiency standards for passenger cars (km/L): (2006) 10.76 → (2008) 11.47 → (2010) 12.87 → (2012) 14.16

- Buildings: Targets for energy conservation design standards for buildings,* including insulation standards and window/door seal performance grades, have been expanded (2013)

  * Health care and lodging facilities bigger than 2,000 $m^2$, offices and shops bigger than 3,000 $m^2$ → all buildings bigger than 500 $m^2$

- Appliances: 2.2 million TOE (equivalent to 1.4 trillion won of imports) has been saved annually by enforcing an energy efficiency labeling program for major home appliances, a system for saving stand-by electric power, etc.

[ Increased Efficiency of Major Home Appliances (2012 figure compared to 2008) ]

| Refrigerator | Washing Machine | A/C |
|---|---|---|
| 27.7% | 11% | 25% |

## B. Limitations

◎ Transportation: The average fuel efficiency of domestic passenger cars is slightly higher than in the US, but 15~20% lower than in Japan and the EU.

* Average fuel efficiency: (US) 15.3km/L, (Japan, 2010) 19.6km/L, (EU) 20.4km/L

◎ Building: There is an urgent need to improve the energy efficiency of pre-existing buildings, which account for 97% of total buildings, as most efficiency measures for buildings have been focused on newly-built buildings, public buildings and big buildings.

- Residences, which account for 53% of all building energy consumption, face many barriers to implementing regulations or incentives related to residential energy efficiency.
- While energy saving for buildings had been carried out on the basis of appliances and equipment, energy consumption management has not been carried out systematically and comprehensively for entire facilities.

* Replacing existing facilities with high-efficiency ones is a main business area for ESCO.

◎ Appliance: As home appliances are integrated with ICT and become smarter, bigger and more connected, their electricity use has increased despite improvements in energy efficiency.

- For windows and built-in devices, which determine a building's insulation performance, low-efficiency and low-price products, which consume large amounts of stand-by power, have been installed.

* Construction companies supply low-efficiency built-in products to consumers because they do not bear the cost of electricity.

## C. Main Tasks

### ① Transportation

◎ Fuel efficiency standards for cars: Design new fuel efficiency standards for 2016 to 2020 so that average fuel efficiency can reach the level of advanced countries by 2020 (Japan: 20.3km/L, EU: 26.5km/L)

- Expand the scope of fuel efficiency standards from passenger cars to small commercial vehicles

* Fuel efficiency regulations in the US and Europe have already been expanded to cover small commercial vehicles.

◎ Energy conservation target for freight: Require large shippers, such as manufacturers and distributors, with a freight amount above a certain level to report their energy consumption and comply with energy savings targets

◎ Eco-friendly cars: Distribute hybrid cars and clean diesel cars, which require less new infrastructure by 2020 and lay a foundation for distributing electric cars and hydrogen fuel cars

- Build charging stations in accordance with the green car distribution rate and pursue the establishment of appropriate standards, revision of safety regulations and improvement of certification schemes
- Develop business models, such as car sharing and long-term lease services, and begin the formation of a new market through purchase subsidies for different vehicle types and other measures

  * Consider the introduction of sunrise and sunset systems for subsidies and tax credits based on vehicle age and type

### ② Building

◎ Newly-built buildings: Gradually strengthen the Energy Conservation Design Standards for Buildings to achieve the goal of zero energy for all newly-built buildings by 2025

* Insulation standard based on 2009 figures: (2017) 60% reduction → (2025) 100% reduction

- Strengthen the consultation system for energy use plans and recommend the efficient use of integrated energy and the active utilization of renewable energy when developing cities or industrial clusters.

  * Improve the energy efficiency of heating in large-scale residential complexes through small-scale CHP plants and the expansion of the integrated energy supply.

◎ Existing buildings: Expand the scope of the certification scheme for energy efficiency performance, which currently covers only new buildings (e.g., office and apartment buildings), to include existing buildings

- Expand the scope of the energy performance certification scheme*, which requires the issuance and submission of a certificate containing the energy consumption information of a building in the event of a property transaction

  * (2013) Apartment buildings in Seoul with more than 500 units, offices of 3,000m2 or larger → (2016) All buildings across the country

- Train professionals, including building energy performance assessors, to prepare for the possible increase in demand for the certification

◎ Distribution of district cooling and gas cooling: Promote the distribution of devices using non-electric energy sources

- To ease the burden of initial investment costs, provide more subsidies for district cooling and gas cooling installation and promote the distribution of desiccant cooling systems* to provide district cooling for apartment buildings

  * Desiccant cooling: a new technology which uses existing heating pipelines of apartment complexes to remove humidity from indoor air and uses the evaporation heat of water for refrigeration

- Expand the installation of cooling facilities for power load management (e.g., gas cooling, ice thermal storage) to all buildings above a certain size and treat district cooling as power load management equipment

### ③ Improvement of Appliance Efficiency

◎ Expansion of the energy efficiency management scheme: Expand the scope of the energy efficiency management scheme, which now applies to energy-using machinery, to cover energy-related products (ErP)* including construction materials (2014)

  * Products that do not directly use energy but have a direct or indirect impact on energy consumption, such as insulation products and glass

- Establish energy efficiency management standards for built-in energy-using machinery/products* that construction companies install and provide to residents

  * Efficiency of built-in refrigerators (2011-2012 estimates): (grade 1) 3.1%, (grade 2) 2.7%, (grade 3) 45.8%, (grade 4) 13.4%, (grade 5) 35.0%

◎ Enhancement of energy efficiency standards: Improve energy consumption efficiency by banning the production and sale of incandescent light bulbs, expanding the distribution LED lights, and distributing premium motors

- Maintain the ratio of first grade products below 20% by strengthening minimum energy performance standards for cooling and heating devices, home appliances and motors

  * Closely regulate the standby power of set-top boxes and other devices which are on standby for 24 hours and gradually tighten the standard for standby power of electronics (current 1W → 0.5W 2015)

◎ Creation of a road-map: Draft and present a road map for energy efficiency management programs, including energy efficiency labeling on products, to reduce market uncertainty

  * A mid- to long-term time-line to improve efficiency should be outlined, including a 5-year (to 2017) regulatory directions.

- Introduce a sunset system for energy efficiency management; periodically monitor the operation, maintenance and termination of efficiency standards; and systematize the operation of energy efficiency programs

### ④ Industry

◎ Energy-intensive businesses: Reduce energy consumption through the target management scheme and other measures in accordance with the 2020 greenhouse gas emissions reduction target (18.5% reduction compared to BAU).

◎ Small and medium sized companies (SMEs): Encourage voluntary energy conservation by providing additional support and incentives

* Target SMEs which are not subject to the target management scheme and the emissions trading scheme

* Promote factory energy management systems (FEMS), provide conservation consulting services, facilitate financial and technological cooperation between big and small companies (green credits), and offer policy support, such as financial and tax incentives

◎ Promotion of energy management systems (EnMS): Promote systems to systematically plan and implement energy demand management and energy efficiency activities in industry

* Develop manpower and educational programs, bolster international certification and cooperation for measuring and verifying efficiency performance

**Response measures for different industries and sectors**

- Steel: Develop technologies* for CO2-free steelmaking and promote ICT-based energy management systems

  * The replacement of coal with hydrogen in the steelmaking process is expected to reduce greenhouse gas emissions by 30%.

- Operate in-house commercial power generators, improve the use of thermal energy through waste heat and by-product gas recovery and promote distributed generation

  * POSCO operates in-house generators with capacity of 2.88 GW, equivalent to 3 reactors.

- Petrochemicals: Invest in equipment for better heat recovery (larger heat exchangers), improve processes to minimize standby power, install waste vapor reuse facilities (MVR), etc.

- Vehicles: Facilitate R&D and early commercialization of environmentally friendly vehicles; remove energy-intensive stages, improve the manufacturing process by constructing resource-recycling plants,1) etc.; and diversify the energy mix2) to protect the environment

* 1) Abolish the heat treatment stage, which consumes the largest amount of energy, and construct resource-recycling plants where captured CO2 can be used as a resource

* 2) Introduce photovoltaics, fuel cells and other renewable energy sources for vehicles and processes, adopt VOC recovery systems, etc.

- Others: Increase the use of emergency generators and replace low-power facilities (e.g., semi conductors), install wind power facilities (ship building), use lighter materials to improve transport efficiency (e.g., textiles), etc.

## 5. Reform of the Energy Information Management System

■ Systematically manage and share information on energy supply, demand and reduction technology to improve the effectiveness of energy policy

◎ Demand management: Create a virtuous cycle of policy implementation, analysis/assessment, and policy improvement

- Cooperation of consumers: Obtain from consumers consumption information and patterns regarding transportation (region, type of car, engine displacement), homes and buildings (location, type of use, size), factories (type of business, location, size), etc.

  * Consumers who volunteer to provide the information may receive incentives, while heavy consumers may be required to submit the information.

- Analysis of policy effectiveness: Analyze energy consumption patterns and other information to assess the effectiveness of each policy, including pricing policy and reduction of energy consumption for each sector, and make policy measures more precise and efficient

◎ Demand outlook: Use Energy information service systems to provide timely and appropriate information for policy makers and energy consumers through a reliable energy forecasting system

- Open and integrated systems: Establish a system for cooperation on statistics and policy and conduct joint forecasting between energy suppliers and related organizations. Additionally, seek cooperation with outside professional agencies

- Improvement of forecasting methods: Continuously improve forecasting models and tools and make regular and official announcements of demand forecasts to increase their reliability and authority

◎ Future technology: Develop technology portfolios, including the best available technology* that can be applied in advance, by reviewing and analyzing demand management technologies and policy trends at home and abroad

* e.g. Ultra Super Critical (USC), carbon capture storage, and other energy conversion technology for reduction.

◎ Establishment of infrastructure: Establish a system to collect end user energy consumption data and set up a legal and institutional framework to expand related infrastructure

# CHAPTER V

**- Six Major Tasks -** 2. Establishment of a Distributed Generation System

## 1. Stabilization of the Power Grid Through Distributed Plant Locations

■ Shift away from the current practice of constructing transmission and transformation facilities as a subsidiary part of power plant construction plans toward securing power plant locations in advance based on consideration of grid restraints

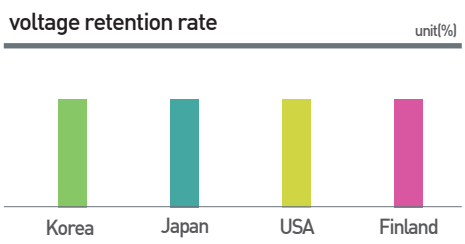
| | Existing Policy Paradigm | New Policy Paradigm |
|---|---|---|
| Planning | · First develop power generation plan → then plan transmission accordingly | · Consider grid restraints in advance before building generation facilities |
| Construction | · Large power facilities + Extra-high voltage transmission lines | · Utilize existing lines as much as possible + Develop small energy sources near end-users |

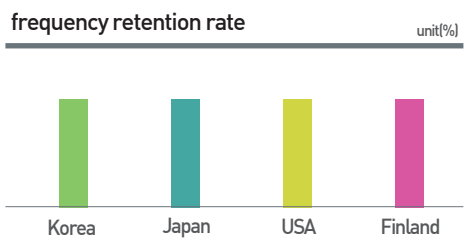
### A. Progress

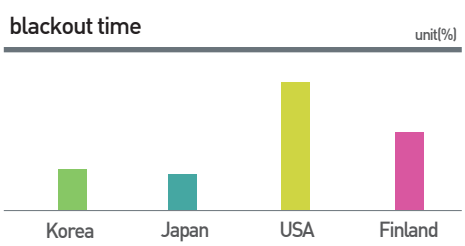
◎ Stable power supply: Industrial competitiveness has been improved by producing a stable and affordable supply of energy through large-scale power plants (nuclear, coal, etc.).

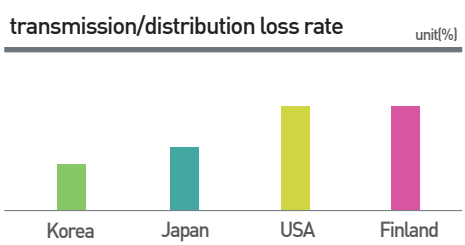
- Korea has grown to have the world's 13th highest installed capacity with a total installed capacity of 81.8 GW as of the end of 2012.

◎ High quality power: A stable supply of high quality power with the world's highest level of voltage stability has been produced on a mass scale.



## B. Limitations

◎ Power generating conditions: Current power policies are now facing limitations because of opposition from local residents and environmental concerns despite the continued expansion of the power supply led mainly by large plants

- Opposition from local residents and environmental advocacy groups has often resulted in hold-ups or cancellations of plant construction, causing disruptions in the power supply.

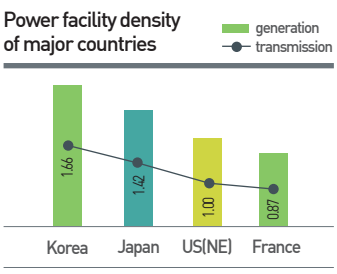
◎ Power transmission conditions: The transmission lines which deliver electricity northward to the Seoul metropolitan area have reached full capacity due to the disparity between areas of high power consumption and plant locations.

[ 2013 Electricity Supply Conditions by Area (10,000 kW, %) ]

| | Seoul Metropolitan Area | Gangwon Area | South & West Coastal Area | Honam Area | Yeongnam Area |
|---|---|---|---|---|---|
| Electricity Demand | 3,100 (41) | 200 (3) | 1,200 (16) | 700 (10) | 2,300 (30) |
| Installed Capacity | 1,900 (23) | 900 (11) | 1,700 (21) | 1,100 (14) | 2,500 (31) |

◎ The density of transmission lines in Korea is extremely high compared to the rest of the world. It is difficult to construct additional large-scale transmission lines due to the small land mass of Korea and opposition from some local residents.

[ Power Facility Density by Country ]




| | | Korea | Japan | US (Northeast) | France |
|---|---|---|---|---|---|
| Site Area (㎢) | | 100,210 | 377,915 | 554,250 | 643,801 |
| Generation Capacity (㎿) | | 79,300 | 203,970 | 185,600 | 117,628 |
| Transmission Lines (㎞) | | 31,353 | 101,390 | 104,600 | 105,228 |
| Compared to US | Generation | 2.36 | 1.61 | 1.0 | 0.55 |
| | Transmission | 1.66 | 1.42 | 1.0 | 0.87 |

## C. Direction

◎ Minimize the construction of new extra-high voltage lines and construct such lines only when unavoidable, such as when expanding nuclear and other power plants for policy reasons and improving the public grid

## D. Plan

◎ Give priority consideration to grid constrains when formulating the Basic Plan for Long-term Electricity Supply and Demand.

- Avoid the past approach of formulating transmission plans only after planning plant construction
- In the future, integrate both plant construction plans and transmission installation plans into a single package

◎ Provide location guidelines/grid maps to utility operators in advance

- Encourage operators to choose locations where no additional grid construction is needed by offering them location guidelines before conducting intent surveys

◎ In the mid- to long-term, consider applying differential transmission fees according to plant locations, with lower fees for the plants near a demand site

* Currently, plants do not bear transmission fees.

# 2. Promotion of Distributed Generation

- Supply more than 15% of electricity from small-scale, distributed sources by 2035 (currently 5%)
- Finalize detailed measures in the Distributed Power Sources Promotion Plan (expected to be available in 2014)

## A. Current status

◎ Distributed sources account for 12% of Korea's power grid in terms of installed capacity, but only 5% in terms of actual generation and contribution to the power grid.

| Type | Note |
|---|---|
| Integrated Energy (5.83GW) | Co-generation of heat and electricity, sold exclusively to consumers in certain areas |
| In-house/ private Generator (4.88kW) | Generating power internally to meet a portion of general power needs. |
| Renewable Energy (4.08kW) | solar PV, wind, geothermal, fuel cells, ESS, etc. |

## B. Obstacles

◎ Current policy has limited the rise in electricity rates, while prices of LNG and other fuels have increased, making in-house/private generators and integrated energy less economically viable.

| | 2005 | 2012 | rate of increase |
|---|---|---|---|
| electricity price | 74 won/kWh | 94 won/kWh | 27% ↑ |
| gas price | 453 won/㎥ | 884 won/㎥ | 95% ↑ |

* Japan: The price of industrial-use electricity in Japan is more than double that in Korea. As a result, distributed generation facilities account for almost 23% of total installed capacity (price as of 2012 ($/MWh): Japan 194, Korea 82).

◎ Need to improve the inconsistent power quality of renewable energy by developing advanced technologies, including microgrid

## C. Implementation measures

### ① Promotion of In-house/Private Power Generators

◎ Encourage energy intensive companies and industrial clusters larger than a certain size to meet some of their demand by in-house/private generation

- Revise electricity tariffs (stricter peak pricing) and offer incentives for power conservation, such as energy use rationalization funds and tax benefits

◎ Share best practices and study measures such as technology support and grant support aimed at improving the economic feasibility of generators by recycling waste heat and by-product gas

**Best practices of POSCO**

- 70% of POSCO's power consumption needs are met by in-house/private generation (2.90 GW, equivalent to 3 nuclear reactors).
- POSCO uses waste heat and by-product gas as a main fuel. Additionally, it has adopted high-efficiency LNG combined generation using by-product gas and other fuels in addition to LNG since 2000.

### ② Promotion of Integrated Energy

◎ Review possible reforms of energy pricing, taxation and subsidies with a view to improving the profitability of integrated energy supply and the fair treatment of energy sources

◎ When granting permits, give preference to larger-scale projects involving more than 50,000~100,000 households and more than 100MW in order to achieve economies of scale

- Strengthen evaluation of measures to diversify business, such as ensuring low price heat sources, developing district cooling supply plans and cooperating with local operators

◎ To improve economic feasibility during summer, commercialize desiccant cooling, which is suited to apartment complexes, and expand the number of buildings targeted for the adoption of district cooling (e.g. larger than 3,000㎡→ larger than 1,000㎡)

### ③ Promotion of distributed renewable energy

◎ Promote projects for small-scale energy distribution to meet the daily energy demand of homes, villages, schools and others with renewable energy

- Introduce a photovoltaic rental business to provide one-stop service to help anyone easily install and maintain such devices

  * Existing government-led initiative: Consumers pay for the 50% of the initial investment, and a subsidized 3-year warranty is provided over the 20-year product life.

- Create a renewable energy complex by designating certain areas to receive support for a total package of solar PV, wind power and ESSs (Currently, support is provided for individual energy sources.)

- Revise distribution projects to focus on local residents and projects with benefit sharing mechanisms*, and promote private investment, including investment in the financial sector

  * Benefit Sharing: In Germany, citizens' generators that are invested in and owned by residents are becoming more common.

◎ Build power supply systems for specific sites (islands, buildings, etc.) with a focus on distributed generation through development and demonstration of microgrids

  * For islands, demonstrations have been underway at three sites, including Jeju island (Gapa island), by local governments and KEPCO with total funds of 41.2 billion won. For buildings, an industrial complex has been created in GuroGValley as part of the K-MEG project.

### D. Plan

◎ Confirm details in the Distributed Generation Promotion Plan (2014) and the 7th Basic Plan for Long-term Electricity Supply and Demand

## 3. Efficient Planning and Operation of the Transmission Network

■ Change the process of planning and constructing transmission lines in such a way as to improve the stability of power grid and the level of social acceptance

### A. Grid conditions

◎ There is an increased possibility of massive blackouts in the event of transmission line malfunction because of increased installed capacity at four major power generation sites, concentrated demand in the metropolitan area, etc.

◎ Because KEPCO, the Korea Power Exchange and plant operators share responsibility for grid operation, it is unclear who is responsible for what, and this lack of clarity is a limitation when preventing and responding to accidents.

  * There is no impartial supervisory body. Every party involved takes the role of player and judge at the same time and focuses more on profits than grid safety.

## B. Main Tasks

### ① Enhancement of Acceptance When Constructing New Transmission Lines

◎ When the construction of extra high voltage transmission lines is unavoidable, carry out complementary measures, such as burying HVDC lines underground

* HVDC lines are more socially acceptable as they have no distance restrictions, deliver power over long distances with underground cables, and emit few electromagnetic waves. However, Korea lacks practical experience in this area.

- Establish grid control and operation strategies that are appropriate for the features of HVDC and achieving self-reliance in HVDC technology

◎ Commence the construction of transmission lines only after giving full consideration to the opinions of local residents at every stage, from selecting routes to finalizing construction plans

### ② Stable Operation of Transmission Lines in the Metropolitan Area

◎ There has been a gradual rise in grid instability, including an increased possibility of fault currents, as the power load is concentrated in the Seoul metropolitan area, which has a loop-type transmission grid

◎ Continuously retrofit the grid to ensure the stable operation of transmission lines. Additionally, in the mid- to long-term, consider reconfiguring the loop-type grid, introducing a load-dispersing pricing scheme, etc.

- For the short-term, take measures to retrofit facilities, such as installing reactors and increasing breaker capacity, to reduce faults
- For the mid- to long-term, review the possibility of dividing the Seoul metropolitan area into small, alternate current network areas and to link with BTB HVDC
- Review possible pricing schemes to disperse the demand in the metropolitan area and others for the mid- to long- term

### ③ Improvement of the grid reliability management structure

◎ Establish a specialized body dedicated to impartially managing and supervising the national grid along the lines of the US NERC

- The body will be responsible for supervising and analyzing power grid operation, ensuring compliance with reliability standards, investigating and resolving grid malfunction, etc.

◎ Create "Power grid reliability standards*" to improve grid reliability to the level of advanced countries and to establish clear-cut lines of authority and responsibility among related organizations

* 10 tasks in 4 categories are to be carried out, including emergency measures and supply and demand based on systematic analysis, transmission plan, operation and maintenance, protective control, cyber protection, etc.

◎ Introduce a certification program to ensure that personnel working in the power grid sector have the necessary skills and qualifications

* Eligible for certification: Power grid operators in the Korea Power Exchange, transmission and substation operators in KEPCO, and generator operators in power plants

SECOND ENERGY MASTER PLAN

# CHAPTER V

## - Six Major Tasks - 3. Improvement of Sustainability of Energy Policy

(Environmental Protection, Safety Enhancement, Energy Technology, etc.)

# 1. Response to Climate Change

■ Shift the policy paradigm from regulation-driven reduction to fundamental, creative reduction and market promotion using cutting-edge technology

| In the Past | New Policy Paradigm |
|---|---|
| Set GHG reduction targets | Design cost-effective measures to achieve targets and strengthen industrial competitiveness |
| Regulation-oriented GHG reduction | Technology and market-oriented GHG reduction |

## A. Progress

◎ Introduction of regulations: The institutional basis has been laid for reducing greenhouse gas emissions by establishing the Greenhouse Gas and Energy Target Scheme (implemented in 2012) and Emissions Trading Scheme (enacted in 2012).

* The national emissions reduction target was announced in November 2009: 30% below the BAU level by 2020.

◎ Creation of a carbon market: A voluntary carbon market (Korea Voluntary Emission Reduction Program (KVER)) has been operated since 2005. Korea will also launch a national emissions trading market (allocation market), the 4th of its kind in the world, in 2015.

* KVER: The government pays for greenhouse gas emissions reduction achieved by companies participating in the target scheme without reduction obligations.

** ① EU (2005), ② New Zealand (2008), ③ Australia (2015, considering an early launch in 2014)

## B. Limitations

◎ Increase in GHG emissions: Despite reduction efforts, greenhouse gas emissions have been steadily rising due to the prevalence of energy-intensive companies, the export-oriented industrial structure, etc.

* Greenhouse gas emissions in 2010 increased by 9.8% compared to the previous year. Energy consumption from 2010 to 2012 was also greater than initially forecasted, and greenhouse gas emissions continue to rise.

* GHG Intensity (tCO2/million won): (2007)0.617 → (2010)0.641 → (2011)0.643

◎ Impact on businesses: There is a need to prepare sufficient counter-measures as the introduction of the emissions trading scheme and other measures may undermine business competitiveness.

* Business competitiveness may be weakened as the GHG emission permits to be allocated from 2015 may lead to increase in production costs, reduction in sales, etc.

- While the target scheme has come into effect, most businesses have not yet taken action and are lacking in reduction capacity.

■ A survey released in January 2012 showed that more than 80% of companies lacked methods to reduce emissions sufficiently.

■ Methods for achieving emissions targets are mostly aimed at improving the efficiency of processes and facilities, doing little to reduce emissions in the long term. (2012: 71%, 2013: 73%).

[ Reduction Methods Indicated in the Reduction Plans of Companies with Reduction Obligations (Unit: 1,000tCO2) ]

| Year | Efficiency Improvement | Fuel Conversion | Waste Heat Recovery | Renewable | Building/Lighting /Air-conditioning |
|---|---|---|---|---|---|
| 2012 | 5,600 (71%) | 1,146 (15%) | 642 (8%) | 208 (3%) | 159 (2%) |
| 2013 | 7,767 (73%) | 1,298 (12%) | 1,074 (10%) | 351 (3%) | 135 (1%) |

## C. Main Tasks

### ① Creative Response Using Technology and the Market

◎ New strategies for climate change in the creative economy: Design national policies to create a new market and industry in response to climate change based on science, technology and ICT (2014)

■ Present new policy directions to improve energy efficiency using ICT, increase R&D investment in key clean technology for the future, create a new market and industry in climate, etc.

■ Develop measures to combat climate change for coal-fired plants and energy-intensive industries, which are the main sources of greenhouse gas emissions

◎ Creation of a virtuous cycle with economic growth: Review a variety of potential measures to ease the concerns of businesses about a loss of competitiveness and carbon leakage as a result of the introduction of the Emissions Trading Scheme

- Energy-intensive and export-oriented industries (e.g., carbon-leakage industries) need to take measures to prevent carbon emissions and job leakage.
- ETS compensation program: Review measures to help carbon-intensive industries avoid a loss of competitiveness, such as carbon leakage

◎ Promotion of an offset market: Design offset programs to help industry achieve cost-effective reduction of GHG emissions in the ETS

- Review the use of green credits in the domestic offset market, which can be earned from the Korea Voluntary Emission Reduction Program, renewable and energy efficiency projects and other projects
- Encourage small-scale emitters, such as companies with reduction obligations, to implement offset projects

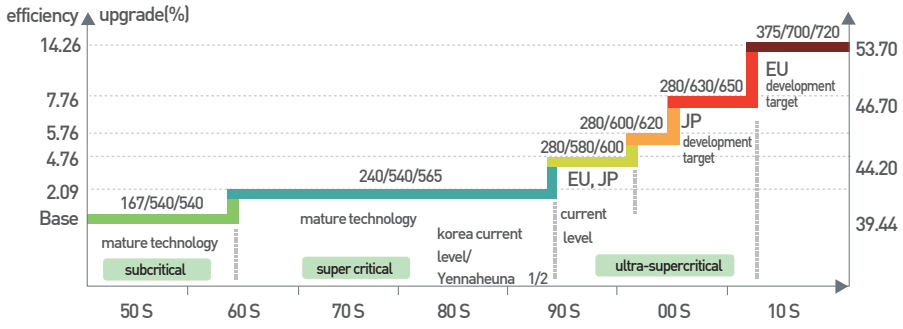
◎ International response: Actively participate in international efforts to address climate change using technology and the market

- Take appropriate measures in response to the technology-driven climate change initiatives led by the US (e.g., exporting efficiency technology, employing environmental strategies that can be used as an advantage in trade such as stricter standards and certification, etc)

※ Negotiation on the post-climate change system (to be completed in 2015): Breaking from the Kyoto Protocol, which focuses on reduction obligations for advanced countries and voluntary reduction for developing countries, a single framework that will bind all countries is being negotiated.

### ② GHG Emissions Reduction in the Power Generation Sector

◎ Adoption of reduction technology: Apply the best available technology to new plants, taking into account the technology's commercialization timing, and evaluate the reduction efforts of such plants

| | |
|---|---|
| CCS | ▪ Commercial CCS systems greater than 100 MW are being built in the US and Canada.<br>• 75 projects are underway, including large-scale projects in planning.<br>▪ CCS pilot plants with capacities greater than 10 MW are in operation in major countries (about 10 countries). |
| USC | · Increasingly adopted by new plants<br>  |

◎ Demand management: Promote an ICT-applied demand management market to create a level playing field for demand resources to compete with supply resources

• When the power supply is stabilized, integrate and operate existing similar demand management systems as reliability demand response and economic demand response

* Reliability demand response: Reduce and shift load away from peak hours to stabilize power supply and demand
Economic demand response: Reduce power supply costs through bidding and competition among power generation resources in the power market

◎ Fuel conversion: Increase the operation rate of LNG plants to promote distributed generation, reduce greenhouse gas emissions, etc.

### ③ Enhancement of Businesses' Capability to Address Climate Change

◎ Support for vulnerable sectors: Increase support for sectors of high vulnerability to address difficulties arising from GHG reduction compliance and help improve competitiveness

▪ Take inventory of SMEs, develop reduction technology, offer financial support and tax credits for industries concerned about a loss of competitiveness, etc.

◎ Promotion of joint emissions reduction: Transition from the current reduction system, which is focused on large emitters and individual companies, toward a system which encourages cooperation between businesses, including large companies, SMEs, and industrial complexes

- Green Credits: Review the possibility of recognizing emissions reduction achieved with capital and technology investment of large companies in SMEs as external reduction performance (offsets) under the target scheme and emissions trading scheme
- Industrial cluster: Switch to low-carbon industrial clusters by establishing integrated energy monitoring systems and joint power generation using waste heat

◎ Professionals: Identify promising job opportunities and systematize current manpower training programs based on the analysis of the supply and demand dynamics of human resources needed in Korea's climate change sector

◎ Specialized companies: Systematically nurture specialized service companies, including IT specialized ESCO companies connected to power and carbon markets and conservation (DR) consulting firms

- Design measures to promote service companies specialized in energy demand management and greenhouse gas emissions reduction (2014)

◎ Global green market: Establish comprehensive support mechanisms, supporting all stages of a project from selection and planning to financing and implementation, to help domestic businesses enter foreign markets

- Benchmark again the Green Initiative implemented in 2010 by the Japan Bank for International Cooperation. Under this Initiative, green projects selected by the government are financed by public funding and private investment.

## 2. Reform of the Nuclear Industry and Safety Enhancement

■ Continuously strengthen the stability of nuclear power through nuclear industry reforms, such as introducing an open and check system and improving the management and supervision systems of nuclear operators

■ Aim to become a Nuclear Power Plant (NPP) export powerhouse by 2020

| | In the Past | New Policy Paradigm |
|---|---|---|
| Industrial Reform for Safety Reinforcement | · Emphasize efficiency and economic feasibility of NPP construction and operation<br>· Achieve self-reliance in NPP technologies within a short period of time → "Choose and Focus strategy"<br>· In general, give operators autonomy in business management | · Prioritize safety to assure public acceptance<br>· Introduce a system of checks/ surveillance + openness/competition<br>· Strengthen management and supervision to prevent corruption and reinforce safety |
| Promotion of Nuclear Industry as Export Industry | · Establish a bridgehead to export NPPs<br>· Prioritize the export of NPP systems | · Concentrate on profitable projects for the national economy<br>· Export both nuclear parts and equipment |

### A. Progress

◎ Electricity supply: The foundation for a stable electricity supply was maintained by constructing NPPs as scheduled, securing new sites and efficiently operating NPPs

- Three NPP units have already been constructed*, and candidates for new NPP sites (Yeongdeok/Samcheok) have also been officially announced.

* Shin-kori Unit 1 (February 2011), Shin-kori Unit 2 (July 2012), Shin-wolseong Unit 1 (July 2012)

◎ NPP exports: Korea is the 6th country in the world to export nuclear power plants (4 units of APR1400 to the UAE in September 2012).

- The industrial foundation has been laid for creating a high-added value chain through self-reliance in three core technologies, including Reactor Coolant Pumps, Man-Machine Interface Systems and design code

◎ Safety enhancement: In the wake of the Fukushima accident, measures have been taken to improve facility integrity (2012-2015, 1.1 trillion won) and nuclear power plant operations (59 tasks).

## B. Limitations

◎ There have been limitations in creating a sound foundation for the industry in the process of the rapid growth of the NPP industry over a short period of time

- As Korea has pushed for 'NPP self-reliance*' in a short span of time, a few institutions and companies with a competitive edge have inevitably played a leading role in the formation of the industrial ecosystem.

  * (1978) Kori unit 1 → (1999) Uljin unit 3 and 4 (standard reactor (OPR1000)) → (2014) Shin-kori unit 3·4 (new pressurized light water reactor, APR1400)

- As a result of the nuclear industry's focus on a high level of technical expertise and specialization, it generally lacks competition, openness and supervision, leading to corruption and cronyism.

- The management system has been relatively lacking in safety and transparency, as the nuclear industry has overemphasized efficiency-oriented NPP construction and operation, and performance, focusing on increasing capacity factors, shortening construction periods, etc.

◎ There is a growing need to bolster the systematic management and supervision over state-owned NPP companies

- The management activities of state-owned NPP companies are subject to virtually no government management and supervision, unlike government-led activities regarding technical safety and electricity supply and demand management.

- The lack of a self-regulating and monitoring structure in the market as well as the insular structure of the industry have resulted in persistent problems, such as certificate forgery and corruption scandals.

◎ Since Korea won a contract to build NPPs in the UAE, global competition in the NPP market has become fiercer, while Korea has not taken sufficient measures to secure the foundation for NPP exports.

- Korea is less experienced in project financing and lacks large-scale government funding compared to rival countries, such as Japan and Russia, where a large amount of government funding is available.

- The focus on training experts for long-term domestic projects and developing a supply chain has led to a weakened capacity to respond to global changes.

## C. Main Tasks

### ① Safety-First Nuclear Policy

◎ Safety investment: Increase investment in safety to significantly enhance nuclear safety in Korea

- In the wake of the Fukushima accident, there has been increased investment in nuclear safety to prepare for natural disasters and other risks, and more focus has been put on the development of safety technologies.
  * Enlarging coastal barrier, securing vehicles with portable generators, building hydrogen gas removal systems not dependent on electricity, etc. (2011~2015, 1.1 trillion won)
  * Share of nuclear R&D dedicated to safety: 2012: 100 billion won (23%) → 2017: 40% → 2035: 60%

◎ NPP operation: Shift to a safety-first NPP operation system

- To improve planned preventive maintenance, conduct sufficient safety monitoring and maintenance by expanding the list of items monitored and maintenance periods, and minimize outages during operation
  * Main items monitored: 50 items → 100 items Standard maintenance period: 30 days → 35 days or longer
- To enhance the management of aged plants, conduct stress tests on plants whose operation licenses have been extended, preemptively replace equipment older than 20 years, etc.
- Switch to a safety-first management system by shifting from efficiency-focused management assessment of nuclear operators to safety-oriented assessment

◎ NPP construction: Construct nuclear power plants with the world's highest level of safety

- Thoroughly carry out quality tests and verification* of construction materials and nuclear parts regardless of construction deadlines
  * The originals of test result sheets should be verified, and witness tests should be conducted by the Korea Hydro & Nuclear Power Corporation. Additionally, third-party organizations should verify quality.
- Construct new reactors (APR1400)*, which have a much improved safety record compared to the existing standard reactor OPR1000, and develop a next generation reactor (APR+)**

* Used first in Shin-kori 3 and 4 under construction (10 times safer than OPR1000 in case of severe accidents)

**Aiming at completing technology development by 2015 (100 times safer than OPR1000 in case of severe accidents)

### ② Reform of Nuclear Industry

◎ Develop short and mid- to long-term anti-corruption measures by identifying structural problems in the nuclear industry, including the non-transparent procurement system, and gradually enforce such measures

■ Short term: Immediately implement improvement measures and periodically carry out follow-up management in accordance with the government's comprehensive plan (June 2013)

① Eradication of collusive ties: Prohibit retirees of state-owned NPP companies from employment in cooperating companies, restricting bidding by companies hiring such retirees, etc.

② Improvement of procurement: Minimize direct contracting without bidding, introduce pre-qualification, disclose procurement plans in advance, etc.

③ Enhancement of quality: Examine documents related to the quality of NPP parts to determine whether such documents are forged by third party independent organizations

■ Mid - to Long-term: Seek fundamental measures to foster competition in the industry and enhance the transparency of the value chain

① Encourage competition/expand supply networks in the nuclear market

* Standardizing parts by opening markets dominated by certain companies to competition, easing bidding requirements by lowering entry barriers (delivery performance requirements) for newcomers, and creating a localized road-map by eliminating demand for certain companies

② Improve procurement procedures/ reform procurement management system

* Establish a price system based on original cost to prevent below-cost competition that could cause quality degradation and to guarantee appropriate prices; implement a Multiple Award Schedule to make insular procurement practices more transparent; develop an Integrated Management System to systematize complicated management systems; and strengthen the contractor management process to weed out substandard contractors

③ Enhance quality self-assessment of the nuclear industry

* Making it clear where responsibility lies within the nuclear industry to prevent forgery of test results

◎ Establish a surveillance and control system for stated-owned NPP organizations to enhance transparency and safety

- Enact an Act on Management and Surveillance of Nuclear Operators to serve as an overarching law to manage and supervise the four stated-owned NPP organizations, which have related functions

  * Share safety-driven management goals among the Korea Hydro & Nuclear Power Corporation, KEPCO E&C, KEPCO NF and KEPCO KPS, build inter-organizational cooperation and coordination mechanisms, and monitor and assess activities to enhance safety and prevent corruption

- Establish a nuclear industry policy council* to coordinate the distributed management and supervision roles of stated-owned NPP organizations and facilitate a speedy decision-making process

  * Participants: Office for Government Policy Coordination (Chair), Ministry of Strategy and Finance, Ministry of Science, ICT and Future Planning, Ministry of Trade, Industry and Energy, etc.

  * Discussion topics: Supervision to promote safety-driven management, measures to build public trust in nuclear safety, etc.

◎ Greatly enhance the safety management capabilities of the government and nuclear industry

- The regulator, the Nuclear Safety and Security Commission, should tighten safety regulations* and expand enforcement manpower, while related ministries, including the Ministry of Trade, Industry and Energy, focus their support on safety equipment investment and technology development.

  * Introduce an inspection system for parts suppliers, designate a specialized certification organization for testing and inspection agencies, etc.

- Secure a sufficient number of safety management personnel before establishing a system for supplying manpower optimized to ensure safety

  * Secure necessary manpower by downsizing headquarters and increasing staff quotas and assign the manpower to equipment maintenance and repair units

  * Implement a system for securing sufficient human resources in advance (2 years ahead of the actual placement) to provide skilled professionals on site in a timely manner. Additionally, establish standard job classifications for each type of nuclear reactor.

- To strengthen the comprehensive and continuous capacity of the Korea Hydro & Nuclear Power Corporation in terms of safety assurance, undertake extensive and voluntary reform in three areas: organization, human resources and corporate culture

  ■ Organization: Strengthen the expertise and role of the procurement team, create a new team dedicated to engineering, reinforce the function of the audit team, etc.

- Human Resource: Drastically increase recruitment of external staff, designate responsible senior executives for each NPP site, stipulate primary HR policies as company regulations, etc.
- Corporate culture: Make safety and integrity as core company values, benchmark against domestic and international best practices for safety, etc.

### ③ Promotion of NPP Exports

◎ Select projects that are profitable to the national economy

- Select target export countries and strive to win contracts after reviewing financing capacity, policy credibility, electricity supply and demand outlook, etc.
- Decide whether to participate in a project based on a thorough review of project feasibility by a public-private consultative group
- Establish export strategies tailored to promising projects/countries and carry out inter-ministry efforts to win contracts

◎ Develop professional manpower for NPP exports by providing systematic training, increasing staff quotas in a timely manner, etc.

- To ensure a sufficient number of professional personnel for the construction and maintenance of the UAE NPPs, adjust staff quotas of state-owned companies to sufficient levels in a timely manner in consideration of training periods

  * Train overseas projects specialists by providing systematic training programs specially devised for the design of reactors for export (APR1400)

- Systematize the process for state-owned companies to secure manpower needed for overseas NPP contracts

◎ Plan and implement strategies to export parts and equipment along with NPPs

- Build a high-added value NPP supply chain through technology development, package development and other measures and provide support to ensure a stable procurement route in the international nuclear market

  * Provide support at every stage, from R&D for essential equipment to commercialization, domestic sale, and export

### ④ Enhancement of Public Communication and Community Involvement

◎ Improvement of transparency: Enhance the transparency and credibility of NPP polices by regularly disclosing information on NPP operations and constantly communicating with local residents

- Promote activities of environmental watchdog groups, which help residents directly participate in monitoring and overseeing the environment and safety of NPP areas
- Expand and conduct safety monitoring with the participation of local residents, and designate a spokesperson to deliver regular monthly briefings on overall NPP operations for each NPP site

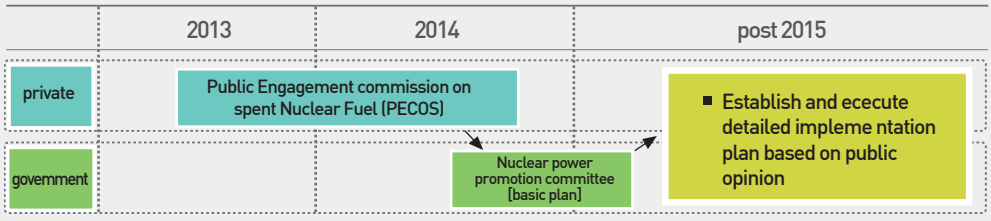
◎ Community benefits: Revise community support projects to ensure that government and operator funds are used effectively for purposes such as increasing incomes for the community

* Revise support projects to effectively bring mutual benefits to nuclear energy and the community (e.g., task force teams consisting of community, operator and government)

* SOC-oriented projects → community assistance focused on income generation and direct support for residents

## 3. Foundation for Nuclear Decommissioning and Waste Disposal

■ Establish and implement a plan to manage spent fuel in a timely manner following public discussion and consensus building



## A. Progress and Limitations

◎ Establishment of foundation: The Korea Radioactive Waste Agency, which was set up in January 2009 to manage radioactive waste disposal in Korea, is constructing a waste disposal facility in Gyeongju.*

* As of July 2013, 95.9% of the first phase construction is completed. Preliminary design and other activities are underway for the second phase.

◎ Basis for public involvement: The Public Engagement Commission on Spent Nuclear Fuel* was launched and has began to build consensus for the management of spent fuel.

* Established in October 2013, the commission consists of representatives from the liberal arts and social studies, technology and engineering, civil environmental groups, NPP-located communities, etc.

◎ Delay in implementation: The scheduled construction completion date was postponed twice*, first due to issues regarding the first phase construction of low and intermediate level radioactive waste disposal facilities and second due to reinforcement work to ensure safety.

* The construction completion date for the first-phase facility: (originally) December 2008 → (extended to) December 2012 → (extended twice to) January 2014

◎ Lack of decommissioning technology: Technologies for decommissioning have not been commercialized at the industry level as Korea lacks experience decommissioning commercial NPPs as well as the necessary engineering technology and experts

* Korea has 17 core technologies among 38 decommissioning technologies, which is about 70% of the international level.

## B. Direction

### ① Promotion of Public Involvement in Spent Fuel

◎ Start establishing management measures from 2015 based on the results of public discussion by the Public Engagement Commission on Spent Nuclear Fuel created in October 2013

- The Commission will supervise the general discussion processes, including discussion on ground rules and topics, and will convey the results of the discussion to the government by the end of 2014.
- Form an inter-ministry consultative group led by the Office for Government Policy Coordination to bolster communication and cooperation between the Commission and relevant ministries

### ② Timely Construction of a LILW Disposal Facilities

◎ Complete the construction of low and intermediate level radioactive waste (LILW) disposal facilities in 2014 in a timely manner on the principle of safety-first

- Complete the first phase construction in a timely manner. Beginning with the designing stage in the second phase, thoroughly conduct* safety inspections

  * Carry out technology consultations with overseas experts (ANDRA in France, etc.) and geographic investigation of fault lines and other factors during preliminary designing

### ③ Commercialization of nuclear decommissioning technology

◎ Secure in advance industrial capacity to commercialize technologies that can be directly applied to decommissioning nuclear facilities

- Identify categories of technology for commercialization, factoring in applicability and marketability, and seek to achieve technology demonstration and manpower development through customized demonstration projects*

  * (e.g.,) Large waste disposal technology → decommissioning pilot projects for aging NPP parts, such as steam generators

## 4. Enhancement of Safety Management of Energy Facilities

■ Moving away from the 'supply first, safety later' approach for industrial development, move toward an energy safety regime of prevention and systematic management to protect the safety of the public

- While strictly managing safety issues that directly affect public safety, continuously enhance other safety regulations regarding private participation and business activities

| | Current Safety Management | New Safety Management |
|---|---|---|
| Policy Objective | Build energy facilities to develop industry | Ensure the safety of energy facilities to guarantee public safety |
| Direction | Take short-run, accident-oriented measures | Establish a management system focused on prevention |
| Subject and Method | Led by government regulations | Expand self-management in the private sector along with safety technology development |

## A. Progress

◎ Expansion of the foundation: The government has strengthened its regulatory capability and expanded its organization and human resources for energy safety

- Established an energy safety experts committee and an energy safety division under the Ministry of Trade, Industry and Energy (MOTIE) and an safety management committee for energy public enterprises
- A system has been established to respond to energy-related cyber issues with the launch of the National Cyber Security Center in 2008

◎ Spread of safety-first culture: A safety-first culture has been fostered in state-owned energy companies, from the CEO level to workers in the field, and private companies have a greater awareness of the importance of safety assurance

- Safety assurance is now stipulated in management contracts with CEOs and safety commitment conferences and safety education sessions are held on a regular basis

## B. Limitations

◎ Safety regulation system: There have been difficulties in effectively implementing safety policies due to the absence of safety governance involving both MOTIE and public energy enterprises and the low participation of the private sector

◎ Safety service promotion: There have not been sufficient development of and support for safety services using experience and technology, including safety diagnosis for gas and electricity facilities and workplace safety assurance

◎ Cooperation for safety: The current response capability to new energy safety issues arising in areas such as industrial complexes and cyberspace remains insufficient.

## C. Main Tasks

### ① Expansion of safety systems and development of safety technology

◎ Public safety: Thoroughly regulate safety issues related to LPG, city gas and other sectors directly related to people's lives

* Design measures to eradicate the distribution of substandard LPG cylinders for household and commercial use, prohibit smoking in LPG stations by law, mandate the in-line inspection of city gas pipelines in urban areas, etc.

◎ Improvement of regulations: Continuously identify and improve safety regulations that hamper the business activities of SMEs

* Relax the period for the re-inspection of unused high-pressure gas products, support the tracking of LPG cylinders using electronic tag, etc.

◎ Safety R&D: Improve the safety performance of companies/the private sector by expanding R&D support for energy safety technology

* Lay out guidelines to support safety technology R&D by companies/the private sector and establish and implement a road-map for gas safety technology

◎ Export of safety services: Provide support for safety certification, diagnosis and consulting for Korean plant companies operating in South East Asia, Iraq and other regions through cooperation between the Korea Gas Safety Corporation and the Korea Electrical Safety Corporation

* Introduce Korea's safety regulations and infrastructure to trade partner nations to support the export of equipment by Korean companies

### ② Response to Emerging Safety Issues

◎ Safety of industrial complexes: Conduct precise safety diagnosis of aged complexes, renovate old facilities, and establish six joint disaster prevention centers jointly operated by the Ministry of Environment, Ministry of Employment and Labor, the National Emergency Management Agency and other parties

- The joint centers will play an integral role in disaster prevention, preparation, response and recovery by sharing information, providing joint guidance and oversight on business, etc.

◎ Cyber security: Establish a system to respond to cyber terror by enacting management regulations customized to individual organizations, developing a security index, creating an information protection system, etc.

- Launch a three-tiered security control system for public energy enterprises, MOTIE, and the nation. As part of this system, establish internal security control centers in major energy-related organizations

### ③ Reinforcement of the Energy Safety Regulation System

◎ Safety system: Regularly conduct "planning, enforcement, and assessment" safety management under the direction of the energy safety experts committee of MOTIE and the safety control committees of public enterprises

- The activities of the safety control committees of public enterprises will be regularly reported to the energy safety experts committee, which will then evaluate the activities and ensure systematic safety management

| | | |
|---|---|---|
| Establish and review safety policies | ➡ | Energy safety experts committee |
| Implement safety control | ➡ | Safety control committees of energy public enterprises |
| Share results and give feedback | ➡ | Safety control meeting and evaluation of administrative tasks |

◎ Development of a safety index: Develop a safety index that takes into account the special characteristics of different public enterprises in order to compare and assess the safety management capability of public enterprises (2014, research task)

◎ Contractor management: To ensure transparency in transactions between public enterprises and contractors and enhance awareness of safety management, create and share a database of the employment statuses of retirees, accident cases, etc.

## 5. Competitiveness of Future Energy Technology

- Aim to achieve 15% global market share and 15% efficiency upgrade by 2035
- Strive to develop core technologies, such as demand management and distributed power generation

| | Present | Direction for Technology Development |
|---|---|---|
| Demand Management | · R&D for efficiency improvement of unit devices | · R&D for creating business opportunities |
| Renewable Energy | · R&D for core technologies for high efficiency | · R&D for grid parity demonstration |
| Electricity/ Nuclear | · R&D for stable supply technology | · R&D for distributed generation and energy safety |
| Convergence | · R&D for convergence of three major energy sources | · R&D for convergence of ICT, defense, agriculture and industrial technology |

## A. Progress

◎ Increased investment: The amount of energy R&D investment reached 1 trillion won in 2013, continuing a trend that began in 1988.

- In 2011, government R&D investment ranked the 8th in the world (9th as a percentage of GDP)

  * Government energy R&D investment (2011, in 100 million dollars): US 64.9, Japan 41.7, Germany 9.3, Korea 5.5

◎ Securing core technology: Core technologies for the energy industry have been developed and achieved profitable results

- Important technologies for the renewable energy sector, such as solar PV, wind and fuel cells, have been developed.

  * Development and international certification of 3 MW offshore wind power system, development of technology for polycrystalline silicon mass production, etc.

- The foundation for commercialization of smart grid was laid through the establishment of a Jeju Smart Grid Test Bed

  * Development of Advanced Metering Infrastructure (AMI), Energy Management System (EMS), Energy Storage System (ESS) and other key technologies

◎ NPP exports: Korea has become the 6th country in the world to export nuclear power plants (UAE: APR1400 4 units, December 2009).

- The foundation has been laid for high value-added industrial development by achieving self-reliance in three core technologies: reactor core design code, reactor coolant pumps, and man-machine interface systems

## B. Limitations

◎ Korea lacks world-class technologies needed to increase its global market share.

- Despite increased investment in energy R&D, Korea's technology level* and industrial competitiveness** have remained below those of major countries.

  * US 83.4% → EU 83.1% → Japan 80.4% → Korea 68.8% → China 62.9% (as of 2010, NTIS)

  **Global market share for green energy in 2010 (Source: Roland Berger, 2012): China (24.5%, 1st), US (17.8%, 2nd), Germany (12.8%, 3rd), Japan (7.8%, 4th), Brazil (4.8%, 5th), Korea (2.2%, 9th)

- The industrial benefits of energy R&D investment have been lessened by the insufficient size of markets for new energy technologies, such as smart grid, high efficient buildings and energy storage.

  * Only 29% of the government's energy R&D projects have been commercialized (2013 research outcome utilization survey)

◎ Sufficient preparations have not been made for the transition to a future-oriented energy system.

- There is a need to focus on innovative R&D, demonstration, and deployment to support commercialization in order to prepare for the transition to an innovative energy system based on distributed generation and ICT.

  * To switch to a system that uses the latest energy technologies, such as smart grid, ESS, K-MEG and CCS, efforts should be made to facilitate the demonstration and deployment processes, where technologies are actually applied to the energy network.

◎ Insufficient efforts have been made to resolve social controversies, including concerns about energy safety.

- Technology should be developed to prevent energy-related accidents,* which have become more frequent in recent years.

  * Yeosu Industrial Complex outage (January 2011, damage 70 billion won), hydrofluoric acid leak in the Gumi Industrial Complex (September 2012), etc.

## C. Main Tasks

### ① Expanding R&D on Core Technology for the Future Energy System

◎ Develop technologies for distributed power generation based on ICT

- Virtual power generation: Develop and demonstrate technologies for the realization of virtual power plants

* A technology that can create a virtual network of various distributed power generators, which can then be operated and controlled like a single large-scale power plant

- Vehicle to Grid (V2G): Develop V2G, a technology that utilizes vehicle batteries as a virtual power supply, to secure an added source of power generation.

  * When electric vehicles are utilized as devices for storing distributed energy power storages (V2G), the estimated peak load is reduced by 19% compared to the baseline (IEA, 2011).

- Smart grid: Increase investment in common platform technologies for standardization, testing, and certification, and develop commercial technologies in connection with the Jeju Smart Grid Test Bed

◎ Realize energy-saving by applying demand management ICT technology

- Smart buildings: Increase investment in the development of passive building techniques and building energy management systems* (BEMS), such as exterior insulation systems and vacuum heat insulating materials

  - Establish building management systems linked with an energy distribution plan to achieve a 20% reduction in energy building use; and lay a foundation for the expanded distribution of K-MEG.

  * A service technology that monitors the energy consumption of a building through sensors and networks, and automatically optimizes energy use

- Smart industry complexes: Develop technology for high-efficiency processes in energy intensive industries, such as steelmaking and chemicals, and increase investment in R&D for motors, boilers, driers and other devices

  * Goal: reduce the energy use of smart industry completes by 30%.

◎ Develop technology to prepare for the wide availability of energy storage systems (ESS)

- Technology development: Lower the cost of ESSs by half by 2020 through expanded investment in R&D to develop core technologies and accelerate their commercialization

  - Develop technologies that will lead to the early commercialization of storage systems other than lithium batteries, such as Redox Flow Battery and NaS, before 2020

- Demonstration studies: Demonstrate medium- to large-sized 50-100 MW ESSs

  * Demonstrate a 100 MW compressed air energy storage system, operate lithium batteries of 50 MW that harnesses wind power, etc.

◎ Remove technological barriers that impede the expansion of the renewable energy supply

- Removal of barriers: Increase investment in developing new materials and new processing technologies to resolve the problems of low efficiency and high generation costs, which hinder market growth.

  * By 2022, solar PV generation is expected to achieve a generation cost of $0.112/kWh and improve the efficiency of cells and modules by 25% and 23% respectively (vision road map, 2013).

- Demonstration model development: Promote R&D to nurture the renewable industry into an export industry and develop a model to expand the scope of application to include BIPV, large-scale wind farms, etc.

  * Establish solar PV generation clusters and large-scale wind farms, expand solar panel installations in large buildings, etc.

◎ Expand the development of innovative energy technology for the future

- Investment expansion: Invest four trillion won by 2035 in developing technologies, such as distributed generation and demand management technologies. Moreover, expand investment in developing core technologies to more than three times the current level by 2022 (From annual investment of 14.5 billion won as of 2013 to annual investment of 50 billion won by 2022).

  - Develop innovative and cutting-edge technologies to keep up with megatrends and make breakthroughs in enhancing performance, saving costs, shortening the time interval from development to commercialization, etc.

  * Using the Step and Gate approach at each stage from development to commercialization

- Focus on core sectors: Identify core technologies that can replace existing technologies, dramatically reduce costs, and enhance efficiency, and provide necessary support for such technologies from the R&D stage to commercialization

  * Magnesium batteries, metal-air batteries, highly efficient solar cells that harness quantum dots, floating wind turbines, etc.

### ② Securing Core Technologies for a Sustainable Energy Society

◎ Expand investment in R&D aimed at making fossil-fuel based conventional energy sources cleaner

- Thermal power generation: Develop highly efficient and environmentally friendly thermal power generation systems and seek technologies to increase the use of domestic parts and materials in power plants.

  * Use domestically developed high-efficiency gas turbines, develop key components for gas turbines and operation systems, etc.

- Clean fuel: Expand investment aimed at making the use of coal cleaner, such as a 1000 barrels/day coal-to-liquid plant demonstration and a 300 MW integrated gasification combined cycle demonstration
- Greenhouse gas reduction: Promote the commercialization of carbon capture and storage technologies through a 100 MW carbon capture and CO2 storage demonstration

◎ Ensure the safety of nuclear power plants from development and operation to decommissioning

- Short term: Develop technologies to improve the safety of nuclear power plants currently in operation
  * Prevention, mitigation and clean-up technologies in case of natural disasters and complex accidents, technologies to ensure safety in case of black-outs, etc.
- Mid- to long-term: Solidify the foundation for mid- to long-term power generation by developing new reactor models with guaranteed safety, next generation nuclear reactors and nuclear decommissioning technology
  * (Mid term) Development of passive restraint technology to maintain safety in the event of black-outs, etc. (Long term) Joint development of fourth generation nuclear reactors, radioactive waste disposal technologies, including decontamination and decommissioning technologies, etc.

◎ Reinforce technology development to ensure energy safety

- Supply chain safety: Together with R&D on the safety of gas, electricity and electric installations, develop a safety management system* that applies information technology and a monitoring system for testing, diagnosis, etc.
  * Including toxic gas safety regulations, high compression gas regulations and petrochemical safety regulations
  - Develop a public monitoring system that reflects Korea's unique characteristics to promote a culture of safety and security among nuclear organizations and their employees

### ③ Creating Future Growth Engines to Promote the Mutual Growth of SMEs and Large Businesses

◎ Undertake public-private joint investment of 2 trillion won in win-win commercialization projects that will create future growth engines for both SMEs and large companies by 2035

- Carry out Medium and large commercialization projects to secure new technologies and develop demonstration models through joint R&D investments by SMEs and large companies.

* In mutual growth R&D, large companies will focus on the management of overall systems while SMEs will put a greater emphasis on developing components and materials.

[ Examples of Win-Win Commercialization Projects ]

| Classification | Top 10 Projects |
|---|---|
| Distributed power generation applying ICT | Demonstrating a 100 MW compressed air energy storage system |
| | Operating 50 MW lithium-ion battery that harnesses wind power |
| | Establishing a sustainable zero energy smart system |
| | Establishing and demonstrating a virtual power plant operation model |
| Expanded use of renewable energy | Demonstrating built-in solar panels for the buildings |
| | Integrating operation and control systems for large-scale renewable energy complex |
| | Demonstrating hybrid power generation systems that can be exported |
| GHG emissions reduction and energy efficiency improvement | Demonstrating 100 MW carbon capture and storage |
| | Developing an Auto-DR system and technologies that reinforce energy efficiency in industry |
| | Demonstrating a clean coal plant |

◎ Expand the support ratio for SMEs in the government's energy R&D budget

- A share of the government's energy budget for SMEs: (2012) 23% → (2015) 35% → (2020) more than 50%
- Ensure that SMEs are always included in R&D consortiums for R&D assignments that require an annual budget of more than 2 billion won
- Establish a support system to reinforce the technological capacity of SMEs by introducing an energy R&D mentor system*, establishing a government-funded SME support center, etc.

  * A researcher or retiree of a government-funded research institute will be designated as a mentor for a company doing business in his or her professional area. Mentors will provide assistance and advice in planning R&D assignments and throughout the assignment process.

### ④ Establishing a Strategic Energy R&D Investment System

◎ Formulate mid- to long-term investment strategies/portfolios to determine technology development priorities

- Establish investment strategies by conducting quantitative analysis of energy security, greenhouse gas reduction targets, job creation, economic benefits, etc.
- Strengthen the information side of energy technology by establishing and operating statistics databases, conducting surveys and analysis, and sharing information in order to make portfolio analysis as accurate as possible

  * 200 employees (10%) at the National Renewable Energy Laboratory in the US are deployed to the Strategic Energy Analysis Center to perform functions such as technology and market analysis, forecasting and modeling, and policy impact studies.

◎ Link energy R&D investment strategies of the government and public institutions

- Establish an energy R&D council to coordinate yearly public sector R&D investment plans

  * In 2013, the projected R&D investment of 9 state-owned energy companies, including KEPCO and KOGAS, is 970 billion won.

◎ Design a mid- to long-term R&D strategy road map

- Develop a systematic national, mid- to long-term energy action plan by preparing an R&D road map that reflects national energy policies and industry demand

  * The roadmap will present a comprehensive plan that integrates R&D warehouses, vision road maps and strategy road maps.

◎ Expand international joint research funding and establish a joint research network with advanced countries

- Increase funding for international joint R&D more than two-fold by 2020

  * As a share of energy R&D: 2.7% (20 billion won) in 2013 → around 5% (50 billion won) in 2020

- Use associations of Korean scientists and technology experts living abroad, such as the UKC, CKC, and EKC, as a platform to promote technology exchange with partner nations

SECOND ENERGY MASTER PLAN

# CHAPTER V

## - Six Major Tasks - 4. Enhancement of Energy Security

## 1. Reinforcement of Overseas Resource Development to Strengthen Resource Development Capability

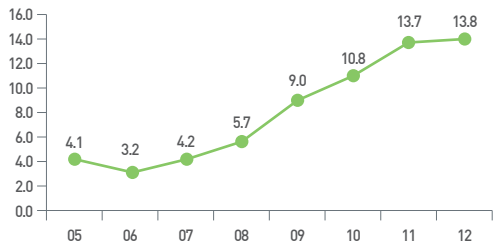
- Shift the policy focus from enlarging public enterprises and achieving quantitative growth to enhancing industrial competitiveness in the mid- to long-term
- Public enterprises will take the lead in high-risk sectors requiring long-term investment, while the private sector will play the main role in sectors with high market potential.

| | Current Policy Paradigm | New Policy Paradigm |
|---|---|---|
| Policy Target | Secure larger amounts of overseas resources (enlargement of public enterprises) | Improve the government's capability to develop resources (Strengthening industrial competitiveness and creating jobs) |
| Key Player | Public enterprises | Public and private enterprises |
| Funding | Financed mainly by public enterprises | Financed mainly by the private sector |
| Method | M&A, buying shares in production fields | Securing operating licenses in exploration fields |

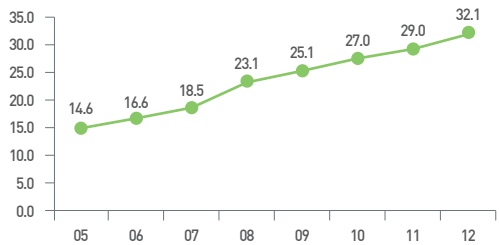
### A. Progress

◎ Quantitative growth: The amount of oil and mineral resources successfully secured increased over a short period of time.

[ Self-sufficiency rate in oil and gas (%) ]




[ Self-sufficiency rate in major mineral resources (%) ]



◎ Enlargement of public enterprises: The Korea National Oil Corporation (KNOC) has secured the minimum amount of oil (200,000 b/d) required to invest in high-quality and valuable fields, and the Korea Resources Corporation (KORES) has grown into one of the world's top 80 mining companies.

① (KNOC) 50,000 B/D → 241,000 B/D, World's top 90 → World's top 70

② (KORES) Annual production of $300 million → $2 billion, World's top 100 → World's top 80

◎ Advancement into key markets: Regional hubs have been secured and inroads have been made into new markets in the UAE, Iraq and other countries in the Middle East, which has the world's highest oil reserves.

- Supply and demand hubs of major minerals, including bituminous coal, copper and steel, have been established in Central and South America, Australia, Indonesia, and other regions, and the efforts to develop rare earth metals in emerging, untapped regions, such as Africa, has been expanded.

## B. Limitations

◎ Excessive emphasis on quantitative growth: Public enterprises have focused narrowly on short-term gains because they used the self-sufficiency rate as a rigid, short-term indicator of success.

- Insufficient technology and experience developing and operating mines has been gained given that projects related to operating rights for oil fields and mines accounted for 37.6% of all projects, and the share of KNOC's investment in exploration projects was a mere 10% from 2008 to 2012.

  * Proportion of operating rights projects: 77 out of 205 projects (37.6%), KNOC 55.6%, KOGAS 14%, the private sector 26.2%

◎ Weakened investment efficiency: The debt ratio of public enterprises has soared, and it is now agreed that past resource development was focused excessively on external growth through M&As and equity investment.

- The debt ratios of public enterprises, including KNOC and KORES, have more than doubled over the past five years, increasing to the point that the level of debt threatens their financial soundness.

  * State companies' debt value (2007→2012, trillion won): (KNOC) 3.7 → 18, (KOGAS) 8.7 → 32.3, (KORES) 0.4 → 2.4

* State companies' debt ratio (2007→2012, %): (KNOC) 64 → 168, (KOGAS) 227→ 385, (KORES) 103 → 177

◎ Insufficient infrastructure for growth: Not enough has been done to establish infrastructure, such as human resources, R&D, and government support systems, necessary to take the overseas resource development industry to the next level.

* Human resource: Mismatch between supply (mainly university graduates with bachelor's degree) and demand (for graduates with master's or doctoral degrees).

  Technology level: Korea's technology level is 47% of that of advanced countries. Moreover, research has largely been conducted in laboratories, and as a result it has failed to reflect reality in the field.

- Although the quantitative growth strategy, including the enlargement of public enterprises, could be considered successful in so far as it was necessary to secure the mid- to long-term growth of the overseas resource development industry.
- there have been negative effects, such as the weakened financial soundness of public enterprises and insufficient efforts to improve quality.

## C. Main Tasks

### ① Enhancing Capabilities for Long-term Energy Security

#### Using new indicators and terminology for resource development

◎ The "self-sufficiency rate/self-development rate" should be renamed the "resource development rate," because the word "self" leads the public to mistakenly believe that the "self-sufficiency rate/self-development rate" is equivalent to the amount of resources flowing into Korea.

- The resource development rate should be calculated by year (annual production/annual imports), instead of by the actual number of days of operation (daily resource development/daily imports).

◎ Use the resource development rate as a long-term policy indicator, rather than as a short-term, rigid performance indicator which have undermined investment efficiency

- In order to ensure that the growth of public energy enterprises is centered on exploration, adopt the management efficiency indicators (e.g., securing new reserves) of global exploration and production companies as performance indicators of public enterprises

## Strengthening emergency response capability

◎ Encourage the introduction of foreign resources for which domestic companies hold exploitation rights

- Amend existing mining rights contracts to bring minerals to Korea in case of emergency. Moreover, provide larger loans for projects that can be implemented in Korea under the success-repayable loan program[1].

◎ Enhance oil stockpiling capacity to better respond to instability of short-term supply and demand. For example, jointly stockpile oil with global E&P companies and public oil enterprises of oil-producing countries.

- Stockpile rare metals, such as chrome and molybdenum, that are essential for domestic industrial production, as planned.

### ② Strengthening the Foundation of Public Energy Enterprises

◎ Focus on exploration: Decrease investment in the form of simply buying shares and enhance mid- to long-term resource development capability by putting a greater emphasis on operating licenses, exploration and development.

- Korea National Oil Cooperation: Increase the average proportion of investment in mining exploration to over 20% of total investment between 2013 and 2017 from current 10%, and enhance the success rate of exploration by concentrating scattered exploration capabilities
- Korea Gas Corporation: Take advantage of KOGAS's strong LNG purchasing power to pursue vertically integrated projects related to introduction through joint development in North America and other regions in cooperation with global E&P companies
- Korea Resources Cooperation: Make large investments in operating rights projects rather than a diversified portfolio of small projects, and pool the capacities of domestic enterprises* to jointly enter new markets

* (KORES) Technological prowess and global trustworthiness + (End user company) Purchasing power + (Trading company) Marketing + (Mine Reclamation Corporation) Mine reclamation + others

1) In Korea, a government loan system to support overseas resources development projects was established in 1984 in order to initiate the development activities of private/public companies. According to this system, Resource developing companies are obliged to pay back the principal and the interest when they succeed in their resource business.

◎ Enhancing capability: Establish a foundation for further progress by making efforts to enhance capability, including streamlining the investment process and public enterprise governance, improving human resources and technological prowess, etc.

- Korea National Oil Cooperation: Build key capabilities by increasing exchange in technology, information and human resources as well as joint exploration projects with leading global companies
- Korea Gas Corporation: To pursue vertically integrated LNG projects, secure key technologies and operational capacity needed at every stage of the process, from development and liquefaction and transport.
- Korea Resources Cooperation: Focus on initiating new investment projects and increasing the production of existing investment projects. In addition, expand the company's mid- to long-term profit base and accumulate technology and know-how in mine operations.

◎ Financial soundness: Improve the debt ratios of public enterprises to the level of global companies by selling distressed assets, securitizing assets, attracting financial investors, etc.

- Conduct asset sales from a long-term perspective that considers various factors, such as business feasibility and market conditions, rather than carelessly selling assets in a short period of time

### ③ Promoting Private Sector Investment in Overseas Resource Development

#### Attracting more financial investors

◎ Promote private sector investment by expanding the investment guarantee scheme for the Resource Development Fund from the current 1.9 trillion won to 4 trillion won by 2017, and by enhancing principal protection for investors in the fund

- Enhance training programs, such as courses to train experts in managing financial assets related to resource development, to strengthen the capabilities of financial investors in the field of resource development

◎ Securitize sound assets with stable cash flows to provide investors with more opportunities for participation, and increase the investment capability of resource development companies

#### Expanding and reorganizing support for the private sector

◎ Expand the budget for success-repayable loan programs and revise the loan system to select and focus on promising projects, such as operating rights projects

◎ Encourage the launch of private-public consortiums in which public enterprises take the lead in the high-risk exploration stage while the private sector takes the lead in the low-risk stages of development and production

### Entering related industries

◎ Create systems to enable cooperation, such as information sharing, between domestic resource exploration companies and businesses in related industries, such as plant construction and ship building.

- Provide incentives based on the level of participation of related domestic industries in the development stage. Such incentives may include preference for resource development companies when applying for loan programs.

## ④ Strengthening Industrial Infrastructure by Training High-quality Workers and Conducting Practical R&D

### Training high-quality workers with the skills businesses need

◎ Revise the basic curricula of universities specializing in resource development to produce high-quality workers through professional training with a focus on practical skills

- Form consortiums among universities to encourage each university group to be specialized in a different area and to be involved in exchange with universities overseas to strengthen global competence

◎ Train high-quality workers skilled in specialized technologies* through cooperation between businesses and universities/graduate schools, and launch training programs in skills ranging from law and contracts to accounting

* To develop a high-tech workforce, encourage research focusing on geophysical oil exploration, unconventional resource development, including shale gas and oil sand, and mining development.

◎ Form partnerships between universities and companies with overseas locations so that workers can gain field experience through on-the-job training programs in businesses overseas

### Promoting practical R&D

◎ Shift from small-scale, laboratory-centered research driven mainly by academia and

research institutes toward large-scale, business-centered research with practical results that can be more readily applied in the field

- Promote R&D on core technologies for developing resources such as shale gas, and encourage active participation by businesses to secure sites for demonstration

  * Conduct R&D projects whose results can be demonstrated in shale gas fields in North America (2013-2017, 10 billion won annually).

  * Under success-repayable loan programs, give preference to private enterprises which provide sites needed to conduct R&D.

◎ Actively promote industry-university-institute cooperative projects, and encourage businesses to conduct research projects with leading universities/graduate schools which have specialized technologies.

- Companies should provide field data for research purposes and carry out joint research with universities and research centers on core technologies needed for enhancing operational capabilities, such as increasing production.

## 2. Further Deployment of Renewable Energy

- Achieve renewable energy deployment rate of 11% by 2035
- Develop the domestic renewable energy industry into one of the world's top five by 2035

### A. Current Status

◎ Deployment: As of 2012, 3.18% of the total primary energy supply was produced from renewable energy. Waste-to-energy, bio and hydro energy accounted for 92% of total renewable supply.

  * Compound Annual Growth Rate (2008-2012, %): Solar PV (41), Wind (20), Fuel Cell (109), Geothermal (43), and Bio (33)

- Renewable power accounted for 3.7% of total power generation, and waste-to-energy and hydro power made up 80% of total renewable energy generation.

◎ Industry: The renewable energy industry has shown strong growth with exports increasing 2.6 times and private investment increasing 2.4 times over the previous four years.

[ Indicators for the Renewable Energy Industry (2008~2011) ]

| Indicator | 2008 | 2009 | 2010 | 2011 | CAGR |
|---|---|---|---|---|---|
| No. of companies | 136 | 193 | 212 | 224 | 18.1% |
| No. of employees | 6,700 | 10,395 | 13,651 | 14,563 | 29.5% |
| Sales (billion won) | 3,370 | 4,749 | 8,078 | 9,854 | 43.0% |
| Exports (million dollar) | 1,957 | 2,424 | 4,536 | 5,105 | 37.7% |
| Exports / Sales | 62.0% | 54.5% | 59.9% | 55.3% | |
| Investment (billion won) | 1,955 | 2,993 | 3,549 | 4,674 | 33.7% |

* The numbers of companies and employees are the figures at the time of the survey. Sales, exports and investments are the net figures of each year.

◎ R&D: In the five years from 2008 to 2012, annual average R&D investment was about 400 billion won, representing 89% of planned R&D investment in this field.

- More than 70% of total funding was allocated to three main energy sources, solar PV (32.2%), fuel cell (21.9%), and wind power (16.4%).

## B. Evaluation

◎ Deployment: The share of the total primary energy supply from renewable energy reached 2.75% in 2011, which is 85% of the target (3.24%). However, the gap between the actual and target numbers has been rising.

* Actual deployment against the target: 94% (2008) →92% (2009) →88% (2010) →85% (2011)

[ Evaluation of Domestic Conditions for Renewable Energy Deployment ]

| | |
|---|---|
| **Wind** | · Installation is difficult because of environmental and location regulations and other factors. |
| **Offshore** | · Tidal power and tidal current power may have an impact on mudflats and fishing. |
| **Hydro** | · The construction of large-scale dams faces difficulties due to environmental concerns and opposition from local residents, and the amount of power generated is decreasing. |
| **Bio** | · A high import dependence and low prices due to fierce competition are limiting deployment in Korea. |

◎ Industry: It is difficult for renewable energy to compete in the market due to low price competitiveness and technological limitations.

- External factors: Oversupply in the global market, intensified competition due to falling prices, as well as a low distribution rate
- Internal factors: Location regulations and low public acceptance have resulted in a low deployment rate, limiting the size of the domestic market.

◎ R&D: The localization of core technologies in Korea has been low. Moreover, the link between technology commercialization and investment is weak due to the absence of technology commercialization programs.

* The average import rate of main parts, materials and equipment (2011): Solar PV 79%, wind power 85%, and fuel cells 91%

- Inefficiencies, such as a disconnect from mid- to long-term investment, have arisen due to a lack of consideration for technology commercialization and separate budget allocation for different programs and energy sources.

◎ Policy environment: The policy environment is unfavorable due to low electricity rates, insufficient financial support, etc.

- Electricity rates are consistently low compared to generation costs, leading to increased consumption of fossil fuels and undermining the deployment of renewable energy.

◎ Low public acceptance: Although the necessity of renewable energy is widely recognized, opposition to high electricity rates, poor follow-up management of facilities, complaints from residents, and insufficient promotion efforts have led to low public acceptance.

## C. Mid- to Long-term (2035) Renewable Energy Deployment Targets

◎ Deployment targets are based on supply potential, which is estimated through consideration of various factors, including economic feasibility, location regulations, and deployment conditions.

**Estimating the potential supply of renewable energy**

① Upgrade the existing resource map by improving accuracy and reliability

② Estimates are based on the following steps, using the resource map:
(1) theoretical potential → (2) geographical potential → (3) technological potential

(1) The total amount of energy resources in the country (e.g., insolation in the case of solar energy)

(2) The amount in consideration of geographical conditions for locating facilities (e.g., not including railways, roads)

(3) The energy generation amount at the current technological level (e.g., solar PV efficiency of 16%)

③ Estimate supply potential by adjusting technological potential to take account of location regulations and economic feasibility

◎ Despite relatively poor conditions for renewable energy deployment, the 2035 deployment rate target has been set at 11% in the interest of energy security, greenhouse gas reduction, and other considerations.

[ Deployment Target for Renewable Energy as a Share of Primary Energy (%) ]

| Year | 2020 | 2025 | 2035 |
|---|---|---|---|
| Proportion | 5.2% | 7.5% | 11% |

- While the shares of waste-to-energy and bioenergy are expected to fall, solar PV and wind power are anticipated to offset this fall.

* Energy source shares in 2035: Waste-to-energy (29.2%) → wind power (18.2%) → bioenergy (17.9%) → solar PV (14.1%)

[ Deployment Target as a Share of Primary Energy by Source (%) ]

| Energy source | Solar PV | Solar | Wind | Geo-thermal | Waste-to-energy | Bio | Hydro | Offshore |
|---|---|---|---|---|---|---|---|---|
| 2020 | 11.1 | 1.4 | 11.3 | 2.5 | 47.3 | 17.6 | 6.3 | 2.4 |
| 2025 | 13.3 | 3.9 | 12.5 | 4.6 | 40.2 | 19.6 | 4.3 | 1.6 |
| 2035 | 14.1 | 7.9 | 18.2 | 8.5 | 29.2 | 17.9 | 2.9 | 1.3 |

## D. Deployment and Commercialization Plans

### ① Creating New Markets and Converging Related Systems

◎ Renewable Heat Obligation (RHO): Adopt the RHO, which requires new buildings to use a certain share of heat energy from renewable sources

- First, require new buildings with more than 10,000㎡ in total floor space, except for residential and public buildings, to meet 10% of their heat energy demand with renewable sources

◎ Renewable Fuel Standard (RFS): Introduce the RFS, which requires transportation fuel to contain a minimum volume of renewable fuel

- Initially, the RFS will be applied to biodiesel. Subsequently, a decision on whether to apply the RFS to bioethanol and biogas will be made in consideration of various factors, such as domestic supply and demand of raw materials, technology, and infrastructure.

◎ Recommendation to heavy power consumers: Advise heavy power consumers to install their own renewable energy generators. A decision on whether to make such installation mandatory will be based on the results of such installations.

- Review targets for the recommendation as well as required installed capacities of renewable energy by business type and size. Additionally, create incentive programs, such as a program linked to the GHG emission reduction

◎ Establishment of an integrated market: Integrate the renewable energy certificates (REC) markets for power, heat energy and transportation fuel to provide obligated entities with flexibility in terms of implementation and to expand the size of market

- Link not only to renewable energy related programs, such as RPS (power), RHO (heat energy) and RFS (transportation fuel), but also to other energy programs, including the Greenhouse Gas and Energy Target Scheme and the Emissions Trading Scheme

### ② Improving Existing Systems for Further Deployment and Enhancement

#### Reorganizing the Renewable Portfolio Standard (RPS)

◎ Integration of the solar PV and non-solar PV markets: Integrate the solar PV market into the broader market from 2016 in order to give more options to power generators, increase flexibility, etc.

* An independent market for solar PV has been created for the first four years (2012-2015) out of concern that deployment will be slow due to low economic feasibility. However, this has led to limited investment in solar PV.

◎ Inclusion of new renewable energy sources in the RPS: Calculate the weight of the Renewable Energy Certificate for bioenergy, waste-to-energy, geothermal energy, and other energy sources to include additional types of energy source to the RPS

◎ Promotion of distributed power generation: Allow private power generators (e.g., solar PV power generator rental), energy donations (to social welfare centers) and other relevant activities to be counted as implementation of renewable energy

### Improving deployment projects and loan programs

◎ Convergence: Revise deployment projects to take into account the entire local community, instead of a single home or building

◎ Focus on performance: Adopt a system that provides incentives later in proportion to the amount of energy actually generated, instead of one that only provides subsidies for the initial investment stage of the project

◎ Expansion of the rental business: Introduce a new business model in which customers pay rental fees and private power generators cover all costs, from the installation of generation facilities to customer service, without government subsidies

* This business model will gradually be applied to other energy sources, such as fuel cells.

◎ Reform of loan programs: Create loan programs for technology commercialization and decrease the size of loans for energy sources with economic feasibility

## ③ Support for Strategic Deployment and Export Competitiveness

### Improving the strategic use of renewable energy

◎ Support for areas with high potential for use: Expand renewable energy deployment to isolated islands heavily reliant on expensive fossil fuels, particularly diesel generators

- In order to improve public acceptance, provide incentives for plant construction projects with local participation in regions where opposition from local residents is likely

◎ Convergence of new technologies: Adjust the weight of the Renewable Energy Certificate upward when an ESS is established alongside wind power facilities. This may also be applied to other energy sources in the future.

- Allow ESSs installed in renewable energy facilities to be counted as renewable energy auxiliary facilities and provide incentives, such as subsidies, financial support, and tax credits, accordingly

### Increased support for exports

◎ Support for overseas projects: Provide package support for overseas projects, from the initial stage to installation, in order to encourage domestic companies to enter overseas markets

◎ Strategic entrance into foreign markets: Pursue a package-type export strategy that, for example, links renewable energy exports to overseas resource development rights, as well as participating in renewable energy projects when winning contracts for fossil fuel power plant

* Korea will participate in projects launched by developing countries seeking to introduce renewable energy systems. Possible projects include resource exploration, designing laws and institutions, and constructing infrastructure (standards and verification).

◎ Establishment of international standards: Establish the existing five domestic standards as international standards by 2014, and propose another five new standards by the end of 2014

## E. Promotion of Strategic Technology Development

### ① Strengthening Strategic R&D and Shifting to a Performance-centered Paradigm

◎ Expansion of R&D and creation of portfolios: Focus investment on renewable energy R&D until 2024. Investment should grow more than 5% annually.

- Produce a mid- to long-term investment strategy, including investment size and technology development priorities, in consideration of deployment targets, the mid- to long-term renewable energy mix, economic effects, etc.

◎ Market-leading program: Strategically reorganize the ongoing 9 programs into 5 pilot programs, including applied strategy and market-leading, to commercialize technologies and cut generation costs

- Establish four R&D strategies - low cost, technology commercialization, future technology, and testing - in order to quickly achieve grid parity and enhance technological competitiveness

### ② Establishing an R&D System Focused on Market and Deployment Outcomes

◎ R&D for deployment and better business planning: Create a virtuous cycle of R&D and deployment, in which R&D projects suitable for the deployment policy are discovered and pursued

- Identify more commercial R&D projects that have a high potential for commercialization and develop R&D projects that go beyond convergence of different energy sources to include different fields

◎ Launch of new programs: Launch new R&D programs aimed at reducing generation costs in order to secure competitiveness. In addition, diversify energy sources, such as geothermal, solar, and offshore energies, through technology development.

- Invest in future technologies to secure core technologies with the target of commercialization within 10 years

## 3. Enhancement of the Global Energy Cooperative System

■ Faced with an extremely high energy import dependence, Korea should pursue strategic multilateral energy cooperation in order to enhance security by securing stable energy sources, etc.

### A. Need for International Cooperation

◎ Global interdependence: Global issues have arisen that no single country can solve, such as price volatility, the development of unconventional energy sources and climate change.

◎ Energy security: Korea imports 96% of the energy it consumes. Northeast Asia can be called an "energy island" because of its geographical isolation.

◎ Enhancement of international status: Korea should exercise leadership in the international community as a country which has achieved rapid economic growth and built infrastructure for this growth through the "efficient economic growth model".

## B. Direction for Implementation by Region

◎ North America: Expand trade with North America, which is expected to lead changes in the global energy market because of its increased production of unconventional resources

- Secure advanced technology by conducting human exchange programs and joint research on future convergence technology, such as energy efficiency and smart grid

### Key Facts about the U.S.-Korea Clean Energy Technology Partnership

- Signing parties: (Korea) Ministry of Trade, Industry and Energy - (US) Department of Energy (concluded in October 2011)
- Collaboration format: Bilateral joint R&D and demonstration projects, human exchange programs, equipment exchange, etc.
- Research areas: Energy storage, smart grid, green transportation, carbon capture and storage (CCS), energy efficiency, renewable energy, etc.

◎ Asia: Establish a consultative body to discuss possible cooperation on various issues, including power grid interconnection, expansion of the gas trade, removal of the Asian premium on LNG, and the establishment of an oil hub.

* Five-country Energy Ministerial Meetings – Korea, China, Japan, the U.S., and India - have been temporarily suspended since 2010.

- Pursue a project connecting the grids of South Korea, North Korea and Russia, a project linking Korean railway with the trans-Siberian railway, and other cooperative projects in order to prepare for changes in inter-Korean relations

### Plan for East Asia Power Grid Interconnection

▪ Overview: Transmit power generated at low cost with Russia's abundant resources to South Korea by way of a transmission line to be built in North Korea

| Country | Conditions for Implementation |
|---|---|
| Russia | Determined to boost the economy of the Far East and to increase its national influence through hydropower development and electricity export |
| North Korea | Willing to provide labor for the large-scale transmission line construction project in return for transit fees |
| South Korea | Interested in making efficient use of power generating facilities and an opportunity to improve inter-Korean relations |

- Direction: Carry out joint study led by the Korean and Russian private sectors on the feasibility of the project, including the technological and economic feasibility

  - If the joint research concludes that the project will profitable and overall conditions for the project, including inter-Korean relations, improve, the project should be considered as a prospective mid- to long-term governmental project.

[ South Korea-North Korea-Russia Grid Interconnection Plan ]

▶ **Plan 1: South Korea-North Korea-Russia single HVDC link**
- Construction of 3-5 GW HVDC overhead transmission line
- Construction of a 1,000 km long transmission line and two converter stations

▶ **Plan 2: South Korea-North Korea-Russia HVDC and North Korean power supply**
- 2-5 GW HVDC and power grid within North Korea
- Construction of a 1,200 km long transmission line and four converter stations


◎ Europe: Collaborate on clean energy technology, including energy efficiency improvement, share policy information, and discover opportunities to gain an early foothold in the market created by the expansion of renewable energy

* The U.K. has announced plans to create 45 GW offshore wind farms by 2020 and become a European offshore wind power hub that supplies 25% of the power it generates to European countries (Currently, 11 farms generate 1.3 GW).

- Share policies on managing energy demand and deploying low-carbon power sources, such as the Emissions Trading Scheme, carbon tax and energy tax systems, and green-pricing

◎ Africa/Latin America: Pursue comprehensive economic and energy cooperation which meets the demand for economic growth and improves the national image through ODA

- Encourage active investment in emerging economies amid rising uncertainty surrounding resource development, such as intensifying resource nationalism and increased environmental regulations

- Establish bilateral or multilateral channels for regular consultation, and promote technology transfer and training in the energy industry and demand management sector, which drive economic growth

◎ North Korea: Lay a foundation for energy cooperation to prepare for changes in inter-Korean relations in the mid- to long-term

- If North-South relations improve, review the potential formation of a coal development complex* in Nampo and the designation of a special zone for resource development in Dancheon to take advantage of North Korea's rich coal and mineral deposits

  * Northern Pyeongan Coalfield will be developed to secure generation fuel, and the power grid will be designed in tandem with the North-South economic cooperation project under contemplation.

## C. Establishment of Governance for Energy Cooperation in Northeast Asia

◎ Necessity: Establish a cooperative system for the mutual benefit of Northeast Asia to respond to rapidly-changing global market conditions

◎ Major issues: Discuss cooperation on nuclear safety, the resolution of the Asian premium issue for oil and gas, the interconnection of Northeast Asian energy transmission networks, the commercial use of the Arctic Sea Route, etc.

◎ Channel to discuss energy cooperation: Create a system for energy cooperation in Northeast Asia with the participation of six ministers from South Korea, North Korea, China, Japan, Russia and Mongolia

- Reorganize the current "Intergovernmental Collaborative Mechanism on Energy Cooperation in Northeast Asia" (Korea, Russia and Mongolia, director-general level) to play a larger role, or build a new channel for this purpose

### Intergovernmental Collaborative Mechanism on Energy Cooperation in Northeast Asia (Since 2005)

- Members: Four members: South Korea, Russia, Mongolia and North Korea, which stopped attending after 2008. China and Japan are observers, and the UN ESCAP is temporarily serving as an interim secretariat.
- Function: To discuss energy cooperative projects in Northeast Asia and build an information network

  * Information exchange: Public-private policy dialogue, workshops between the following parties: Korea-Mongolia, Korea-Russia, and Korea-China research institutes
  Joint research: National Report (2007), Mid- to Long-term Energy Demand Forecast (2007), Five-Year Development Strategy (2009)
  Training: Training programs to raise the energy policy capability of developing countries (2006 and 2007)

◎ Funding: Funds are needed to conduct joint research on new projects and organize meetings (e.g., the launch of foundations and collection of contributions)

- A comprehensive fund, such as the Northeast Asian Development Bank currently under discussion, may be used, or the establishment of a fund dedicated to energy cooperation may be considered.

SECOND ENERGY MASTER PLAN

# CHAPTER V

## - Six Major Tasks - 5. Establishment of a Stable Source-by-Source Supply System

# 1. Oil

## A. Supply and Demand Forecast

◎ Global supply and demand forecast: Short-term supply and demand is expected to improve, and mid- to long-term supply and demand is expected to remain stable.

- In the short term, global economic growth will slow, while supply and demand will be in balance due to increased production by non-OECD countries.

  - The increase in non-OECD countries' supply will be led by the production of unconventional oil in North America, including the U.S. and Canada.

- In the mid- to long-term, global oil demand is estimated to grow by approximately 0.9% a year, reaching 109.4 million b/d by 2035 (assuming an average annual economic growth rate of 3.0%).

  - The production capacity of OPEC members and the supply of unconventional oil, such as oil sand, from non-OPEC members are expected to increase, providing enough supply to consistently meet demand.

◎ Forecast for domestic supply and demand: The supply-demand balance is expected to remain stable in the mid- to long-term.

- In the short-term, an increase in the use of feedstock, such as naptha, for industrial purposes and an increase in demand from the transportation sector will result in modest growth of about 1.1% in 2014 despite the downward trend in demand for oil for heating and power generation.

  - Global oil prices and domestic demand will increase slowly, making it possible to secure a stable supply.

- In the mid- to long-term, due to a continuous decrease in demand from non-transport sectors, total demand is estimated to fall from 2020 at an average annual rate of 0.15% to approximately 773.9 million barrels by 2035.

  * Oil dependency: 52.0% (2000) → 38.1% (2011) → 34.1% (2020) → 26.9% (2035)

  - Thanks to active overseas resource development and an increased rate of refinery upgrading, the capacity to supply oil products will improve in the long-term. However, decreased demand is expected to result in oversupply.

## B. Direction

### ① Stable Supply

#### Stable supply of oil

◎ Diversify import sources to reduce dependence on Middle Eastern oil, reduce premiums and other disadvantages, and contribute to supply stability

#### Enhancement of crisis management capability

◎ Enhance capability to flexibly respond to shifts in the oil stockpiling paradigm

- Draft a new Oil Stockpiling Plan that reflects the increasing risk of oil price surges due to supply instability in the global oil market

  * Oil Stockpiling Plan: The 1st Plan (1980-1989), 2nd Plan (1990-2003), and 3rd Plan (1995-2010) have been completed. The 4th Plan is currently being prepared

◎ Continue to pursue an international joint stockpiling project with governments of oil producing countries, international traders, etc.

- Conduct an indirect stockpiling project, in which KNOC's oil storage facilities are leased to oil producing nations and others, in order to store crude oil and oil products in Korea (Secure priority to purchase stored oil in case of emergency, etc.)

#### Stronger international cooperation

◎ Expand cooperation with major oil-producing countries to secure stable oil import channels

- Form an international cooperative system to conduct national projects, such as an international joint stockpiling project and an oil hub construction project

  * Seek to host the World Petroleum Congress organized by the World Petroleum Council and IEF Ministerial Meetings

### ② Improving the Industrial structure

#### Establishment of a Northeast Asian oil hub

◎ Establish a Northeast Asian oil hub to integrate the energy industry with service industries, such as logistics, processing, finance, and trading

- Construct infrastructure for oil logistics, provide incentives to encourage trading, and establish financial infrastructure

## Promotion of competition in the oil distribution market

◎ Promote competition using market forces by invigorating the spot market for oil (e-commerce) through successful oil distribution policies

- Secure an adequate supply for the spot market through supply by non-refineries, such as import and e-commerce involving four major oil refineries, etc.; formulate measures to meet demand for oil through economical gas stations[2], the sale of mixed oil, etc.
- Once competition in the market is sufficiently stimulated, help level the playing field by encouraging the development of a system of free competition among market players

## Improvement of oil quality management

◎ Establishment of a crackdown system: Form a system to conduct regular joint crackdowns and monitoring by relevant agencies until the sale of adulterated gasoline is eliminated

* Crackdown on the illegal distribution of solvents, from the supply stage to the end-user purchase stage, to prevent such solvents from being used as ingredients in adulterated gasoline

◎ Computerized system for reporting supply and demand: Computerize the system for reporting supply and demand and trading conditions for oil products in order to catch signs of illegal distribution at an early stage.

2) A type of gas station where consumers can buy oil at a cheaper price. KNOC supplies oil to these gas stations by purchasing oil in large quantities.

## 2. Gas

### A. Supply and Demand Forecast

◎ Global supply and demand: The Asian market is expected to lead the increase in demand for natural gas, and the supply of natural gas is expected to grow as the development of unconventional gas in North America picks up pace.

- From 2010 to 2035, global demand for natural gas will show the largest increase among primary energy sources backed by rising demand from emerging economies, such as China, India, and Brazil.

  * Forecast for global demand for natural gas (billion tons, IEA): 2.7 (in 2011) → 3.2 (in 2020) → 4.0 (in 2035)

    - China (million tons): 105 (in 2011) → 245 (in 2020) → 422 (in 2035) (Annual growth rate of 6.0%)
    - India (million tons): 49 (in 2011) → 69 (in 2020) → 137 (in 2035) (Annual growth rate of 4.4%)
    - Brazil (million tons): 22 (in 2011) → 36 (in 2020) → 72 (in 2035) (Annual growth rate of 5.2%)

- The increase in the unconventional gas supply from North America will lead to an increased supply of natural gas in the global market, contributing to diversifying the global supply, which has been disproportionately concentrated in the Middle East and Russia, and alleviating the price gap between regions.

  * Global natural gas production (billion tons) (the proportion of unconventional gas): (2011) 2.7 (17%)→ (2020) 3.2 (21%)→ (2035) 4.0 (27%)

- Global demand for LPG will grow gradually, driven especially by LPG for petrochemical feedstock and domestic and commercial LPG.

  * Global LPG demand forecast (mb/d, IEA): 7.6 (2012) → 8.6 (2020) → 9.2 (2035) (Annual growth rate of 0.8%)

◎ Domestic supply and demand: Domestic demand for natural gas has steadily increased at an annual rate of 7.9% over the past 10 years due to expanded deployment of city gas and increased demand for generation and industrial use.

  * Domestic natural gas demand (million tons): 18.45 (2003) → 23.50 (2006) → 24.64 (2009) → 36.55 (2012)

- In the mid- to long-term, the industrial and transport sectors will drive the increase in demand, while demand from the power generation sector will depend on GHG emission reduction targets, base load power reserve ratios, etc.

- The reserve ratio (storage capacity/annual demand), which is around 11% on average, must be continually increased to ensure a stable supply of natural gas in the domestic market

* As of 2012, the top-down ratio (largest monthly usage / smallest monthly usage) is 2.6, indicating a significant seasonal demand gap.

## B. Direction

### ① Stable Supply

#### Stable supply of oil

◎ In response to changes in the global gas market, such as the expansion of shale gas development, diversify natural gas and LPG import sources, and secure a stable and sufficient supply of gas

* Shale-based LNG from North America is planned to be imported to Korea from 2017 and LNG from 2014.

◎ Alleviate price risks related to oil price changes and enhance capability to develop and supply energy independently by linking gas field development, the construction and operation of liquefaction plants, and market deployment

* As of December 2013, KOGAS was involved in 7 LNG projects, including LNG Canada.

◎ Enhance the foundation for international cooperation by strengthening cooperation between large gas importers in Asia, establishing consultative mechanisms with major energy producing countries, etc.

* Asia: Regularly hold Korea-Japan and Korea-China Gas Dialogues to enable collective action in response to major issues

  North America: Expand cooperation in the unconventional gas sector through the Canada-Korea Natural Gas Forum, Korea-U.S. workshops, etc.

◎ Diversify city gas supplies by establishing an institutional foundation to produce and deploy city gas other than biogas and other non-natural gases

#### Timely expansion of supply infrastructure

◎ Expand LNG storage facilities in a timely manner in order to better respond to the high winter/low summer consumption pattern and ensure stable supply and demand in the mid- to long-term

* Secure an additional storage capacity of 3.21 million ㎘ (or 1.46 million tons) by 2018, backed by the completion of the Samcheok plant (2014), the construction of additional facilities in District 4 of the Incheon plant (2018), etc.

- Lower the financial burden on the public sector through private sector investment in storage facilities, etc.

  * Encourage private sector investment in storage facilities (ton, as of Dec 2012): 230,000 (2013) → 500,000 (2017) (in total)

◎ Build additional main gas pipelines, along with new LNG plants, by 2017 to secure a timely supply of gas. In addition, construct gasification and transmission facilities and other supply infrastructure.

  * Main natural gas pipelines: 3,558km (2012) → 4,928km (2027)

  * Supply capacity of gasification and transmission facilities: 8,770 ton/hour (2012) → 14,099 ton/hour (2027)

## Ensuring stable supply and demand management

◎ Enhance the supply and demand management system and secure a sufficient supply of natural gas in advance in order to ensure a stable supply in the winter season when demand peaks

- Launch a task force* to manage natural gas supply and demand in the winter season every year and respond quickly** at each stage of an emergency (attention-caution-warning-critical).

  * The Ministry of Trade, Industry and Energy, KOGAS, Korea Power Exchange, Korea City Gas Association, etc.

  **Manage supply and demand, operate heavy oil or diesel standby generators, modify preventive maintenance plans, etc.

◎ Expand deployment of natural gas air conditioning, which is effective for load management and for addressing the high winter/low summer consumption pattern of natural gas; and develop technology that improves the efficiency of natural gas air conditioning

- Improve the economic feasibility of and create new demand for natural gas air conditioning by providing support for installation, lowering import tariffs on natural gas*, requiring installation in large buildings, etc.

  * A full refund for tariffs imposed on imported natural gas (24,242 won/ton) will be offered for 3 years from 2014 to 2016.

  * From 2014, develop technology to improve the efficiency of GHP engines and triple-effect absorption chillers

◎ Implement a stockpiling system from August 2016 to stabilize the supply and demand of natural gas

- Pursue strategic stockpiling to prepare for potential disruptions of the gas supply from demand surges caused by abnormal cold waves, conflicts in gas-producing countries, etc.

  * The size of the strategic stockpile should be determined based on analysis by research institutes of examples abroad

  * Examples of the strategic stockpiling abroad: (Spain) Equal to 20 days of winter season demand, (Poland) Equal to 30 days of imports

## Expanded deployment of city gas

◎ Strengthen the foundation of the city gas supply by expanding the main city gas pipeline, and promote the deployment of city gas through policy loans and other measures

- Increase the number of local governments providing city gas to 214 by 2017, and expand loan programs for projects to build pipelines in rural areas

  * Number of local governments with city gas (out of a total of 230 local governments in Korea): 186 (2012) → 207 (2015) → 214 (2017)

◎ Address the problem of a city gas blind spot in some regions by installing small LPG storage tanks and pipelines for people in energy poverty within those regions

  * Eligibility for support: (Social welfare centers) 360 centers (2013) → 720 centers (2014) (all)

    (Rural areas) 9 areas will receive support under the pilot program in 2014, and the program will be extended to more areas in the future.

## Improvement of price transparency and support for low income families

◎ Implement a pricing mechanism which links commodity prices to gas rates, reflecting factors that change the cost of gas ingredients. In addition, enhance the transparency and appropriateness of the pricing mechanism*

  * Improve existing measures to strengthen the cost verification system. For example, design criteria to classify regulatory and non-regulatory projects and create an obligation to prepare financial statements for pricing purposes. Additionally, revise the criteria for calculating the supply price of natural gas.

◎ Realize inclusive welfare by maintaining the city gas tariffs discount program for beneficiaries of the Basic Livelihood Program*, the disabled, etc.

  * As of December 2013, beneficiaries receive a discount of 12,400 won monthly, which is about 20% of their average monthly electricity costs.

◎ For customs and individual consumption taxes, maintain low tax rates on LPG in order to reverse the regressive effect of LPG-related taxes since LPG is the primary fuel of low-income families for cooking, heating, and transportation

### ② Improvement of the Industrial Structure

#### Rationalizing direct import regulations

◎ Rationalize regulations on direct import by the private sector in order to contain potential inefficiency** caused by the natural gas monopoly system* and decrease the LNG import unit price

* Korea is the only OECD member which maintains a monopoly system in the natural gas sector.

**In November 2012, the International Energy Agency recommended that Korea introduce competition into the wholesale gas market for the benefit of consumers and the overall Korean economy.

- Revise the Urban Gas Business Act to relax regulations on the sale and exchange of imports* to enable private-sector direct importers to manage supply and demand more efficiently

* Under current law, direct importers are allowed to sell directly-imported gas only to gas wholesalers or to exchange such gas with other direct importers or gas wholesalers.

#### Laying an institutional framework for the LNG trading business

◎ Given the high potential of the Northeast Asian LNG market* and the expected expansion of the shale gas supply**, an institutional framework should be laid for the private sector to enter the LNG trading business.

* Northeast Asia is the largest LNG market in the world, importing 60% of the world's LNG. The market is expected to enjoy continuous growth due to economic growth in China and increased gas generation in Japan.

**The full scale development and export of North American shale gas will bring an increased supply of LNG that is relatively cheap and has no restrictions on destination, thus making it easier to trade.

- Introduce an LNG import and export business system in which an LNG trading business makes use of LNG storage facilities within bonded areas in Korea (revision of the Urban Gas Business Act)

* Expected benefits include increased private sector investment in LNG terminals and job creation, increased tax revenue collected from profits generated in the trading business, and a large volume of gas imports in a short period of time

## 3. Power

### A. Stable Supply

◎ Enhancing the timely construction of power plants: Encourage the timely completion of power plants under construction and enhance the follow-up measures of power plant construction plans

- Encourage the completion of power plant construction on schedule with periodic process control and streamlined licensing procedures

◎ Building a system to regularize supply and demand: Minimize public inconvenience by expanding supply capacity as much as possible and taking systematic measures to reduce demand when unexpected supply disruptions occur

- In case of emergency, make full use of available generating resources to supply power, including power from private sector generators, standby generators of public agencies, and test-runs of generators in not-yet-completed power plants
- Transition from demand management that places direct restrictions on power consumption through regulations toward systematic, continuous demand management.

◎ Reinforcing a vulnerable power grid: Reinforce the power grid to contain damage in case of transmission line failure in regions where power plants are concentrated, such as the Seoul metropolitan area, and the western, southern, and eastern coastal areas.

- Increase the number of outgoing transmission lines for generated power, establish a plan to reinforce the back-up power system, and encourage the early completion of construction in order to improve the stability of the power grid

### B. Improvement of the Industrial Structure

#### Direction

◎ Target both stability and efficiency of power supply and demand, and maintain and enhance the power industry's role as a public utility in such aspects as network neutrality and protection of marginalized people in society

* The current power industry uses a cost-based pool system in which regulations and competition exist side-by-side.

◎ Create a new, ICT-based power service market to realize the creative economy, and shift the focus in power supply and demand system from supply management to demand management

### Plan

◎ Establish a Korean-style business model appropriate to the current status of the Korean power industry that gives comprehensive consideration to important changes in the power industry*.

* The Fukushima accident, climate change, decreased public acceptance of nuclear power and transmission and distribution facilities, etc.

- Find fundamental solutions through precise analysis and evaluation of the structure of the power industry, thorough discussion among industry experts, and a process to reach public consensus

◎ Enable demand reduction resources to be traded on the market by establishing an institutional framework, creating a variety of business models, and laying a foundation for commercialization

- Allow "smart-demand" resources to be traded on the market; provide ways for demand management companies in fields such as smart grid and ESS to participate in the power market, etc.

◎ Undertake fundamental, systematic reform to stabilize the price of power and avoid excessive price increases in the case of major supply disruptions

- Introduce vesting contracts to build a foundation for securing a stable electricity supply and stable electricity prices, and enhance the legal basis for Soft Cap Price

## 4. Integrated Energy

### A. Current Status

◎ Necessity of diffusion: Integrated energy is key to achieving green growth at home and abroad as it contributes greatly to efficient energy use and reducing GHG emissions.

* Energy efficiency of 26% and $CO_2$ emission reduction of 35.5% annually on average as a share of production of heat and electricity

* At the G8 summit in 2007, a declaration was adopted on significantly increasing the proportion of combined heat and power plants.

◎ Domestic market conditions: Despite favorable conditions for the integrated energy business*, the deployment rate of district heating is expected to remain low due to the poor development of residential land and other reasons.

* Korea has even better conditions for introducing an integrated energy supply system than many advanced European countries, including an appropriate number of heating degree days (annual heating hours) and a high heat density (a high concentration of multi-family residential buildings).

◎ Changes in surrounding conditions: The importance of combined heat and power (CHP) plants as a tool to expand distributed power generation is rising as transmission lines become saturated due to high electricity demand from the metropolitan area.

* Generation capacity shortage of approximately 7,000 MW for Seoul and 11,700 MW for Gyeonggi province

* Electricity shortage (consumption – production): Seoul (44,269 MWh), Gyeonggi province (71,923 MWh)

## B. Direction

### ① Enhancing Distributed Power Generation

◎ Expanding CHP in the Seoul metropolitan area: Encourage the replacement of aged CHP* facilities and the construction of large-scale facilities in suburbs of the capital

- CHP plants with a capacity of 4,435 MW will be built in the metropolitan area by 2020.

* Chuncheon POSCO E&C 422MW, Korea District Heating Corporation Hwaseong and Dongtan Ⅱ 840MW CHP plant construction

◎ Encouraging the construction of large-scale plants: Give priority to large areas with heat loads of at least 100 Gcal/h (or 100 MW) when selecting locations for new plants

- Increase the weight of financial and technological capabilities in the new plant selection process, as these are good indicators of business sustainability

- Reduce regulations on the ratio of heat to power and introduce efficiency standards when granting permission to build CHP plants

* The construction of large-scale CHP plants should be promoted by easing the ratio of heat to power.

### ② Supporting Market Transparency

◎ Reducing cost burdens, such as fuel prices: Make wholesale gas prices for CHP consistent with prices for power generation and grant exemptions from oil import tariffs

- Since an integrated energy company is classified as electricity generation company according to Article 7 of the Electric Utility Act, the wholesale price of gas should be the same for CHP and for power generation.
- To promote distributed power generation, offer a 3 year (2014-2016) refund of import tariffs (19.39won/m3) imposed on integrated energy supply, including community electricity

◎ Increasing the transparency of heating prices: Establish standards for accounting and calculating prices as well as a heating price verification system

- Establish by law accounting and cost calculating standards applicable to all market players and subject to external verification by a qualified institution
- Promote the development of affordable heat sources, energy conservation, and renewable energy investment by reforming the pricing system to provide incentives for demand side management, such as authorizing different levels of return on investment

### ③ Establishing a Basis for Sustainable Development

◎ Expanded deployment of district cooling: Improve the profit structure of district cooling by providing more subsidies for deployment, enhancing user convenience, promoting development of technology for district cooling devices, etc.

- As a follow-up to the R&D and demonstration project on desiccant cooling for multi-family residential buildings that was completed in October 2013, supply district cooling on a trial basis to new homes planned to be sold

◎ Enhancing the use of surplus heat and waste heat: Promote a shift to a low-cost structure by making better use of affordable heat, such as waste heat from industrial complexes

- Provide affordable heat to customers by improving the cost competitiveness of existing market players through the establishment of a heat network and comprehensive operation center for the Seoul metropolitan area

### ④ Protecting Consumer Rights

◎ Introduction of an alternative heat supply system: Introduce an alternative heat supply system to prevent companies from becoming insolvent, carry out response measures and minimize user inconvenience

- The financial status of companies will be thoroughly examined in advance, and the alternative heat supply system will come into effect if a financially unstable company becomes insolvent and stops supplying gas.
- Regulations for heat suppliers will be revised and MOUs will be concluded between companies on a voluntary basis to strengthen the responsibility of companies and rights of consumers in case of heat supply failures.

◎ Implementation of an integrated welfare system: Consider measures to integrate the different welfare systems of companies and revise heat prices to reflect welfare costs

◎ Encouragement of public involvement: Encourage public participation by making it mandatory to collect opinions of residents when considering a permit for a heat source that exceeds the predetermined level

- Mandate that companies hold public hearings and information sessions when soliciting the opinions of local governments

# CHAPTER V

## - Six Major Tasks - 6. Energy Policy Reflecting Public Opinion

## 1. Reform of the Energy Welfare System

■ Address blind spots of the energy welfare system and shift towards a welfare system customized to fit the needs and consumption patterns of recipients

### A. Current Status

◎ In 2005, a middle school student whose family's power had been cut died in a fire started by a candle. Following her death, the Korea Energy Foundation was launched in 2006, and the government began full scale efforts to create a legal basis for energy welfare, including the Energy Act in 2006.

- The First Energy Master Plan set a goal of reducing the number of energy poor to zero by 2030.

◎ An annual average of 3 million households received energy support totaling 1.8 trillion won during the last 5 years from 2008 to 2012.

- More funds were made available for energy welfare by increasing the budget of the Energy Efficiency Improvement Project and beginning the heating oil provision program in 2012. Moreover, the electricity tariff system was revised from a fixed rate system to a flat rate system in order to better serve low-income families.

① Facilities and products: Distribute renewable energy and improve efficiency by replacing obsolete boilers, installing insulation in homes, renovating doors and windows, etc.

* Energy Efficiency Improvement Project: 19.5 billion won in 2011 → 31.1 billion won in 2012 (to be confirmed)

② Heating bills: Provide heating oil (18,000 households, kerosene 200 l) and coal briquette coupons (83,000 households, 169,000 won)

③ Discounts on utilities: Provide discounts on electricity (8,000 won), gas (123.5 won/㎥) and heating costs (exemption from basic charges)

④ Grace period: Postpone service cuts in case of overdue electricity and gas bills

⑤ Energy safety: Provide emergency measures for the marginalized in case of power failure, improve the safety of gas facilities, etc.

◎ Continued high oil prices have driven up overall energy prices, resulting in an increased number of energy poor*.

* The term "energy poor" refers to households that spend more than 10% of their income on lighting and heating. The number of energy poor households has risen from 1.2 million in 2008 to 1.78 million in 2011 (estimated).

## B. Problems

### Blind spots in energy welfare support

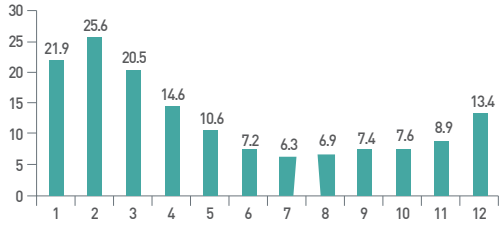
◎ Low-income families that are not eligible for the Basic Livelihood Program, including those in the second lowest income bracket*, face difficulties similar to those of the Basic Livelihood Program beneficiaries, such as limited access to electricity and heating. However, they receive relatively inadequate support.

* A family whose income is under 120% of the minimum cost of living and is ineligible for the program.

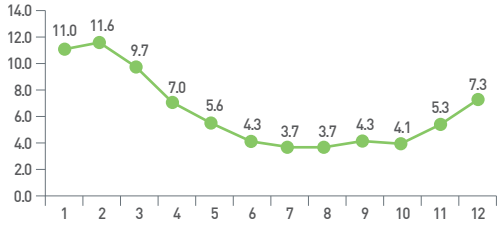
### Uniform method of calculating heating and lighting expenditures

◎ During the winter, average energy spending more than doubles, and the proportion of families living in energy poverty rises significantly (8.9% in November → 26% in February).

[ Share of Energy Poor by Month % ]




[ Monthly Fuel Costs of Families in the Bottom Income Decile (ten thousand won) ]




### Unbalanced welfare support across energy sources

◎ Although expensive energy sources, such as kerosene and LPG, make up a large share* of the energy use of low income families, such families are often ineligible for discount programs.

* The primary heating fuel of the energy poor: gas (45%), kerosene (36%), central heating (7.5%), etc.

[ Share of Low-Income Households That Have Received a Discount on Electricity and City Gas Bills ]

| Electricity Only | Gas Only | Both | (Total) | Excluded From Discounts |
|---|---|---|---|---|
| 35.2% | 5.1% | 31.2% | 71.6% | 28.4% |

◎ Because the support system is centered around network energy sources, such as gas and electricity, it has brought more benefits to homes with higher heating efficiency.

## C. Direction

### Vision

- Establish a tailored welfare system which links together the Energy Voucher Program, energy bill discount programs and energy efficiency programs.

### Policy objective

| Introduce an integrated, tailored welfare system | Reduce energy costs | Expand welfare infrastructure |
|---|---|---|
| Introduce an Energy Voucher Program | Expand the Energy Efficiency Improvement Project | Survey the living conditions of the energy poor / Create a database and enhance promotion activities |

| | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|
| Number of energy poor (unit: ten thousand households) | 85 | 50 | 40 | 40 |
| Support for efficiency improvement (unit: ten thousand households, cumulative) | 34 | 41 | 48 | 55 |
| Increased welfare budget (unit: hundred million won) | 1,361 | 3,382 | 3,450 | 3,520 |

## Introduction of an Energy Voucher Program

◎ Direction: Devise and support an integrated payment method for energy purchases by integrating various sporadic energy assistance programs

- Practical support: Provide practical subsidies in consideration of actual energy consumption patterns

  * Take into account various factors, including seasonal needs and the presence of disadvantaged family members

- Consideration of seasonal factors: Subsidize the energy spending of low-income families during times of cold weather

- Minimization of blind spots: Strengthen support for low-income families ineligible for the Basic Livelihood Program, including those in the second lowest income bracket

◎ Support plan: Introduce an Energy Voucher Program, which enables the purchase of various types of energy, including electricity, gas and kerosene, in order to ease the energy burden on low-income families during the winter season

  * Eligibility will include all Basic Livelihood Program beneficiaries as well as the disabled, the elderly and families with young children in the second lowest income bracket.

## Revision of the Energy Efficiency Improvement Project

◎ Energy welfare analysis project: Launch an energy welfare analysis project using expert analysis based on on-site inspection of the status of households or agencies currently receiving energy assistance

  * An analysis team will be formed under the Korea Energy Foundation to provide advice on aspects that need improvement and design support plans.

◎ Support for improving efficiency: Based on the results of consultations, produce an optimal mix of energy infrastructure for each household and provide support packages for replacing lighting, insulation, boilers, etc.

  * Under the present system, support for improving lighting, insulation, and boilers is provided separately by different agencies.

## Expansion of energy welfare infrastructure

◎ Creating an energy welfare database: Collect district-by-district information from welfare recipients on energy sources in use, usage amount, and dwelling type, and establish a

management system linked to the Social Welfare Information System on the basis of this information

* An integrated database which provides comprehensive data and analysis of each agency's recipient information will be established.

◎ Establishing an agency dedicated to energy welfare: Provide a legal basis for an agency dedicated to energy welfare

* New provisions recognizing energy welfare as a basic human right should be added to relevant laws when they are revised.

◎ Promoting public participation: Build a stronger foundation for energy welfare and expand social monitoring of project implementation through energy welfare projects in which the general public* can participate

* A program which links energy conservation to the welfare system should be implemented. Under this program, a person who has surplus energy from reducing energy consumption will be able to select eligible entities (households or facilities) to which he/she may donate, and he/she will be able to follow how the donated energy is being used.

## 2. Expansion of Local Government Participation

■ Improve the efficiency of policy implementation by establishing regional energy governance in which local governments, which have direct contact with the public and businesses, play a leading role

■ Delegate the planning and implementation of energy projects to local governments in order to reflect local needs and conditions

### A. Progress

◎ Regional energy projects have been implemented since the mid-1990s. The deployment of renewable energy has been carried out on the supply side, while energy-efficient device deployment projects have been carried out on the demand side.

• Supply: The regional energy self-sufficiency rate has been improved through renewable energy deployment projects.

* Financial support: The total amount of support increased from 120 million won in 1996 to 721.6 billion won in 2013.

- Demand management: Deployment of LED lighting and other energy-efficient products was mainly led by public agencies. By late 2012, the deployment rate of LED in the public sector was estimated to be approximately 15.5%.

  * Financial support: The total amount of financial support for demand management increased from 880 million won in 1996 to 238.1 billion won in 2013.

## B. Limitations

◎ Governance: There is insufficient organization, manpower, legal institutions and other infrastructure needed for policy implementation.

- Only approximately 10% of local governments have a well-established implementation system, such as the Basic Energy Ordinance (28 out of 230 local governments).
- The implementation of energy policies is assigned to a number of different teams, including construction, industry, transportation, climate change and environment teams. Moreover, the role of the private-public National Energy Committee* is limited.

  * The National Energy Committee consists of and is run by local governments, local assemblies, research institutes, civil groups, and other participants to advise, deliberate on and coordinate energy policy in accordance with the Basic Energy Ordinance.

◎ Policy Design: Local governments have not been able to fully participate in the central government's policy-making process, meaning that the division of roles between the central and local governments and coordination across policies have been insufficient*.

  * The Regional Energy Plan and the Energy Master Plan, which are required by law, are not coordinated with each other. In addition, since most of the authority for carrying out the plans belongs to the central government, local governments lack policy tools.

- Although local governments are obliged to annually set out Action Plans for Energy Use Rationalization, such Action Plans are rarely implemented and are carried out only at the public agency level.

◎ Project implementation: For energy conservation projects, a high reliance on central government subsidies has resulted in decreased project development efforts as the share of government support fell from 70-100% to 50%.

  * The amount of subsidies applied for by local governments (in billion won): 194.7 (2011) → 194.1 (2012) → 122.5 (2013) → 95.6 (2014)

- Policies and programs planned by local governments are too few and tend to be short-term, yearly plans whose purpose and size change every year.

- For renewable energy deployment projects, insufficient consideration has been given to the different characteristics of each region and energy source. As a result, the majority of such projects have been concentrated in solar PV, which is easy to install.

  * Solar PV projects received 70.4% of regional renewable energy deployment program funds.

## C. Main Tasks

### ① Establishment of Regional Energy Governance

◎ Enhancing the legal basis: Encourage lower-level local governments to establish their own Regional Energy Ordinances and promote the implementation of policies which can improve the effectiveness of such Ordinances

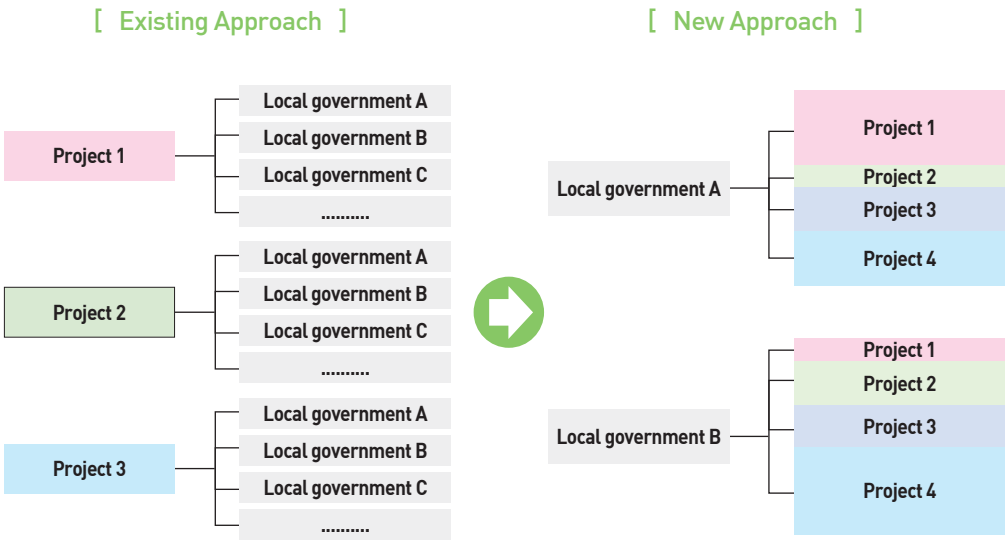
- Upper-level local governments should hold regular Energy Committee meetings, and lower-level local governments should create Committees on Energy Conservation Practices and focus on specific demand management efforts.

  ■ Energy Committee: Responsible for the development and evaluation of basic energy management policies, deliberation on Regional Energy Plans, preparation of private-public cooperation measures, deliberation on restrictions imposed on the energy consumption of facilities and individuals, etc.

  ■ Committee on Energy Conservation Practices: Responsible for discussion of measures to promote energy conservation practices, evaluation of energy conservation policies and performance, development and assessment of alternative energy projects, including solar PV and geothermal, etc.

◎ Strengthening the role of policy: Design Regional Energy Plans which reflect regional conditions and priorities

- Guarantee the autonomy of local governments by replacing the existing approach, in which individual energy projects are assigned to local governments, with a new approach, in which each local government forms its own energy project portfolio




- Set policy objectives for each project and thoroughly evaluate policy outcomes so that the results can be reflected in the following year's budget

| Deployment of distributed generation | Demand management | Energy welfare |
|---|---|---|
| •Deployment targets for renewable energy, integrated energy, ESS, etc.<br>•Energy self-sufficiency targets | •Targets for energy demand and GHG emission reduction<br>•Sectoral targets for the deployment of environmentally-friendly vehicles, LEDs, etc. | •Target for reducing the number of energy poor |

**The central government advises and coordinates the regional energy project plans of each local government, and the Energy Committee confirms the Regional Energy plans.**

### ② Improvement of the Effectiveness of Regional Energy Projects

◎ Energy Efficiency Improvement Project: Shift eligibility for support from facility replacement projects to systematic projects* in order to improve the effectiveness of regional energy conservation projects

* Priority will be placed on supporting generation and heat supply facilities using waste heat from incinerators, cooling and heating systems using treated wastewater or sea water, EMSs of buildings and factories, etc.

- Local governments should implement projects to replace high-energy-consuming products with energy-efficient products that have high economic feasibility using ESCO, project financing, and policy loans.

◎ Renewable energy: Create local government-led Renewable Energy Towns in consortium with local governments, citizens, research institutes, etc.

* Consortium: Project plan design, installation, and maintenance

Government: Project selection, monitoring, etc.

### ③ Establishment of a Foundation for Regional Energy Policy

◎ Infrastructure: Create a system that supports energy statistics and demand management programs* of local governments

* A support system includes the following: analysis and projection of changes in energy consumption patterns, energy conservation effects of each demand management program, economic feasibility assessments, monitoring of policy impacts, etc.

◎ Promotion of public participation: Use private-public partnerships to establish a governance structure focused on sector-specific demand management ranging from households to buildings and transportation

- Set energy reduction targets based on detailed data at the local government and community levels, assign roles to major players, and develop programs.

**Examples of regional energy project implementation that involves the public**

- Establish energy conservation targets and detailed plans for implementation based on apartment building-specific surveys of power usage, number of households, and number of residents per household
- In carrying out the Energy Efficiency Improvement Project for residential buildings, establish a governance system for each topic and issue. For example, forge a partnership that consists of residents, construction companies, assessment companies, and civic groups.

## 3. Proactive Response to Energy Related Conflicts

■ Shift priority from reacting to conflicts, including settlement and mediation, to proactive response, such as prevention

### A. Direction

#### Establishment of conflict control principles

◎ Analyze cases which occur repeatedly and devise response measures in consideration of stakeholders, factors causing conflicts, past solutions, etc.

◎ Find optimal solutions by referring to overseas examples and the results of conflict resolution measures taken by conflict management experts, governments, public energy enterprises, etc.

- Address the root causes of conflicts by improving laws and institutions

#### Proactive response

◎ Identify factors that can trigger conflicts in advance and monitor such factors consistently, considering capital investment plans of public enterprises, past conflicts, values of residents, etc.

- Conduct impact analysis in advance for conflicts with potential to spread and, if necessary, introduce such conflicts to Conflict Management Committees as priority agenda

◎ For priority agenda items, set future plans based on the Conflict Management Manual and periodically examine and manage such plans

- Before implementing policies, minimize factors that can trigger conflicts by providing stakeholders, in particular, with opportunities to be involved in the policy-making process

  * An impartial conflict mediation council consisting of equal numbers of companies, people who filed civil complaints, and professional mediators will be launched.

- Develop compensation and support policies giving consideration to a variety of factors, including national financial conditions, general public acceptance, and damage caused to the region in question

## B. Examples of Planned Responses to Major Issues

### Construction of transmission lines

◎ Maximize the use of existing transmission lines and, in cases where building high-voltage transmission lines is unavoidable, take various measures to improve public acceptance

- Conduct conflict assessment for areas where construction is planned in order to develop measures for minimizing conflict with local residents in advance

  * Conflict assessment will be conducted for the Saemangeum transmission line construction project.

- Plan and carry out measures to provide reasonable compensation for falling property values near planned transmission lines

### Nuclear energy policy

◎ Organize a Steering Committee for each regional headquarters to decide issues related to local residents, such as regional support

  * Example: Heads of nuclear power plant headquarters, heads of Guns (or counties), Chairs of Gun assemblies, environmental watch groups, regional organizations, non-governmental experts, etc.

◎ When a major issue arises relating to nuclear power plants, hold a briefing session about the issue and facilitate information exchange with citizens with the help of non-governmental environmental watch groups. Moreover, promote resident participation in inspection and monitoring.

  * Information reported to regulatory authorities, information on planned preventive maintenance and failure/shutdown, relevant briefing sessions, frequent information sharing on nuclear power plant operations, etc.

◎ Promote resident participation in decisions on support projects in a nuclear plant area and shift to projects which provide high satisfaction to residents

  * Enhance the resident participation process when making decisions on electricity subsidies, medical services, training programs, etc.

# CHAPTER VI

## Future Plans

## 1. Short-term Measures

### 1. Enhancement of energy demand management

◎ Adjustment of relative energy price: Revise statues under the Individual Consumption Tax Act (first half of 2014)

◎ Electricity bill: Review proposals for revising various demand-management-type tariff systems (second half of 2014)

◎ Use of ICT: Create a new business model for the demand management industry using ICT, and provide a comprehensive support system for each industry, size and other standards (first quarter of 2014)

### 2. Implementation of energy mix follow-up measures

◎ Nuclear plant: Make necessary preparations to achieve a nuclear power installed capacity of around 43 GW, including securing land for plant construction

◎ Renewable energy: Gather and review opinions on the introduction of RFS and RHO, and form a task force for discussing methods to advise heavy energy consumers to install renewable energy facilities (first quarter of 2014)

### 3. Distributed power generation system

◎ Deployment plan: Lay out detailed deployment plans, including deployment methods and improvement of related institutions (second half of 2014)

◎ Construction of transmission lines: Promote the enactment of statutes under the Act on Supporting Areas Close to Transmission and Distribution Lines to provide reasonable compensation and support for areas adjacent to transmission lines (first half of 2014)

### 4. Other issues

◎ Northeast Asian oil hub: Conduct a preliminary feasibility study for the port project and prepare a roadmap (second half of 2014)

◎ Spent nuclear fuel: Collect public opinions and submit results to the Public Opinion Solicitation Committee (second half of 2014)

## 2. Short-term Measures

◎ After the Second Energy Master Plan has been finalized, detailed measures will be devised and implemented in the form of 10 sub-plans related to energy supply and demand.

| Plan | Time (TBD) | Main content |
|---|---|---|
| Energy Use Rationalization Plan | 2014 | · Sectoral policies for energy efficiency improvement, measures to develop related technologies, and measures to reduce GHG emissions |
| Renewable Energy Basic Plan | 2014 | · Outlook for renewable energy deployment and measures to improve institutions, develop technology, and train talented workers for further deployment |
| Basic Plan for Electricity Supply and Demand | 2014 | · Long-term outlook for power demand, measures to manage demand, and plans for power facilities |
| Plan for Long-term Natural Gas Supply and Demand | 2014 | · Long-term outlook for natural gas demand and measures related to supply and demand |
| Basic Plan for Integrated Energy Supply | 2014 | · Mid- to long-term supply plan, suggestions on targets and criteria for supply, and energy consumption and pollutant reduction targets |
| Regional Energy Plan | 2014 | · Outlook for regional energy supply and demand, measures to manage demand and to promote distributed power generation, and supply plans for each region |
| Oil Stockpiling Plan | 2014 | · Oil stockpiling target, suggestions on the type and quantity of oil to be stockpiled, and stockpiling facilities plans |
| Basic Plan for Overseas Resource Development | 2014 | · Suggestions on resource development targets, measures to improve the effectiveness of public enterprises and promote private sector investment, and measures to facilitate R&D, human resource development, and international cooperation |
| Energy Technology Development Plan | 2014 | · Measures to facilitate the development of technologies related to efficiency improvement, clean energy and demand management, support for human resources and facilities, and commercialization of technology |
| Long-term Plan for the Coal Industry | 2015 | · Long-term supply and demand outlook, measures to develop the coal industry and related technology, and measures to promote the safety of mines, mine reclamation, and local economies near mining areas |

## This document comes under the jurisdiction of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# KOREA ENERGY MASTER PLAN

Ministry of Trade, Industry and Energy