기후변화센터 CLIMATECHANGECENTER

energy +climate

Konrad Adenauer Stiftung

South Korea's Energy Transition and its Implications for Energy Security

Information and Guidance for Organizations

Imprint

Published by

Climate Change Center in Republic of Korea

Website www.climatechangecenter.kr

Tel +82-2-766-4351

Fax +82-2-766-4361

E-mail info@climatechangecenter.kr

Address No.701, 190, Yulgok-ro, Jongno-gu,
Seoul 03127, Republic of Korea

Note

Published with support from the Regional Project
Energy Security and Climate Change in Asia-Pacific
of Konrad-Adenauer Stiftung, Germany

Date

February 2018

기후변화센터
CLIMATECHANGECENTER

"A GLOBAL CLIMATE RESPONSE PARTNER CREATING A HAPPIER LOW-CARBON SOCIETY"

Climate Change Center(CCC) is Korea's first NGO dedicated toward climate change response. Since its inception in 2008, CCC is accumulating the wisdom and knowledge of people from all works of life to lead the fight against the biggest challenge of mankind.

With a powerful public-private-academia network, CCC develops Green Leaders, conducts policy studies, and collaborates with developing countries in order to fulfill a happy low-carbon society with citizens all across the globe.

www.climatechangecenter.kr

energy +climate
Konrad Adenauer Stiftung

The Konrad-Adenauer-Stiftung (KAS) is a German political foundation closely associated with the Christian Democratic Union of Germany (CDU). KAS programs in Germany and in more than 120 countries worldwide aim to consolidate democratic values, rule of law, freedom of opinion and social market economy, strengthen European integration and promote sustainable development. The Regional Project Energy Security and Climate Change in Asia-Pacific has been established in Hong Kong, China in 2015. It fosters the cross-border cooperation and development of best practices in sustainable ernegy and climate politics.

www.kas.de/recap/en/

TABLE OF CONTENTS

Chapter 1. Introduction

1. Background and Aims

1-1. Background of the research

In responding to serious consequences of climate change, energy transition is the key to transform current energy consumption based on fossil fuel to more sustainable energy supply and use. After disastrous Fukushima nuclear power plant accidents, Germany and some other European countries declare energy transition (enegiewende) to increase renewable energy sources and decrease its dependency on fossil fuel and nuclear based energy system. Morris and Pehnt (2016) identify six rationales for energiewende (energy transition in Germany): fighting climate change; reducing energy imports; stimulating technological innovation; reducing and eliminating nuclear power; energy security; and strengthening local economy and social justice. Energy transition here can be defined as "transformation of existing interests, power, and economy based on fossil fuel or nuclear energy-based systems into renewable energy-based systems by using energy demand management, efficiency enhancements, and innovative and connected technologies (Lee at el. 2014).

Meanwhile, Countries in Asia presents different paths in energy policy and energy transition. China became the biggest emitter of greenhouse gases (GHG). To respond to global climate change, China seeks to increase both renewable energy and nuclear supply in their energy mix. South Korea is ranked top 10 emitters of greenhouse gases. South Korean government has sought to expand nuclear energy supply and industry. However, current Moon administration declared energy transition and zero nuclear energy system. German experience of energy transition can provide policy implications for China and Korea where present similar but different trajectories in energy policies.

1-2. Necessities and Aims

German energy transition has significant implications to the world and Asia. First, energy transition is critical for climate change mitigation. While there was the Kyoto Protocol to mitigate greenhouse gas emission from Annex I countries, even many industrialized countries could not comply with the international environmental agreement (Harris and Lee 2017).

In the meantime, new climate change agreement is formed at UNFCCC COP21. In the Paris Agreement, participating countries that not regulated by Kyoto Protocol should reduce nationally determined contributions (NDC) to tackle the climate change issues. Energy transition from fossil fuels to renewable energy is necessary for countries including China and Korea to meet their NDC.

South Korea imports 97% of energy sources. There are high energy demand from manufacturing economy that heavily depends on the fossil fuel and nuclear energy. Korean government submitted NDC to UNFCCC in June 2016, showing political will to expand the nuclear energy capacity, while to propose relatively low renewable energy which seems against the energy transition trend. However, current government proposed 3020 plan which aims to increase renewable energy by 20% of electricity supply by year 2030.

Energy security which aims to provide stable and clean energy has emerged as a major agenda in South Korea. Since Korea faces challenge to secure stable and sustainable energy supply, while taking responsibilities to GHG emissions, regional cooperation for energy transition is required.

Hence, this study aims

- To raise the awareness of energy transition policy in South Korea, learning from the concept and practices of German Energy Transition (Energiewende)
- To examine the applicability of German Energy Transition in South Korea
- To identify current energy supply and use status
- To discuss constraints of energy transition policy in Korea
- To understand energy transition's implications for energy security
- To provide policy suggestions to Korea based on German Energy Transition for energy plans

2. Contents and Scope

2-1. Korean Energy Policy Change

In the Inter-chapter, we describe the status of energy supply and consumption in Korea. In this part, we outline fossil fuel (coal, petroleum, and natural gas use), electricity production, and renewable energy production with energy statistics.

In the chapter 2, we highlight the current energy policy change. The current Moon government declared that energy transition as national energy agenda. Energy transition here refers to the energy system seeking to have more renewable energy in energy mix and to have decentralized energy system. Energy transition also pursues less reliance on nuclear power. The way of making decisions on energy policy incorporates civic participation, using deliberative pool measures. This effort of energy transition is significantly different to previous energy policy which aims to expand nuclear energy to cope with energy security and climate change.

In the chapter 2, we also identify the applicability of energy transition concept in Korean context. Particularly, through interviews with energy experts, this project finds political, socio-economic, and environmental restrictions to adopt energy transition.

2-2. Energy Transition as an Energy Security Measure

International Energy Agency (IEA) defines energy security as "the uninterrupted availability of energy sources at an affordable price". IEA also points out many aspects: "long-term energy security mainly deals with timely investments to supply energy in line with economic developments and environmental needs. Short-term energy security focuses on the ability of the energy system to react promptly to sudden changes in the supply-demand balance."

To secure affordable and sustainable energy sources, it is critical to have diversified energy supply sources. Particularly, securing self-sufficient energy sources is imperative. Energy transition which enlarges the portion of renewable energy is one way to enhance energy security. Renewable energy sources such as wind, solar, and geothermal do not need to rely on energy import. Most renewable energy sources are locally adoptable for electricity generation.

In this context, we emphasize regional energy cooperation. There have been discussions on regional cooperation over gas pipe line and oil or natural gas hub in the Asia region. However, regional cooperation on energy transition has been rarely discussed. Regional cooperation for energy transition requires civic participation. Cities and provinces can be primary actors in self-sufficient and connected energy system. Across countries, public-private-civic partnership and governance can enhance regional energy cooperation for decentralized and participatory energy transition in South Korea.

Inter-chapter.
Current Status of Power Source

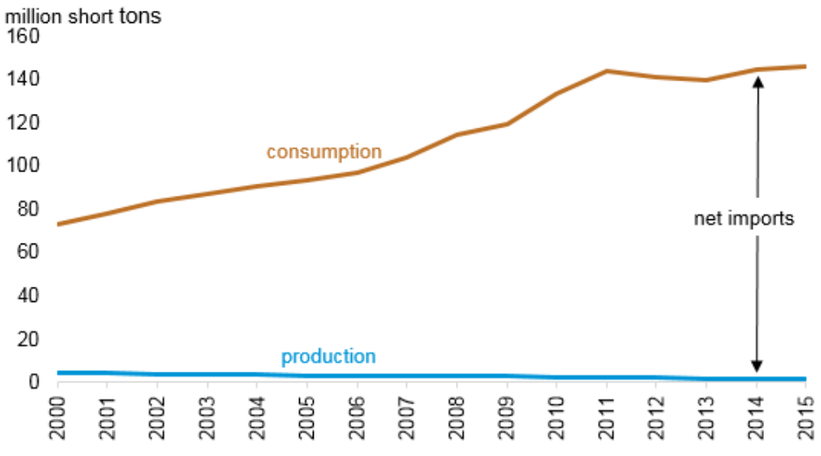
1. Fossil fuels for energy production in South Korea

1-1. Coal

Rising coal consumption in South Korea and negligible domestic production of coal have resulted in large coal imports. In 2015, South Korea was the fourth largest coal importer globally. Domestic production of coal is an estimated 1.9 million short tons (MMst) of anthracite coal annually, whereas annual primary consumption of coal was 146 MMst in 2015. Imports have met the gap between domestic supply and demand, and have increased from 131 MMst in 2010 to 149 MMst in 2015 (see Figure 1). Imports have been driven primarily by growing demand in the electric power sector and have also been affected by the shutdowns of some South Korean nuclear plants in late 2012 because of safety reviews, following the nuclear disaster in Fukushima, Japan, in early 2012.

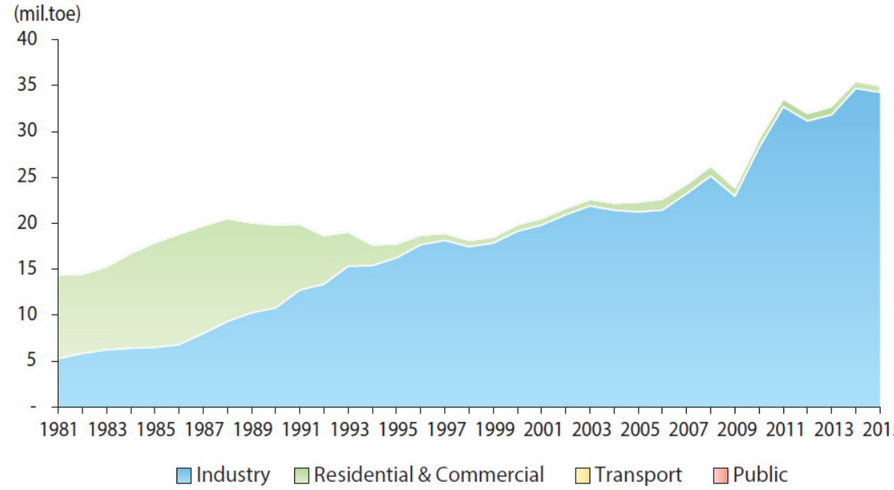
Power generation accounted for more than 60% of the country's coal consumption, where coal is used as a reliable fuel for the generation of baseload (power), while the industrial sector (primarily steel and cement) contributed to most of the remaining coal demand in 2015.[1] In total, power generation and industrial sectors account for 98.1% of national coal consumption (see Figures 2 and 3).

[Figure 1] Coal Production and Consumption in South Korea, 2000-2015



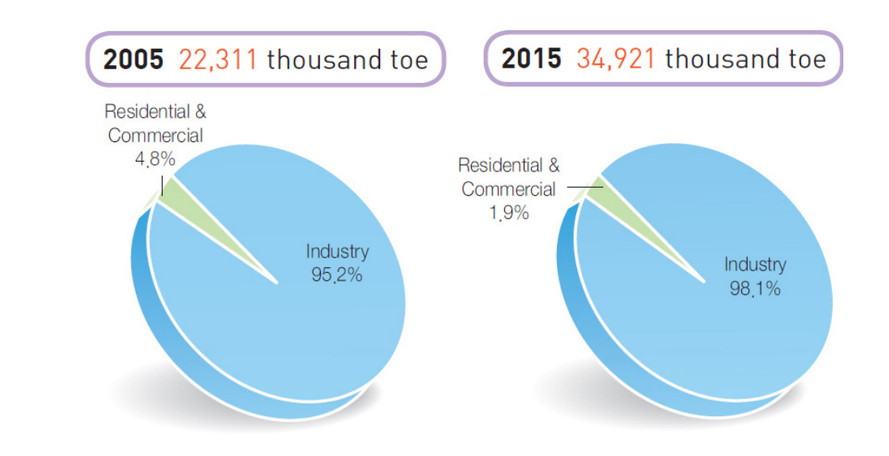
Source: U.S. Energy Information Administration, Country Analysis Brief: South Korea, Updated on January 19, 2017 [2]

[Figure 2] Coal Consumption in South Korea, 1981-2015



Source: 2016 Energy Info. Korea, Korea Energy Economics Institute, Republic of Korea

[Figure 3] Coal Consumption by Source in South Korea, 2005 and 2015



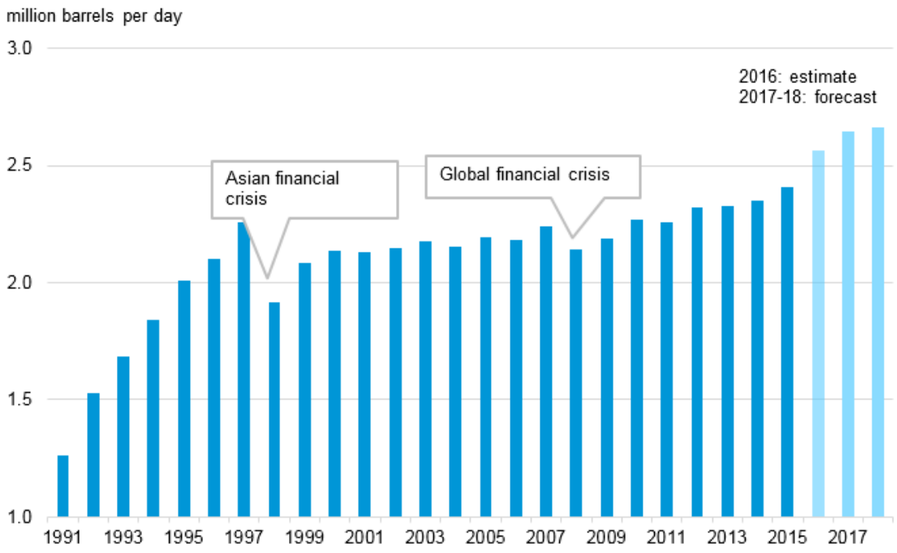
Source: 2016 Energy Info. Korea, Korea Energy Economics Institute, Republic of Korea

[1] Korea Energy Economics Institute, Monthly Energy Statistics, June 2017, pages 61-64
[2] https://www.eia.gov/beta/international/analysis.cfm?iso=KOR

1-2. Petroleum, LPG and other liquid fuels

South Korea has a large oil refining sector, but the country relies almost entirely on crude oil imports to supply its refineries. In 2015, South Korea imported nearly 2.8 million barrels per day of crude oil and condensate, making it the fifth largest importer in the world. Of these imports, South Korea consumed 2.4 million barrels per day (b/d) of petroleum and other liquid fuels in 2015, making it the 8th largest consumer in the world (see Figure 4). South Korea's domestic production of petroleum and other liquid fuels is only about 79,000 b/d. The imports of petroleum products constituted about 60% of the total volume of South Korean imports of fossil fuels in 2015, constituting 72% of the total cost of South Korean imports of fossil fuels in 2015.

[Figure 4] Consumption of Petroleum and Other Liquids in South Korea, 1991-2018



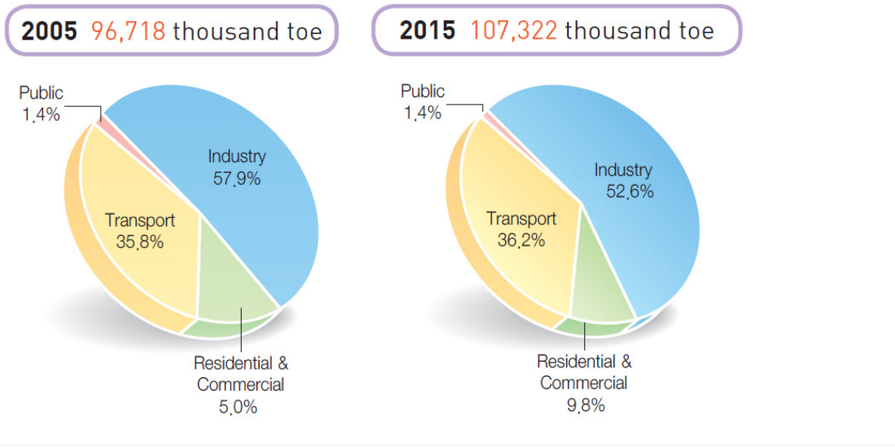
Source: U.S. Energy Information Administration, Country Analysis Brief: South Korea, Updated on January 19, 2017

As with coal consumption, South Korea's oil consumption is directly related with its economic growth. About 53% of the imported petroleum products are consumed as primary energy by the industry sector, whereas over 36% are consumed by the residential and commercial sectors, and slightly over 11% are consumed by the transport sector (see Figure 5).

Naphtha is the primary petroleum fuel with greatest domestic demand and accounts for about 42% of total domestic oil demand. It is used in the South Korean petrochemical and industrial sectors. South Korea also uses liquefied petroleum gas (LPG) for its petrochemical industry. LPG accounted for 10% of domestic demand for petroleum products in 2015.

The domestic oil demand outside of the petrochemical sector is limited and may decline as a result of declining population growth and an ageing society, increasing energy across various sectors, and substitution by cheaper fossil fuels.

[Figure 5] Petroleum Consumption in South Korea, 2005 and 2015

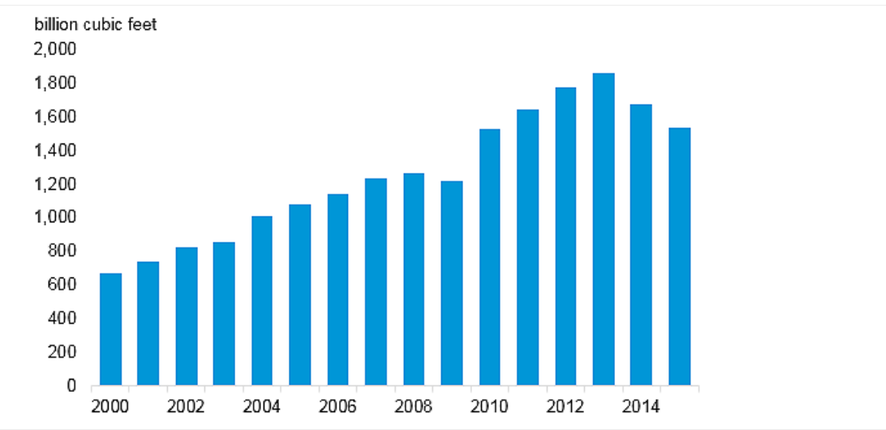


Source: 2016 Energy Info. Korea, Korea Energy Economics Institute, Republic of Korea

1-3. Natural gas

South Korea consumed an estimated 1.6 trillion cubic feet of dry natural gas in 2015 (see Figure 6). Domestic natural gas production is negligible and accounts for less than 1% of total consumption. Thus, South Korea is largely dependent on import and is the second largest importer of liquefied natural gas (LNG) in the world. The import of LNG constitutes about 14% of South Korea's annually imported fossil fuels (in 2015). As South Korea is not connected by international pipelines, all of the gas is imported via LNG tankers. The imported LNG is re-vaporized and pressurised as natural gas at the receiving terminals and sent to domestic power plants and to companies that supply city gas to households, commercial establishment, and some industries.

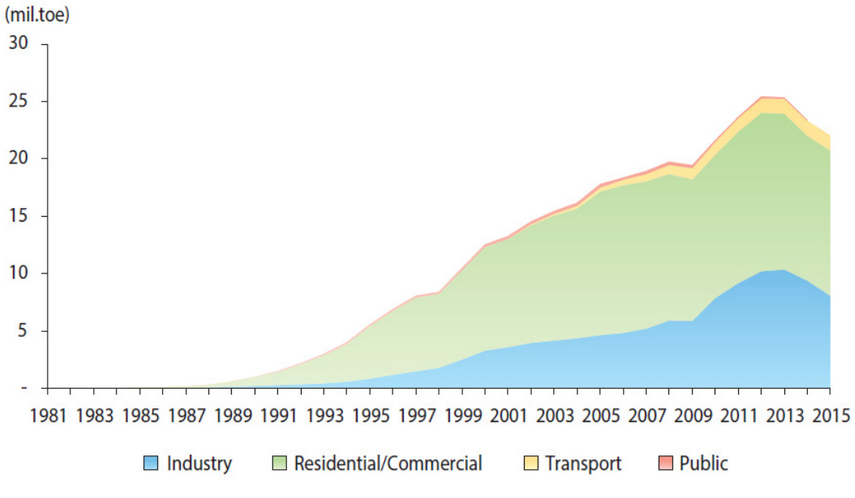
[Figure 6] South Korea's Natural Gas Consumption, 2000-2015



Source: U.S. Energy Information Administration, Country Analysis Brief: South Korea, Updated on January 19, 2017

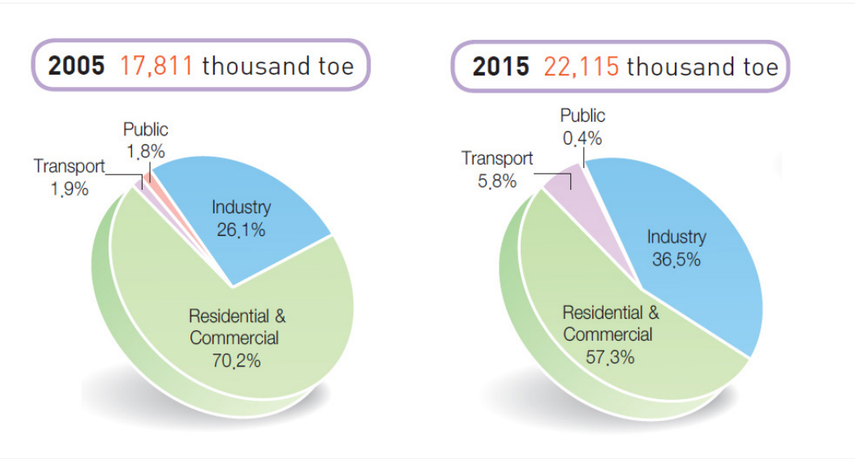
About 58% of all national gas consumption is by residential, commercial and public consumers in urban and rural areas, and slightly over 36% is consumed by industrial consumers and power generation companies (see Figures 7 and 8). Only about 6% is used by the transport sector, mainly in public transport and commercial vehicles. Most of the private vehicles run on gasoline and diesel products.

[Figure 7] Natural Gas Consumption in South Korea, 1981-2015



Source: 2016 Energy Info. Korea, Korea Energy Economics Institute, Republic of Korea

[Figure 8] Natural Gas Consumption by Source in South Korea, 2005 and 2015



Source: 2016 Energy Info. Korea, Korea Energy Economics Institute, Republic of Korea

Compared to other fossil fuels, natural gas is considered more desirable in South Korea as it is converted to electricity and heat, with 40.1% and 8.0% (as of 2015) of total natural gas consumption for power generation and district heating respectively. Although gas power generation has a high peak power generation cost compared to nuclear power and coal power, it has the advantage of quick response to changes in power demand due to short preparation time for power generation, such as in extreme weather. Carbon emissions and air pollution from natural gas is also lower that from other fossil fuels.

Gas power generation accounts for 19.4% (2015) of total power generation in Korea. Natural gas for district heating is converted into heat and electricity through combined heat and power plants where the generated electricity is dispatched to the power grid, and the recovered heat is supplied for district heating.

Prior to the introduction of natural gas in South Korea, liquefied petroleum gas (LPG) was used as the source of city gas. Natural gas used for city gas production now accounts for over 50% of total natural gas consumption nationally. City gas meets the space heating and cooking heat needs of homes, commercial buildings, and public buildings. In 2015, city gas reached about 1.7 million households in South Korea, with a penetration rate of over 88%.

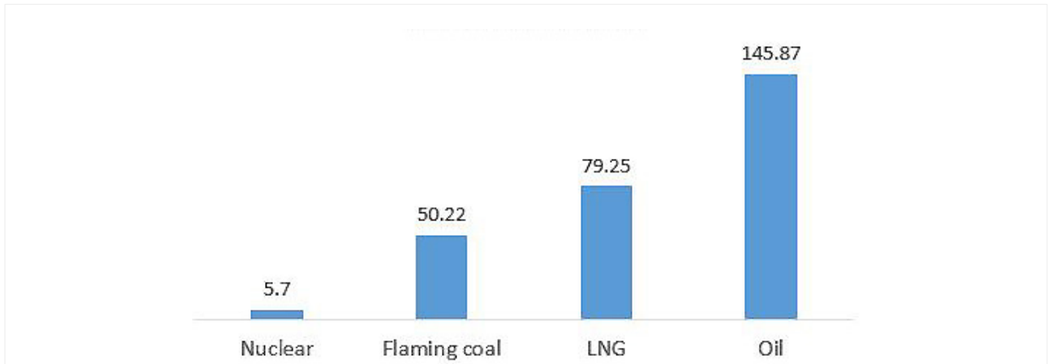
National consumption of natural gas grew from 2009 to 2013 driven primarily by electricity demand in the industrial sector. Since 2014, power generation has relied more on coal, as a result of reducing global coal prices that made imported coal less expensive than imported natural gas. Nonetheless, nationally natural gas continues to be a preferred source of energy and power, due to the public recognition of its cleaner power conversion and better air quality compared to other fossil fuels, and the national and local governments are emphasing the use of natural gas for buildings and public transport.

Korea is the 2nd largest importer of natural gas, accounting for about 15% of global consumption. However, relevant industries are having hard time as the main demand source, natural gas distribution became saturated and domestic industry has reached limitation. Demand for natural gas in Korea is expected to remain flat from 33,690,000 tons in 2015 to 33,960,000 tons in 2022, compared to population growth. Yet, as President Moon Jae-in promised massive changes in energy policy 2017, natural gas industry is expected to have opportunities for another big leap for further growth.

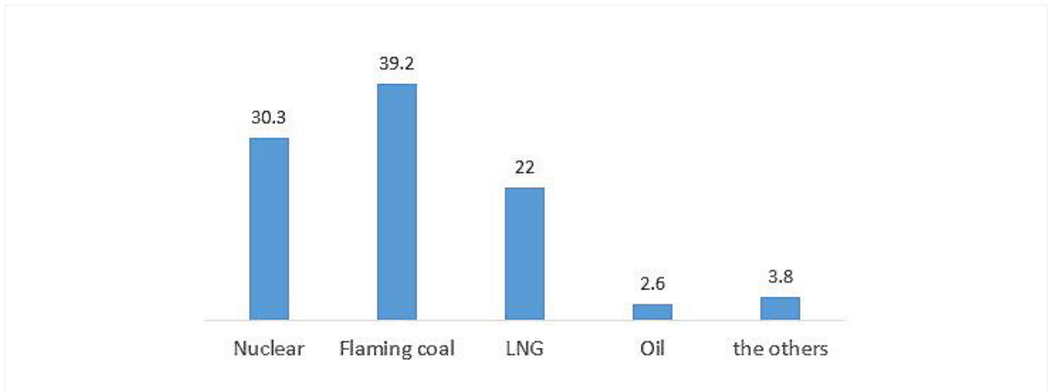
Currently, private sector power generation in Korea is mostly covered by combined generation, using LNG. In combined thermal power generation, gas turbine is operated to generate energy in the 1st phase, using natural gas or diesel and then steam turbine is operated, using heat from gas emission in the 2nd phase.

As power supply crisis is gone, use of LNG power generation drastically declined. In the energy market in Korea, power generating companies produce energy, based on the demand estimates by Korea Power Exchange (KPX) and the wholesaler, Korea Electric Power Corporation (KEPCO) buy the generated volume to distribute across the nation. Yet the generating companies follow the order of operation, decided by KPX. Following the 'Principle of economic load dispatching' to reduce cost in electricity generation, the power plants are operated in the fuel order of nuclear, flaming coal and LNG. According to KPX, fuel cost is the least expensive for nuclear generation at KRW 5.70/kWh. The fuel cost is KRW 50.22 for flaming coal and KRW 79.25 for LNG. In general, LNG power generation is not operated when power supply is sufficient and operated only in the supply shortage. That is why operation rate of LNG power plants is relatively low. As a result, usage rate of LNG power generator significantly dropped from 66.3% 2012 and 66.9% 2013 to 50.8 2014. In 2016, it slided further down to 38.8%. The portion of LNG power generation out of total electricity trade volume dropped from 26.4% 2012 to 25.0% 2013. As of 2016, power generation from coal and nuclear power plants accounts for 70% of total power supply while the portion of gas remains at no higher than 20%(see Figures 9 and 10).

[Figure 9] Cost of Fuel by Fuel Type (Unit : KRW/kWh, as of April 2016)



[Figure 10] Trade Volume by Fuel Type (Unit : %, 2016)



Source: Korea Power Exchange

According the government plan, LNG power generation will expand to take up the largest portion by 2030. The demerit of LNG is that it is 100% dependent on export. Countries in Europe built pipeline from Russia for direct supply of LNG to ensure flexibility in LNG power generation and when there is supply shortage, they can share energy, using power exchange network in the region. However, we can only use marine shipment for LNG supply, due to North Korea.

Unit cost of power generation for LNG(KRW 99.4/kW) is about 35% higher than that of coal(KRW 73.9/kW). Some argue that the unit cost can be declined to similar level of coal, by reducing import tax of LNG. However, KPX explained that even after tax, unit generation cost of LNG(KRW 87.2) is 33% higher than that of coal(KRW 65.6). LNG requires much higher investment than coal as it includes production cost for gas liquidification, shipment cost for use of specialty vessel and storage tank maintenance and management cost. This leaves the cost issue increase of LNG power generation will inevitably cause increase of electricity price.

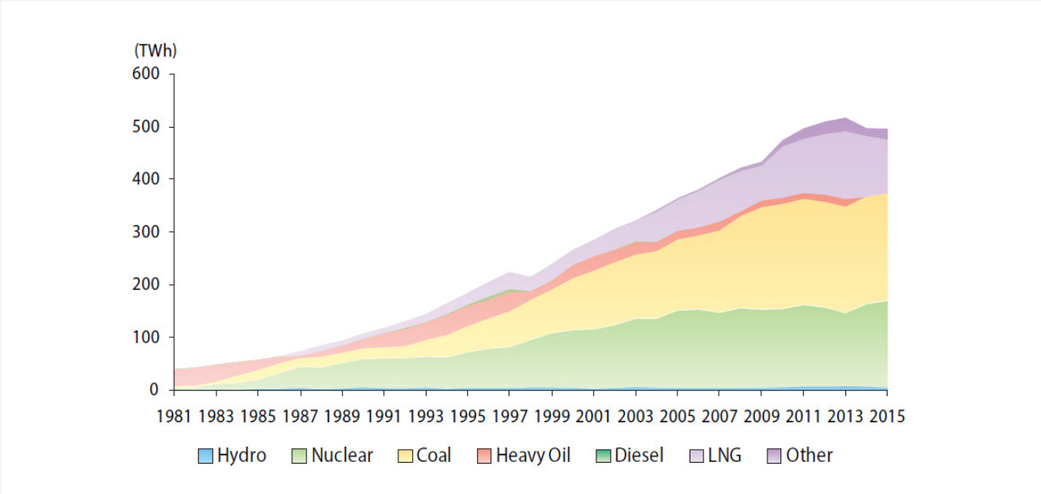
2. Electricity production in Korea

South Korea generated more than 528 terawatt hours of power in 2015 from an installed power generation capacity of 98 gigawatts.[3] Its power generation has increased by an average of 4% annually since 2005, but since 2013 has been less than 1% annually due to weaker domestic industrial demand.

Fossil fuels generated about 62% of South Korea's electric power in 2015, while around 33% came from nuclear power and 5% came from renewable sources, including hydroelectricity (see Figure 11). If we take out hydroelectricity, the share of renewable source reduces to about 3.3%; of this the majority is from waste incineration, which is considered a source of renewable energy in South Korea.

Base load power generation in South Korea is primarily

[Figure 11] Electric Power Generation by Energy Source, 1981-2015

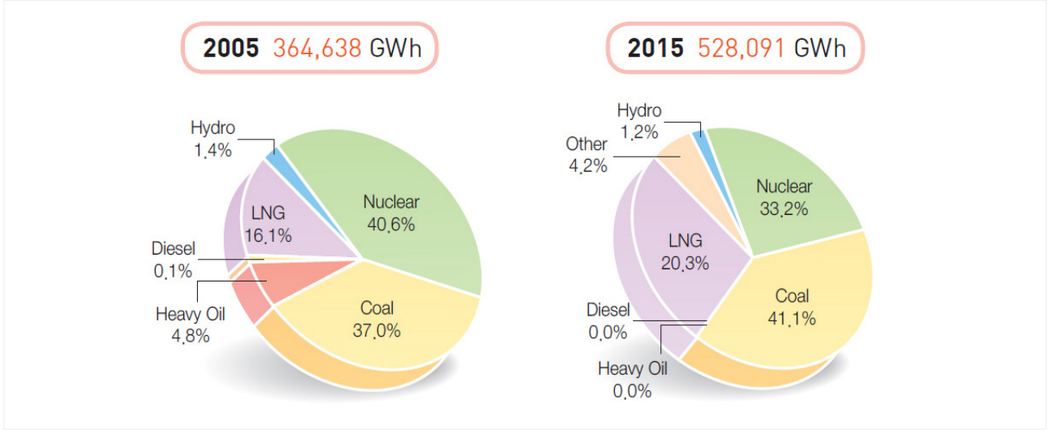


Source: 2016 Energy Info. Korea, Korea Energy Economics Institute, Republic of Korea

[3] Korea Energy Economics Institute, Monthly Energy Statistics, June 2017, pages 67-68: accessible at: http://www.keei.re.kr/keei/download/MES1706.pdf

made up of coal and nuclear power, while peak demand is met by natural gas. South Korea generated 528 terawatt hours at the end of 2015, primarily from natural gas (33%), coal (28%), and nuclear (22%) plants. Oil, hydroelectricity, and other renewables made up smaller shares (see Figure 12).

[Figure 12] Electric Power Generation by Facilities in South Korea, 2005 and 2015



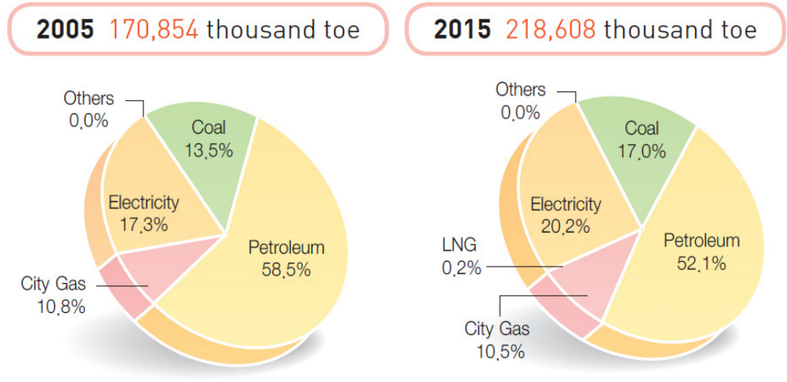
Source: 2016 Energy Info. Korea, Korea Energy Economics Institute, Republic of Korea

South Korea intends to reduce its greenhouse gas emission levels by 37% from business-as-usual projected levels (projections of emission levels without any carbon price scheme) by 2030, according to the submitted Nationally Determined Contributions (NDCs) at COP 21 in Paris in December 2016. The new Korean government launched in May 2017, announced its policy to establish a nuclear power plant roadmap. The policy is a step-by-step plan to ban the construction of new nuclear power plants and extend the life expectancy of older nuclear power plants and plan to include it in power supply plan. Through this policy, Kora will be transformed into an energy paradigm with safe and clean energy, and it is expected that it will become a country that does not worry about nuclear accident due to innovation of nuclear safety regulation system. South Korea plans to close ten older coal-fired power plants by 2025 and by 2030, the proportion of renewable energy will be increased to 20%. Through it, the energy consumption economy will be transformed into a low-carbon/high-efficiency structure and based on this, Korea aims to become a leader in energy new industry.

Regarding nuclear generation capacity, as of late 2016, South Korea was ranked sixth highest in the world. South Korea imports all of its required uranium and does not reprocess uranium due to the nation's nuclear cooperation agreement with the USA, which is valid until 2035. Nuclear generation utilisation rates in South Korea are higher than 90%, some of the highest in the world. In 2013 and 2014, capacity factors were below 90% because a few nuclear facilities were closed for safety reasons in late 2012. However, as mentioned above, South Korea is planning to establish a roadmap for nuclear power plants.

Electricity constitutes roughly 20% of the total primary energy consumption of the nation. In 2015, about 55% of produced electricity was consumed by industries, 45% by the residential, commercial and public sectors, and only 0.5% by the transportation sector (see Figure 13).

[Figure 13] Final Energy Consumption by Source in South Korea, 2005 and 2015

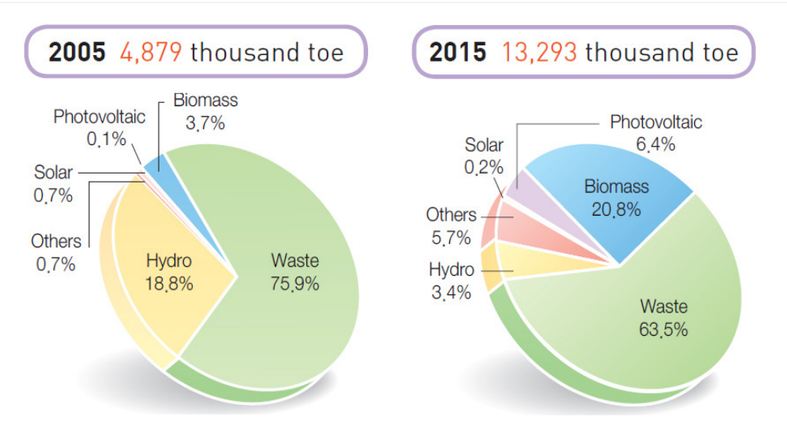


Source: 2016 Energy Info. Korea, Korea Energy Economics Institute, Republic of Korea

3. Renewable energy supply in Korea

South Korea is ranked last among the 34 OECD countries with regard to the level of renewable energy[4] use. About 4.5% of South Korea's final energy consumption, equal to about 13.3 million tons of oil equivalent, comes from renewable energy sources (Figure 14).

[Figure 14] Renewable Energy Consumption in South Korea, 2005 and 2015



Source: 2016 Energy Info. Korea, Korea Energy Economics Institute, Republic of Korea

[4] Renewable sources here mean: solar, onshore or offshore wind, wood biomass, hydro, bioenergy, integrated gasification combined cycle, by-product gas, landfill gas, refuse derived fuel, waste gasification, waste incineration, tidal power, fuel cell, and energy storage system.

Energy from waste gasification and incineration constitutes about 64% of the total renewable energy consumption, while wood biomass (which includes domestic and imported wood pellets and imported woody biomass from short-rotation forests)[5] accounts for 21% and solar photovoltaic and thermal make up around 7%. Hydro represents over 3%, while other renewable energy sources such as wind, fuel cells, geothermal and tidal represent about 6%. The Korea government announced a 'New Renewable 3020 Implementation Plan' to achieve 20% renewable power generation by 2030. To this end, it will need to supply new facilities with a capacity of 53GW. In order to achieve a mix of advanced countries with solar power and wind power at 80% level, it will add 2GW of annual average annual supply over 1.7GW. Later, the '8th Basic Plan for Electricity Supply and Demand' will be announced, reflecting the plan.

In order to achieve a 20% share of renewable energy generation capacity by 2030, the government plan to introduce a fixed purchasing system to secure stable profits for small-scale operators, introduce a system of planned locations such as wind power, the RPS obligation rate will raise to 28% in 2030(10% since 2023). The government plan to install ESS in public institutions and install intelligent weighing system nationwide by 2020 to build environmentally friendly smart energy infrastructure and create new business based on IoE in energy new industry. Energy efficiency will be shifted from low-carbon and high-efficiency structures by strengthening demand management by core sectors(home, commercial, transportation, public buildings, etc.) It is required to certify the zero-energy buildings in the public sector.

On 6 July 2016, the Ministry of Trade, Industry and Energy announced that the South Korea government will invest a total of 42 trillion won (USD 36.6 billion) into the new energy sector by 2020 to expand the environmentally-friendly power supply system in the country. The government will invest 33 trillion won in developing the renewable energy sector, 4.5 trillion won in developing the energy storage system (ESS) industry, 2.5 trillion won in developing smart metering, and 2 trillion won in environmentally-friendly power development. In addition, the government plans to build new renewable power stations by the year 2020 to produce 13 million kilowatts of electricity annually, equivalent to the generation from 26 coal plants. The government also plans to raise its scheduled renewable portfolio standard (RPS) to 6% in 2018 from an earlier target of 4.5%; the rate will go up to 8% in 2020, up from earlier goal of 6%.

The RPS was initiated by the national government in 2012 and requires South Korea's major electric utilities or power producers that have power generating facilities with installed capacity over 500 megawatts to produce a minimum proportion of their power using new and renewable energy sources and to gradually increase the renewable energy share in their power generation portfolios. The proportion of renewable energy is stipulated by the government: As of 2017, it is 5%; by 2022 it is set to be 10%.

Under the RPS system, power producers which are subject to the RPS can also trade in renewable energy certificates (RECs) to meet their obligatory new and renewable energy supply target. A REC certifies that a power generator has produced and supplied power using new and renewable energy facilities. A REC is issued based on weighted renewable energy supply (MWh); the weights are assigned by the national government.

On 29 August 2017, the Ministry of Trade, Industry and Energy decide to invest 1.657 trillion son in the 2018 budget to focus on safe and clean energy conversion. The budget for 2018 totaled 6.7706 trillion won, down 2.9% from the previous year. Among them, 1.657 trillion won will be invested in a policy for safe and clean energy conversion. This is an increase of 14% compared to 1.4112 trillion won this year. This amounts to 24% of the total budget of the Ministry of Trade, Industry and Energy next year. ESS, Smart grid, reduction of power generation cost and efficiency improvement R&D investment to increase the efficiency of existing energy industry and create new business through it. The related technology development budget increased 14.2 billion won. In addition, the 'high value-added future new industry upbringing' budget to create a new industry is 6.19%, up from 919 billion won this year to 975 billion won next year.

[Table 1] Renewable Energy Certificate Weighting System by Energy Source and Criteria

<table>
<tr><th rowspan="2">category</th><th rowspan="2">REC weighting</th><th colspan="2">Energy source and criteria</th></tr>
<tr><th>Facility type</th><th>Criteria</th></tr>
<tr><td rowspan="6">Solar PV</td><td>1.2</td><td rowspan="3">Facility installed on general site</td><td>Less than 100kW</td></tr>
<tr><td>1.0</td><td>More than 100kW</td></tr>
<tr><td>0.7</td><td>More than 3,000kW</td></tr>
<tr><td>1.5</td><td rowspan="2">Facility installed on existing buildings</td><td>Less than 3,000kW</td></tr>
<tr><td>1.0</td><td>More than 3,000kW</td></tr>
<tr><td>1.5</td><td colspan="2">Facilities floating on the water</td></tr>
<tr><td rowspan="10">Others</td><td>0.25</td><td colspan="2">Integrated Gasification Combined Cycle, Byproduct gas</td></tr>
<tr><td>0.5</td><td colspan="2">Waste, landfill gas</td></tr>
<tr><td>1.0</td><td colspan="2">Hydro, onshore wind, bioenergy, RDF, waste gasification, tidal power (with embankment)</td></tr>
<tr><td>1.5</td><td colspan="2">Wood biomass, offshore wind (grid connection less than 5km)</td></tr>
<tr><td>2.0</td><td colspan="2">Fuel cell, tidal power</td></tr>
<tr><td>2.0</td><td rowspan="2">Offshore wind (grid connection longer than 5km), geothermal, tidal power (no embankment)</td><td>Fixed</td></tr>
<tr><td>1.0~2.5</td><td>Variable</td></tr>
<tr><td>5.5</td><td rowspan="3">Energy Storage System (connected to wind power)</td><td>'15</td></tr>
<tr><td>5.0</td><td>'16</td></tr>
<tr><td>4.5</td><td>'17</td></tr>
</table>

Source: Korea Energy Agency, Repiblic of Korea, 2016[6]

[5] https://blog.forest2market.com/new-opportunities-for-biomass-growth-japan-and-south-korea

[6] http://www.energy.or.kr/renew_eng/new/standards.aspx

In the case of solar energy, different weight values are applied in consideration of different types of facilities (general facilities, buildings, and floating facilities) and sizes. The smaller the size of the business, the higher is the weight; the larger the size of the business, the smaller is the weight.

To compensate for the intermittent nature of wind power generation, energy storage is linked to wind power generating facilities so that a higher weight of 5.5 can be applied in the case of power discharge at peak times, while a weight of 1.0 is used during non-peak times.

As energy sources such as offshore wind power, tidal power, and geothermal heat require a large initial investment, a flexible weight system has been adopted. In the case of geothermal and offshore wind power, a weight value of 2.5 is applied for 5 years, 2.0 for the next 10 years, and 1.0 afterwards. As for tidal power, 2.5 is applied for 20 years, and 1.0 afterwards.

In addition to national standards and incentives, metropolitan cities also have programs to enhance the installation of decentralised, small-scale, renewable energy systems.

A good example of this is the solar power policy in the capital of Seoul, which was formulated during the public outcry against nuclear power installations in South Korea after the Fukushima nuclear accident. The Seoul Metropolitan Government (SMG) started a city-wide energy transformation campaign known as "One Less Nuclear Power Plant" (OLNPP) in April 2012, with the objective of reducing energy usage in the city by two million tons of oil equivalent - roughly equivalent to the annual output of a nuclear plant in 2014. Simultaneously, the city government aspired to increase the city's self-sufficiency ratio of electricity supply from 3% to 8%, partly through increased usage of renewable energy (in 2012, Seoul was 97% dependent on external sources of energy).

The "Make Seoul a City of Sunlight" project was a core component of the city-wide campaign for energy self-sufficiency, trying to convert Seoul into a "huge solar power plant" through the creation of a large number of small-scale solar generation projects scattered around the city. The policy target was to expand solar photovoltaic capacity by fourteen times in less than three years to 320 megawatts by 2014, primarily through the installation of rooftop solar PV systems on 10,000 buildings across the city. To accomplish this, SMG undertook the following steps:

- (a) **Entered into memoranda of understanding with domestic energy companies** to obtain their commitment of at least 700 billion KRW to a fund for kickstarting solar projects. In return, the energy companies could obtain long-term operating rights of the projects and can earn saleable certificates for the produced solar power;

- (b) **Rented out unused public sites to ease space shortage for solar projects.** SMG leased out at least 26 idle public facilities such as the rooftops of the city's main water treatment plant at concessionary rates to encourage privately-funded projects which have a combined capacity of 23 MW;

- (c) **Initiated a feed-in-tariff scheme** as an economic incentive for small solar projects below 50 kilowatts in 2013. Project operators were subsidized at a rate of 50 won per kW for one hour generated power for up to 5 years. In addition, SMG also provided loans to any eligible solar photovoltaic system of up to 150 kW at a preferential rate of 1.75% per annum;

- (d) **Prepared a Seoul Solar Map**, which is an online map displaying the development potential of solar photovoltaic systems on building rooftops, in 2013. This informed and encouraged more building owners to install PV systems. SMG also streamlined the licensing procedure for solar power plants from 60 to 30 days;

- (e) **Established a Solar Power Generation Citizens' Fund**, to which any Seoul citizen can contribute for solar projects under government-backed citizen funds, and earn a fixed annual return by subscribing up to 100 million won for each fund with a total amount of 50 billion won.

By mid 2014, the OLNPP campaign had exceeded the energy consumption reduction target, resulting in an annual saving of reduced oil import worth of up to US$ 2.8 billion. In terms of electricity consumption alone, Seoul has departed from the national trend of persistently rising consumption. Between 2011 and2014, Seoul's electricity consumption fell by 4%, a sharp contrast to the 4% national increase during the same period.

SMG also made significant progress in the "City of Sunlight" initiative, with installed solar generation capacity tripling from 22 MW in 2011 to 84 MW in 2014. Although the initiative fell short of its expected target of 320 MW due to a combination of lack of suitable sites, insufficient financial incentives and cheaper electricity, the achievements of the initiative twice outpaced nationwide growth during the same period.

In 2015, SMG rolled out Phase 2 of the OLNPP campaign with a specific target to double the solar photovoltaic installation in Seoul to 200 MW by 2020. Other additional measures include expanding rooftop solar photovoltaic installations in schools from 30 units in 2014 to 230 by 2018; installing 40,000 mini photovoltaic power plants on the balconies of households by 2018, and increasing the capacity cap of the feed-in-tariff subsidy from 10 MW to 20 MW.

Chapter 2. Energy Transition Policy in Germany and South Korea

1. Germany's Energy Transition Policy

1-1. Outlook

Germany is one of the countries that have promoted renewable energy most actively among European countries. Germany's energy policy is based on its attempts to tackle present challenges such as the EU guidelines on electricity supply through renewable energy sources, decision to close nuclear power generation facilities, and compliance with climate change agreement, in addition to mid-long term strategies to secure alternative energy source in order to prepare for fossil fuel depletion. Like South Korea, Germany is an energy importer that imports most of its first energy. Germany's energy consumption structure has changed as being influenced by the oil crisis in the 1970s, Chernobyl nuclear accident in the 1980s, decision to "abolish nuclear power" in 2000s, German former government's policy to expand renewable energy, and the EU's efforts to reduce greenhouse gases (GHG).

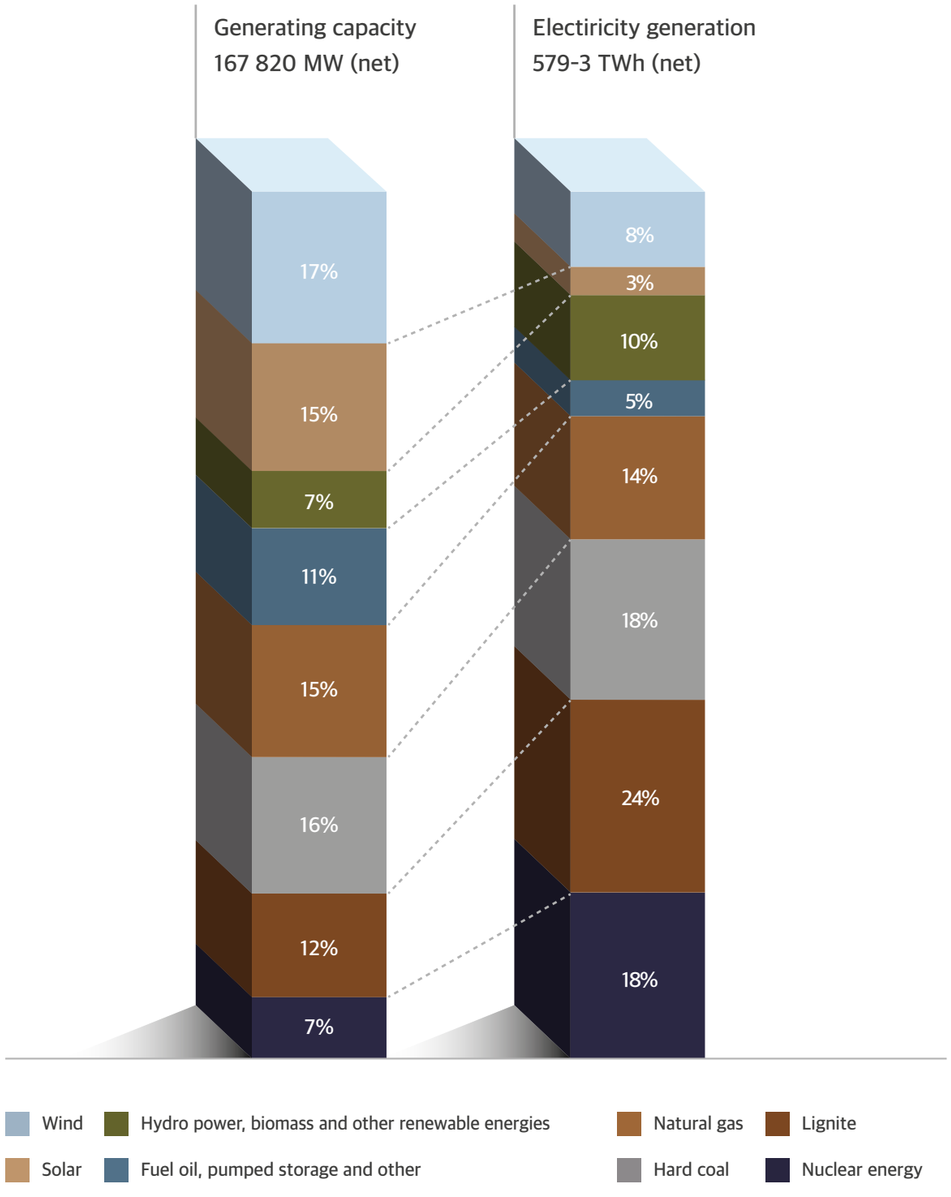
Since the 1970s, due to reduced profitability of coal and oil crisis, both coal and oil consumption has decreased, but thanks to gas pipe construction from Norway and Russia, gas consumption has steadily risen. As to nuclear power, after the decision to "phase out nuclear energy" in 2000, its consumption has declined while renewable energy consumption has stably increased since 2000 based on the EU's efforts to reduce GHG emissions and the government's policy to expand renewable energy. In terms of Germany's power composition of 2011, coal and renewable energy generation represent relatively large proportion. Based on generating equipment, wind power accounts for 17%, solar energy for 15%, water power, bio, and other renewable energies for 7%, oil, pumping-up power generation, and others for 11%, natural gas for 15%, coal for 28%, and nuclear power for 7 %. Based on generation quantity, wind power accounts for 8%, solar energy for 3%, hydroelectric power, bio, and other renewable energies for 10%, oil, pumping-up power generation, others for 5 %, natural gas for 14%, coal for 42%, nuclear power for 18% energy policies. (see Figure 15).

Since the oil crisis in the 1970s, as the necessity for alternative fuel development has been raised, Germany has pursued energy diversification policy to secure stable energy supply. Chernobyl nuclear accident in 1986 has raised awareness of anti-nuclear, leading to discussions on "nuclear abolishment" and "expansion of renewable energy" as well as relevant policy implementation.

Since then, as Social Democratic Party and Green Party of Germany came to power in 1998, energy policy was shifted in an environmentally friendly direction. In 2000, they decided to shut down nuclear power stations through "nuclear agreement" that limit the lifespan of nuclear power plants to 32 years and ban new construction of nuclear power plants. Against this backdrop, "Renewable Energy Sources Act (EEG)" took effect in Germany, introducing "Feed in Tariff (FIT)" which expanded nationwide. With the introduction of the FIT, Germany aims to reduce GHG emissions by 40% in 1990 by expanding the portion of renewable energy generation power by at least 35% by 2020. It also established an important foundation towards renewable energy transition by increasing the percentage of renewable energy generation to 80% by 2050. The German government prompted investment in the renewable energy sector through the FIT system. With the support of the government, Germany had successfully increased the portion of renewable energy source generation from 5% to 10% from 1999 to 2005 during the time of red-green coalition.

Germany amended the nuclear energy act in 2002 based on the EEG and the FIT, establishing the first breakaway policy from nuclear. As a result, nuclear energy power generation reduced while renewable energy power production steadily increased. The nuclear energy act jointly designated the amount of expected electricity that can be produced in the conventional power plant for 32 years, which is the normal operating period, limiting the operation period of the conventional power plants, and prohibited the construction of new nuclear power plant.

[Figure 15] German energy composition based on generating facilities and generation quantity (2011)



Source:Bundesverband der Energie- und Wasserwirtschaft, German Electricity Consumption in 2011, 2011

As part of continued eco-friendly conversion policy, chancellor Angela Merkel, who served as the Minister of the Environment, reaffirmed her commitment to 2020 target of reducing Germany's GHG emissions by 40% by 2020 compared to 1990 levels through "integrated energy climate program 2007". She also set a target for an increase in the share of renewable energy sources to 30% of total electricity production by 2020. In 2009, "Energy Concept 2010" was announced: the Merkel government's energy policy, called "energy transition" which increases renewable energy and enhances efficiency of energy by expanding renewable energy source, lowering dependency on fossil energy by 2050, and eventually shutting down nuclear power plant. This was the policy that aims to prepare for the upcoming era of renewable energy and to emphasize stable energy supply and better competitive edge of Germany, and at the same time, to replace conventional energy source to renewable energy in phases and achieve the climate protection goal. Although the "Energy Concept 2010" is based on the integrated energy climate program, it maintains ultimate de-nuclear policy, and also insists extending the period of use of nuclear power plants in order to achieve GHG reduction targets and to gradually increase the share of renewable energy. There is a big difference in nuclear energy policy in that it decided to extend the operation of nuclear power plants by 8~14 years unlike the decisions made in 2000 by re-green coalition. Germany suggested long-term energy policy up to 2050. In particular, it emphasized renewable energy as a future energy source.[7] Then, it set up targets of decreasing electricity and energy consumption, increasing the share of renewable energy in final energy consumption and electricity consumption while decreasing GHG emission. It aimed to reduce primary energy consumption by 20% by 2020 compared to 2008, and 50% by 2050. In terms of power consumption, the goal was to reduce by 10% by 2020, and 25% by 2050(see Table 2).

[Table 2] 'Energy Concept 2010' Target

Category	2012	2020	2030	2040	2050
GHG emission (compared to 1990)	-27%	-40%	-55%	-70%	-80%
Portion of renewable energy from the final energy consumption	10%	18%	30%	45%	60%
Portion of renewable energy from the total power consumption	20%	35%	50%	65%	80%
Primary energy consumption (compared to 2008)	-5%	-20%			-50%
Electricity consumption (compared to 2008)	-1%	-10%			-25%
Final energy consumption in the transport sector (compared to 2008)		-10%			-40%

Source:IEA, Energy Policies of IEA Countries-Germany 2013 Review, 2013

[7] http://www.fes.or.kr

Following the 2011 Fukushima nuclear accident, Merkel and her government decided to withdraw existing life extension of nuclear power plants and to close all nuclear power plants by 2022. In addition, Germany strived to accelerate energy transition by expanding electrical grid, increasing FIT subsidy for renewable energy promotion, establishing eco-friendly business fund with cap and trade, boosting energy efficiency, strengthening R&D support on energy saving technology, etc., which are all included in "Energy Package". This policy that backs up the "Energy Concept" consists of six acts and one code including the revised one(see Table 3).

[Table 3] Major Content of "Energy Package" Policy

Category		Content
Atomic Energy Act	→ Amendment	By 2022, all nuclear power plants are closed in phases. Federal government bears the burden of the relevant compensation.
Renewable Energy Sources Act		For renewable energy source, FIT subsidy increase
Energy Industry Act		All power grid operators in Germany are obliged to establish a joint plan to build power grid.
Energy and Climate Fund Act		Save all profits of the EU ETS cap and trade in fund. This fund is used for demolishment of atomic energy, supplying environmentally friendly energy, global project related to climate and environment protection, and development of electric vehicles.
Network Expansion Acceleration Act		Enacted to expand electric grid and linkage. Federal network agency is in charge of electric grid implementation project.
Strengthening Climate-Friendly Measures in Towns and Municipalities Act		Expand the use of renewable energy and CHP in urban and local communities
Offshore Wind farm Revision		Federal Agency for Maritime Shipping and Hydrography authorizes approval procedures for offshore wind project

Source:IEA, Energy Policies of IEA Countries-Germany 2013 Review, 2013

In particular, the Network Expansion Acceleration Act, established for electric grid expansion and linkage, was created as most of the renewable energy power plants are concentrated mainly in northern region while most demands come from southern region, which requires the connection of electric grids between regions. To prevent a delay in project, the existing electric grid construction project was under the jurisdiction of the provincial government, simplifying approval process of projects. By amending the Renewable Energy Sources Act, Germany increased the FIT subsidy for renewable energy such as wind power, geothermal heat, and biomass so as to expand the development of renewable energy and to phase out nuclear power. The FIT subsidy for wind power was 15% per kWh, for biomass, as to facilities less than 150kW; it was about 30% per kWh. For geothermal power, the FIT subsidy increased by around 50% per kWh and the FIT subsidies for onshore wind and solar power did not change.[8]

Germany, which amends the existing act in accordance with the government policy, revised the EEG in phases, and "EEG 2017", a revised version of the "EEG 2014", took effect as of Jan. 1, 2017. Through this, it built competitive system through open bidding within renewable energy market and strived to shift paradigm. In relation to public bidding model, the German government set up three goals such as plan improvement, better competitiveness, and enhancement of diversity. It maintained its renewable energy stance confirmed in 2014, improved the plan for effective management of future expansion business through bidding, and encouraged competition among operators of energy generating facilities to compensate renewable energy electricity enough to operate the generating facilities by reducing costs for securing renewable energy. Furthermore, Germany diversified power generating equipment companies encompassing from small companies to large corporations, provided fair opportunities, and enhanced diversity in order to apply a simplified and transparent bidding model for the equipment of power capacity of 750kW or more (in case of biomass, 150kW). Germany's Federal Ministry for Economic Affairs and Energy emphasized that this amended act would be able to plan or control Germany's energy transition policy and become a backstay that will lead to cost effective, continuous success.

1-2. Germany's Experience and its Implications for South Korea

South Korea has the lowest-level penetration rate of renewable energy among the OECD countries, and its renewable market has not been stabilized yet. Therefore, it is required to have improved support system in Korea. Moreover, in realizing sustainable, affordable, stable energy supply and its transition, there should be supports from the general public and political & industrial sectors to reform electric charge system. Hence, even though it is difficult for Korea to bring Germany's energy policy just as it is, Korea needs to learn the whole process of energy transition including policy enactment and amendment, participation of stakeholders, opinion gathering, information sharing, etc. This will become an opportunity for South Korea to lead global energy market like Germany, beyond Korea's energy transition.

German energy transition project first started as a small energy project, but it is now more than just simple energy project. Germany establishes better energy policy based upon energy incidents in Germany and the outside world and often amends the conventional policy. At this time, Germany prepares the policy as a long-term plan, and even if its administration may change, Germany pushes forwards, in most cases, the existing policy direction and details as they are. However, in the case of Korea, even though energy incidents occur within the nation, it is not easy to arrange opinions of many stakeholders during the course of new policy establishment or amendment, making it difficult to bring about tangible outcomes. In addition, if a new administration starts, conventional policy often changes its direction. With regard to this part, South Korea needs to consistently carry on the ultimate direction of energy policy based on German cases, and should create long-term, detailed policy.

[8] World Energy Market Insight, Background and Prediction of Energy Transition Policy in Germany, 2013

2. South Korea's Energy Transition Policy

2-1. Change in Korea's Energy Policy

Korea has proportionately high added value of energy guzzling industry, which shows steady growth. And since the nation has the world's highest level of energy efficiency, Korea stands at the crossroads that its domestic industry and energy structure should become low-carbon oriented by adopting compatible strategies between GHG emission and economic growth such as low carbon growth. Accordingly, South Korea's major energy source has shifted from firewood and charcoal to coal, from coal to oil and electricity with the gradual increase in the share of gas and thermal energy. Against this backdrop, the major reason of Korea's energy policy change is an introduction of competitive system of its energy industry. Until the 1990s, the Korean government pursued energy policy by focusing on efficient and stable supply of energy, necessary for economic growth and daily lives of Korean people amid poor natural resources. During this course, the Korean government's excessive restriction & intervention and energy policy centered on quantitative expansion have resulted in structural vulnerability such as high dependency on oil, less efficient energy use, weaker external competitiveness in the energy industry and reduced market functions. In the 1990s, the ultimate goal of Korea's energy policy was to supply energy in a stable, affordable way, which was required for the nation's economic growth, people's life and industrial production. Energy price was directly regulated by the Korean government. In the early 2000, Korea promoted the competitiveness of energy industry such as an overhaul of electricity industry structure, and the government minimized its market intervention while avoiding market failure.

In Korea, the need for energy transition began to emerge in the late 1980s. As tougher environmental regulations were accelerated globally, in order to curb GHG emission occurring from the energy use, Korea started to limit the use of fossil fuel energy such as oil and coal; and at the same time, transition to clean and renewable energy consumption emerged as an important issue, emphasizing the need for Korea's energy transition.

Since then, in the 1990s, as energy industry developed and government-led market control and industrial restriction continued, resulting in unbalanced issues of governance hampering self-sufficient growth of the industry, Korea began to adopt the policy of structural reform against monopoly of public companies and softened regulations with new economic policy. As a result, the coal industry had been rationalized, and oil price had been liberalized, greatly abolishing and lifting the government intervention system in the energy industry. The Korean government announced the first long-term power supply plan (1991~2006) in 1991 for stable supply of electricity for the long run. Then, it established the fifth long-term power supply plan that encompasses the plan up to 2015. In the 2000s, Korea introduced phased-in competition in the power industry for more efficiency of the power industry and better interest and right of consumers. It also reformed electric industry's structure in order to pursue privatization. Since then, to create a new concept of basic plan for power supply and demand, Korea changed the plan's title as "basic plan for power supply and demand".

The Lee Myung-bak Administration (Feb. 2008 ~ Feb. 2014)

Energy policy under the Lee Myung-bak Administration had basic directions called 3E: Energy Security, Efficiency, and Environment. Its aim was to make a harmonious balance among these 3E and to realize "low-carbon green growth", a key government paradigm of the Lee administration. Korea secured energy on a stable basis by developing oil and natural gas jointly with Russia or China, expanded previous administration's policy of strengthened environmental standards by linking it with industries, and strongly furthered energy & climate sectors as a key government task. Korea sought a society where strong growth is realized with less energy, environmental

pollution is minimized with energy, jobs and growth engines are created through green energy business, and the one where strong energy self-sufficiency and welfare are realized at a time of energy crisis.[9]

For balanced development of economy and environment, as the Lee administration nurtured the basis required for low carbon, green growth and it utilized green technology and green industry as a new growth engine. The Korean government enacted the "Basic Act on Low Carbon Green Growth". The Act aims to improve the lives of Koreans by realizing national economic growth and low carbon society and to take responsibilities in the international community as a more advanced leading nation. Through the efforts, the government strived to achieve energy independence and reduce environmental degradation and climate change by efficiently use energy and resource; it also tried to overcome economic crisis by developing green technologies and green energy. The Korean government set forth "low carbon, green growth as a national vision in creating new growth engine and jobs. Based on this, it set up 3 strategies and 10 strategic directions(see Table 4).

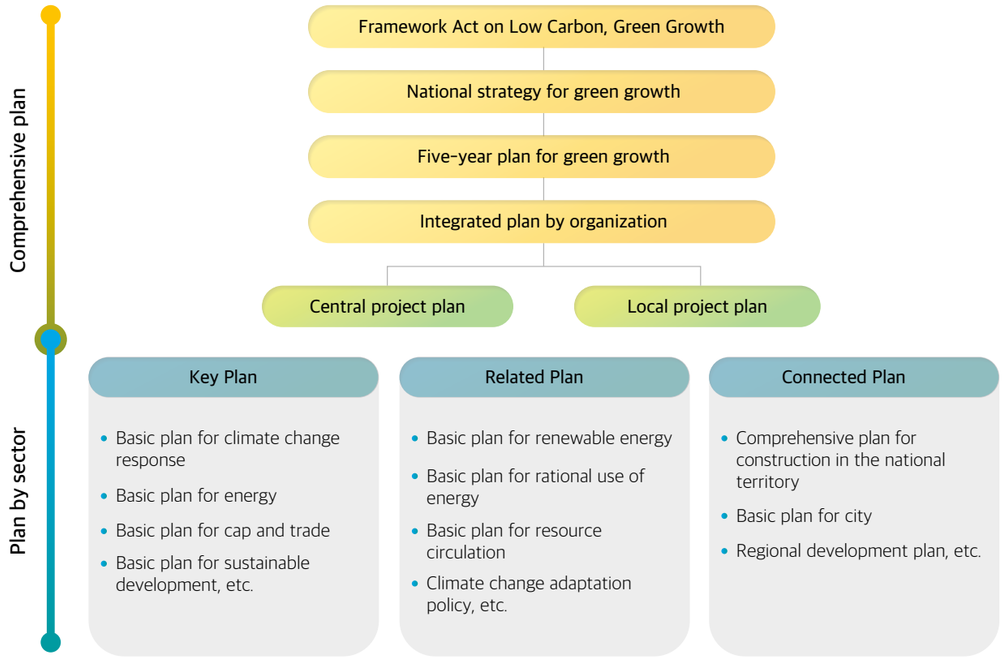
[Table 4] Key Policy Direction of Green Growth National Strategy (3 strategies and 10 policy directions)

Securing new growth engine	Improving the quality of life and environment	Establishment of national status
❶ Realizing non-petroleum energy and energy dependency	❺ Operating environmentally friendly tax system	❾ Green revolution in daily life
❷ Utilizing new growth in green technology and industry	❻ Creating green jobs and nurturing talents	❿ Becoming the world's exemplary nation in green growth
❸ Pursuing environmentally friendly industry and promoting green management	❼ Greening of the land	
❹ Boosting green financing	❽ Actively responding to climate change and relevant disasters	

After the announcement of "national green growth vision", the "Basic Plan for National Energy (Table 4)" set up basic direction of mid-long term energy policy in order to secure energy source required for sound development of national economy, stabilize domestic supply, establish supply infrastructure, and systematically respond to rational use of energy. Additionally, the plan suggested future-oriented energy policy direction such as realizing low carbon, green growth. In particular, as five visions of the plan, Korea put forth realization of energy independent society, transition to de-oil society, transition to low energy consumption society, new growth engine with green technology and green energy, job creation and realization of energy society for all. Especially, in the part of realizing energy independent society, the government aimed to increase the penetration rate of renewable energy from 2.2% in 2007 to 11% in 2030, and set up a goal of lowering oil dependency from 43.6% in 2007 to 33% in 2030.

The key policy goal of the first basic plan for energy was "low carbon, green growth", and aimed to reduce GHG emission by 30% by 2020, compared to the Business As Usual (BAU). This was meaningful in the sense that with these goals, Korea explored sustainability of energy industry, and suggested paradigm called new national growth engine through green technology. Consequently, as of 2012, the final energy increased by 3.3% compared to the first plan's prediction. And if this trend continued, it would increase by 13.3% in 2030. In the case of energy mix, among key tasks from the first plan, since nuclear power satisfied both environmental aspect and economy, it was expanded at a maximum. And as to the Feed In Tariff (FIT), renewable energy was aimed to increase by 11% at a maximum by 2030 through the Renewable Energy Portfolio Standard (RPS), 100 green homes project, etc. To this end, the Korean government designated sustainable development considering the above three Es (Energy Security, Efficiency, and Environment) as the most crucial target for the mid-long term energy policy. And particularly, along with global efforts to cope with climate change, GHG reduction had emerged as a key topic in the energy policy.

[Figure 16] National Green Growth Plan System



Source : the 2nd five-year plan for green growth

[9] Oh Jingyu, Korea Energy Economics Institute, Green Growth Strategy and Evaluation in the Energy Sector, 2010

Since then, the Korean government announced "five-year plan for green growth" in 2009, which includes basic direction of national policy in terms of low carbon, green growth, and specific implementation tasks. "The first five-year plan for green growth (2009~2013)" was the first one of the plans being established every five years for effective and systematic implementation of national strategy for green growth. Climate change had been elevated to national development agenda, not environmental agenda, and the administration set up GHG reduction target and launched reduction system by setting forth co-prosperity of economy and environment as a national development goal. To this end, it set up 30% by 2020 compared to the BAU, recommended by the Intergovernmental Panel on climate Change (IPCC) as one of the most ambitious national goals of GHG reduction among developing countries. In 2010, Korea aggressively introduced and implemented systems to reduce national GHG emission such as "management system of GHG energy target" for heavy emitters or "GHG integrated information center" in support of target setting. Through the efforts, it enacted the "Act on the Allocation and Trading of Greenhouse-gas Emission Permits in 2012, establishing the foothold for cap and trade. However, when considering injected finance, achievement in the major green industry such as photovoltaic power, smart grid, etc. was not satisfactory. And GHG emission, a key performance index, was on the rise. This is estimated that the government-led, supply-oriented policy eventually caused poor demand management.

The Park Geun-hye Administration (Feb. 2013 ~ Mar. 2017)

The Park administration's energy policy maintained and complemented the former Lee administration's green growth stance. Its energy policy focused on the safe use of nuclear power plants, expanded renewable energy system and energy demand management, realized a resource-recycled society by reducing wasteful resource and energy, built a base for stable energy supply with energy grid in Northeast Asia, and accomplished energy welfare without energy poverty, etc. The Park administration pushed forward its policy with principles of energy security, efficiency & equity, environment & safety, new industry, and communication & consensus. However, in responding to increasing energy demands, it valued energy supply more than energy efficiency or energy saving. Therefore, in terms of energy mix, as energy supply rather than energy efficiency or energy saving had become a key value, Korea expanded the portion of nuclear power from the whole generation facilities unlike other nations shifting to de-nuclear power policy since the Fukushima accident.

Following the "first basic plan for national energy" of the former administration, the 2nd basic plan for national energy" was announced in 2014, aiming to supply renewable energy by 11% compared to the primary energy by 2035. Under the principle of the 2nd plan, an energy plan is to be created and implemented every five years for the next 20 years. The 2nd plan's key details are ① trend and prediction of domestic and foreign energy demand and supply, ② measures to stably secure, introduce, supply and manage energy, ③ energy demand target, energy source composition, and better savings and more efficient energy use, ④ measures to supply and use environmentally friendly energy such as renewable energy, ⑤ measures for safe energy management, ⑥ technology development, nurturing professional workforce, international cooperation, resource development, energy welfare, etc. Since then, the "3rd basic plan for national energy" has been scheduled to be based on the "8th basic plan for power supply and demand" and "new renewable 3020 implementation plan."

[Table 5] The Main Points of the 1st and 2nd Basic Plans for National Energy

Category	The 1st (2008~2030)	The 2nd (2013~2035)
Announcement date	Aug. 2008	Jan. 2014
5 key tasks	Achievement of energy independent society • Independent development rate 3.2% → 40% • Renewable energy penetration rate 2.2% → 11% • Portion of nuclear power facilities 27% → 41%	Shift to the policy centered on demand management • Energy consumption reduction 13%, electricity demand reduction 15%
	Transition to de-oil society • Oil dependency 43.6% → 33%	Establishment of dispersed power generation system • Portion of power generation 5% → 15%
	Transition to low energy consumption society • Energy source unit 0.347 → 0.185(TOE/$1,000)	Environment protection and strengthened security • In terms of power generation, GHG reduction by 20%
	Creation of a new growth engine and jobs with green technology and green energy • Upgrade the level of energy technology to that of advanced nations	Strengthened energy security • Self-development rate 40%, renewable energy penetration rate 11%
	Achievement of energy society for all • Portion of energy poverty level 7.8% → 0%	Promotion of energy policy with the People • Introduction of energy voucher system
Goal of nuclear power portion (based on power facilities)	41%	29%
Goal of renewable energy portion (based on power amount)	11%	11%
Legal process	Decide by deliberation of the energy committee	Decide by deliberation of the energy committee, the green growth committee, and cabinet meeting

Source: Ministry of Trade, Industry and Energy

Based on this, the "2nd five-year plan for low carbon, green growth (2014~2018)" announced in 2014 was a complement to the "1st five-year plan for low carbon, green growth." Its most imperative content was effective GHG reduction, and other key details included establishment of sustainable energy system, creation of green creative industry, achievement of sustainable green society, and globally stronger green cooperation. To reduce GHG effectively, the Park administration implemented a roadmap to reduce GHG systematically, and stabilized cap and trade system while boosting carbon market and setting up a goal of long-term national reduction. Along with the efforts, for sustainable energy system, it enhanced energy demand management, expanded renewable energy supply, established dispersed-type generation system, and secured safety of energy facilities. Particularly, to increase renewable energy penetration, the administration improved and expanded renewable energy mandatory system while revamping support system and increasing investment. Moreover, for sustainable green society, it assessed effects of climate change by sector as well as vulnerability and advanced vulnerability assessment system of climate change in order to bolster the adaptability of climate change(see Table 6).

[Table 6] The Main Points of the 2nd Five-year Plan for Low Carbon Green Growth (2014~2018)

Category	The 1st (2008~2030)
Effective GHG reduction	• Systematic implementation of GHG reduction roadmap • Stabilization of cap and trade system and vitalization of carbon market • Establishment of long-term national reduction goals • Establishment of carbon sinks
Establishment of sustainable energy system	• Strengthening energy demand management • Expansion of renewable energy supply • Establishment of dispersed-type power generation system • Securing stability of energy facilities
Creation of green, creative industry ecosystem	• Development of advanced, converged green technologies • Nurturing green creative industry • Stabilization of resource-recycled economic structure • Rational regulations and cultivating green talents
Achievement of sustainable green society	• Strengthening the capabilities to adapt to climate change • Expansion of eco-friendly life base • Creation of green national territories • Establishment of the foundation for green welfare and governance
Stronger global green cooperation	• Effective response to climate negotiation • Expansion of regional cooperation in green growth and international dispersion • Expansion of cooperation among developing countries and enhancement of its outcomes • Strengthening cooperation with the GGGI/GCF and support for them

After that, the "4th basic plan for renewable energy," announced in 2014, aims to provide 11 percent of the primary energy with renewable energy by 2035. It aims to achieve the annual increase rate of 6.2%, 5% by 2020, 9.7% by 2030, and 11% by 2035. Additionally, the plan's another main goal was to create a mutually virtuous circle with domestic supply through aggressive overseas expansion, thereby securing self-sufficiency for sustainable growth(see Table 7).

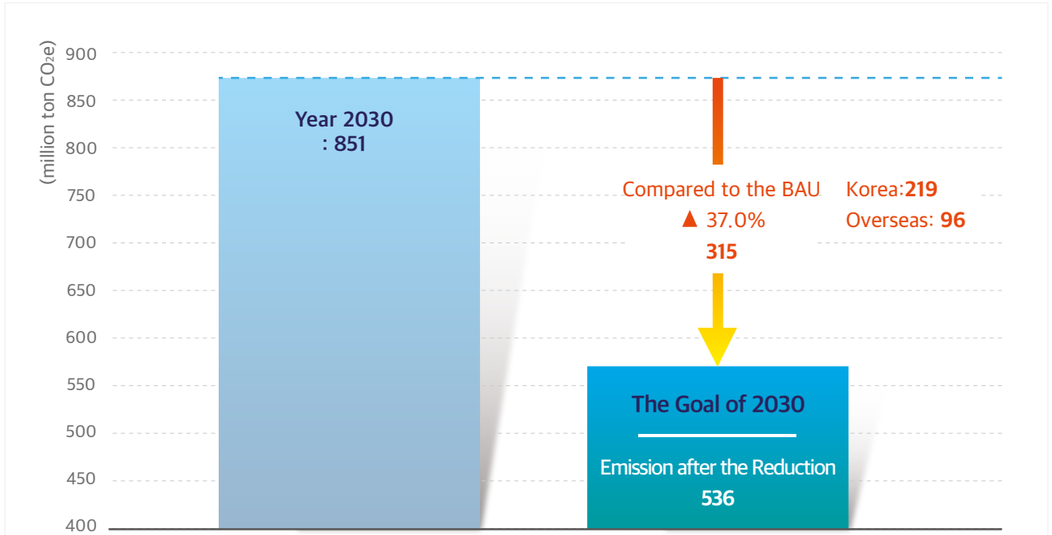
[Table 7] The "4th Basic Plan for Renewable Energy (2014~2035)" and Its Details

Category	The 1st (2008~2030)
Promoted policy of consumer-oriented supply and dispersion	• An increase in consumer participation • Consumer protection • Resource in strategic regions
Operation of market friendly system	• Rearrangement of RPS mandatory supply amount • The amount of implementation delay • Promotion of solar power supply • Grant variable weighed value in non-solar power • Market vitalization • Small scale support
Expansion of overseas market penetration in renewable energy	• Expansion of financial support • Information provision • Professional workforce support • Aid cooperation • Region-specific strategy
Creation of new renewable energy market	• Grant weighed value in REC • Promotion of renewable energy fuel mix system • Review on the introduction of integrated mandatory system in renewable energy
Bolstering R&D capabilities in renewable energy	• Task strategic advancement focusing on commercial technologies • Nurturing workforce and connection with employment in renewable energy sector
Establishment of systematic basis	• Support the Korean companies to go abroad

In relation with this, the "7th basic plan for electricity supply and demand" was announced in 2017: to put stable electricity supply at the top of the agenda, secure the preciseness and objectiveness of demand forecast, manage demand by actively utilizing energy new industry, intensify low carbon power mix for the POST2020 GHG reduction, establish a basis for dispersed-type power generation, and bolster implementation of power generation projects. Korea's energy transition policy has developed by focusing on these key words: green growth, low carbon, renewable energy, GHG reduction, etc.

Last, the Park administration set forth "GHG reduction roadmap", a comprehensive national response plan to climate change, including reduction targets and task allocation among members considering reduction by sector with the aims of effectively achieving 2030 national GHG reduction target of 37% (compared to the BAU) and successfully implementing the Paris Agreement in Dec. 2016. From the beginning, due to an early launch of new climate system, the roadmap was announced when specific implementation regulations of the Paris Agreement had not been created yet. The premise of the roadmap was to reflect the variability of the international climate change policy and rapidly changing domestic economic conditions in the future. The Korean government plans to build the "implementation roadmap" that has been revised and complemented annually until the submission of the Nationally Determined Contribution (NCD: scheduled for 2020) by reflecting international trends and domestic conditions based on the conventional roadmap.

[Figure 17] 2030 National GHG Reduction Target



Source : 2030 basic roadmap for national GHG reduction

2-2. Primary Energy Policies of the Current Government

The Moon Jae-in Administration
(May 2017 ~ May 2022)

Unlike the past, the newly launched Korean government starting from May 2017 shows different policy stance, mentioning environment and energy issues. It suggested clear stance and policy direction towards de-nuclear power energy transition in the initial stages of the administration. In particular, the Moon administration reflected "de-nuclear power" and "environmentally friendly future energy policy" in 100 tasks for the next five years of the government. While energy policy of the previous governments unilaterally focused on energy security and stable supply, the current administration emphasizes safe and clean generation sector. The biggest differentiation from the past administrations has been its emphasis on safe and clean development sector. The government secures the sustainability of nature and economy and put forth comprehensive sustainable strategy and policy.

Currently, as of 2016, Korea's renewable energy accounts for 7.0% of the power supply and 12% of the facility capacity. Renewable power generation shows relatively low level when comparing with major countries. And main composition by facility is also wastes and bio with a recent increase in solar and wind powers.

The new administration stopped the construction of a new No. 2 atomic power plant as the president pledged to pursue de-nuclear policy during the presidential campaign. Accordingly, the Korean government formed the committee for public opinions and a citizen participant group, resuming the construction of the No. 2 plant will be decided based on the result of public consensus. And the Moon administration announced "energy transition roadmap".

[Box 1] Energy Transition Roadmap

[The current status of phased-out nuclear power plants]

Category	No. of plant	Capacity	Target
New nuclear power plan	6	8.8GW	Sinhanul 3·4, Chunju 1·2, new 1·2
Old nuclear power plant	14	12.5GW	By 2038, 14 (Gori 2~4, Welseong 2~4, Hanbit 1~4, Hanwool 1~4)
Welseong 1	1	0.7GW	Welseong 1

❶ Phased-out reduction of nuclear power plants

- As to the Shin-Gori No. 5 and 6 power plants, construction will be resumed depending on the result of public opinions, and currently planned new power plant construction has become canceled.
- Old power plants will not be allowed to prolong its life, and the Welseong No. 1 is closed early considering stable power supply.
- According to energy transition roadmap, the nuclear reactor will be phased out from No. 24 in 2017, to number 28 in 2022, No. 18 in 2031, and No. 14 in 2038. These phased-out reduction measures are reflected in the 8th basic plan for power supply and demand and the 33rd basic plan for energy.
- In relation to phased-out nuclear power plants, fairly spent cost will be covered by reserves through negotiation of relevant ministries and parliamentary review, but if necessary, the government will establish legal grounds.

❷ Expansion of renewable energy

- Current 7% of the power supply that comes from renewable energy will increase to 20% by 2030. Clean energy such as photovoltaic power, wind power, etc. will be expanded to cover the reduced power coming from abolished nuclear power plants.
- To be specific, ▲transition from renewable energy centered on waste & bio to solar energy, wind power, etc. ▲ Support in small scale photovoltaic power business led by cooperative associations & citizens ▲ Prevention of reckless development through the introduction of planned site system ▲Expansion of new business through cooperation among the relevant ministries and public institutions
- Concrete strategic plan for renewable energy expansion will be reflected in "new renewable 3020 implementation plan" within 2017.

❸ Measures of regional & industrial complement

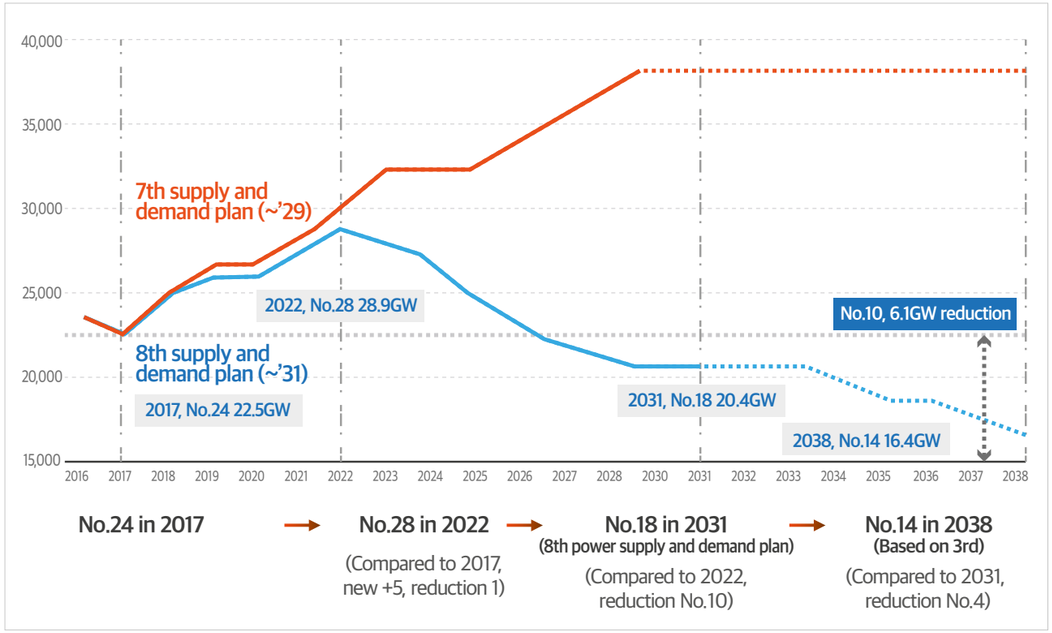
- Find complementary measures for regions and industries to be affected by energy transition to make a soft landing.
- With a permanent stop in the Go-ri No. 1, the government pursues development of 17 unsecured commercial technologies out of 58, and 11 unsecured original technologies out of 38. And in order to preemptively preoccupy overseas de-nuclear markets that are expected to be prosperous in the future, it promotes service for the establishment of de-nuclear research institution in the southeast of Korea.
- As a complementary measure to domestic industry change resulting from energy transition, nuclear power export is actively supported, and the Korean government pushes forward the summit & ministerial bilateral talks with Saudi, the Czech Republic, the UK, etc.

❹ Others

- The government promotes various business generating incomes with participations of residents and local governments, such as sharing renewable profit, utilizing hot waste water, etc. and create specific implementation measures through policy research service during 2017.
- To support successful market transition of small & mid-sized companies in nuclear power business, the Korean government establishes complementary measures in accordance with energy transition with the industry.

The roadmap of energy transition phases out nuclear power plants by abandoning the plan for new nuclear reactors and prohibiting the extension of lifespan of old nuclear power plants, in order to make a smooth transition to safe and clean energy. It also plans to increase the portion of renewable energy power by 20% until 2030. Accordingly, the government phases out from No. 24 nuclear reactor in 2017 to No.28 reactor in 2022, No.18 in 2031, and No.14 in 2038. This phased-out reduction measures were reflected in the "3rd basic plan for energy" and the 8th basic plan for power supply and demand (see Figure 18).

[Figure 18] Future Prediction of Phased-out Nuclear Plants



Source : Energy transition roadmap

Since then, the Korean government has established and announced "renewable 3020 implementation plan" based on "energy transition roadmap".

[Box 2] New Renewable 3020 Implementation Plan

❶ Goals for supply

- (Comprehensive) Considering stability in the power, supply conditions of domestic companies, and potential amount, set up the goal of 20% of the electricity coming from renewable energy by 2030.In relation to phased-out nuclear power plants, fairly spent cost will be covered by reserves through negotiation of relevant ministries and parliamentary review, but if necessary, the government will establish legal grounds.
- (By energy source) Supply more than 95% of new facility capacity with clean energy such as solar power and wind power

- (By year & subject) Provide 12.4GW in the short term (2018~2022) and 36.3GW in the mid-long term

❷ Phased-out reduction of nuclear power plants

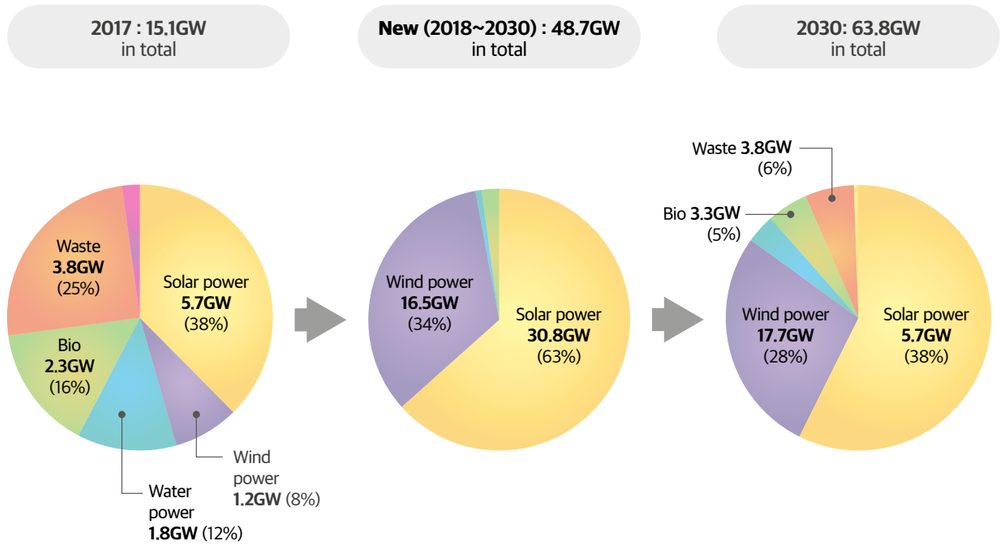
→ Transition to participating energy system that improves the quality of life

- (Sector) waste & bio oriented → clean energy supply such as solar power and wind power
- (Subject) focusing on out-of-towners & businessmen → encourage local residents and ordinary citizens to participate in the system
- (Method) Reckless development of individual site → Planned development of large scale projects
- Among 48.7GW coming from new facilities, 28.8GW is achieved by massive projects of power generators and the rest of the power is used for the projects involving people such as private facilities (2.4GW), small-sized business including cooperative association (7.5GW), solar power in farms (10GW), etc.
- Push forward large scale business in phases considering acceptability and environmental aspects
- In order to encourage people's participation in the business, if the households fail to use all power produced by private solar energy, the remaining power is purchased by the Korean Electric Power Corporation (KEPCO)
- Strengthen support for small photovoltaic power generators

Through this policy, the Moon administration greatly expanded the portion of renewable energy power generation to 20% by 2030 in order to explore and nurture eco-friendly future energy, and set up a goal of becoming a leading nation in new energy industrial sector and shifting to low carbon & highly efficient structure. According to the "new renewable 3020 implementation plan (announced in Dec. 2017)," Korea plans to raise the portion of renewable energy to 20% by 2030 and increase facility capacity of the renewable energy to 63.8GW. In

particular, it plans to supply clean energy such as wind and solar power to the level of more than 95% of the new facilities(see Figure 19).

[Figure 19] The Portion of New Facilities by Power Generation Source



Source : New renewable 3020 implementation plan

In order to achieve the goal, the Korean government devised the strategy to shift to energy system with people's participation for better life quality, thereby making a transition from wastes and bio to clean energy such as solar power and wind power. It also encourages ordinary citizens to participate in the project, and plans to develop large projects. After materializing the strategy, the government attempts to expand urban-type, private solar power in order to nurture an environment where people could easily take part in the solar power project, and boost photovoltaic power in rural regions with participation through cooperative associations and support for small business (less than 100kW). Additionally, to improve supply conditions for renewable energy expansion, Korea will establish a foundation for renewable energy increase through reforms in system and by bolstering capabilities of local governments. For more environmentally-friendly renewable energy, it will also reduce waste and wood pellet power generation. In addition, the current administration has proposed measures to nurture new energy industry through the "renewable 3020 implementation plan": to intensify industrial competitiveness in renewable energy, to cultivate energy new industry based on dispersed power, to grow service industry of demand management utilizing IoE, and to indentify new industry through smart city.

Along with the efforts, unlike the conventional basic plan for power supply and demand that had focused on stable supply and economy, the "8th basic plan for power supply and demand," was announced in Dec. 2017 after reinforcing environment aspect and safety.

[Box 3] The 8th Basic Plan for Power Supply and Demand (2017~2031)

❶ With regard to facility mix, Korea phases out nuclear power and coal while greatly increasing environmentally friendly energy mainly centered on renewable energy.

- In terms of nuclear power, the plan reflected abandonment of No. 6 new reactor construction, suspension of extension of old No. 10 reactor's life, and exclusion of supply of Wolseong nuclear power plant No. 1, etc.
- It abolishes the old coal power plant No.10 by 2022, and the coal power plant No. 6 including Dangjin Eco Power will change its fuel as LNG under the coal generation reduction plan.
- In terms of renewable energy, new facilities of 47.2GW with mainly solar and wind powers will be established, thereby increasing the power to 58.5GW by 2030.

❷ In relation to facility operation, the government proposed measures to increase LNG generation while decreasing coal generation through a harmonious balance between economy and environment.

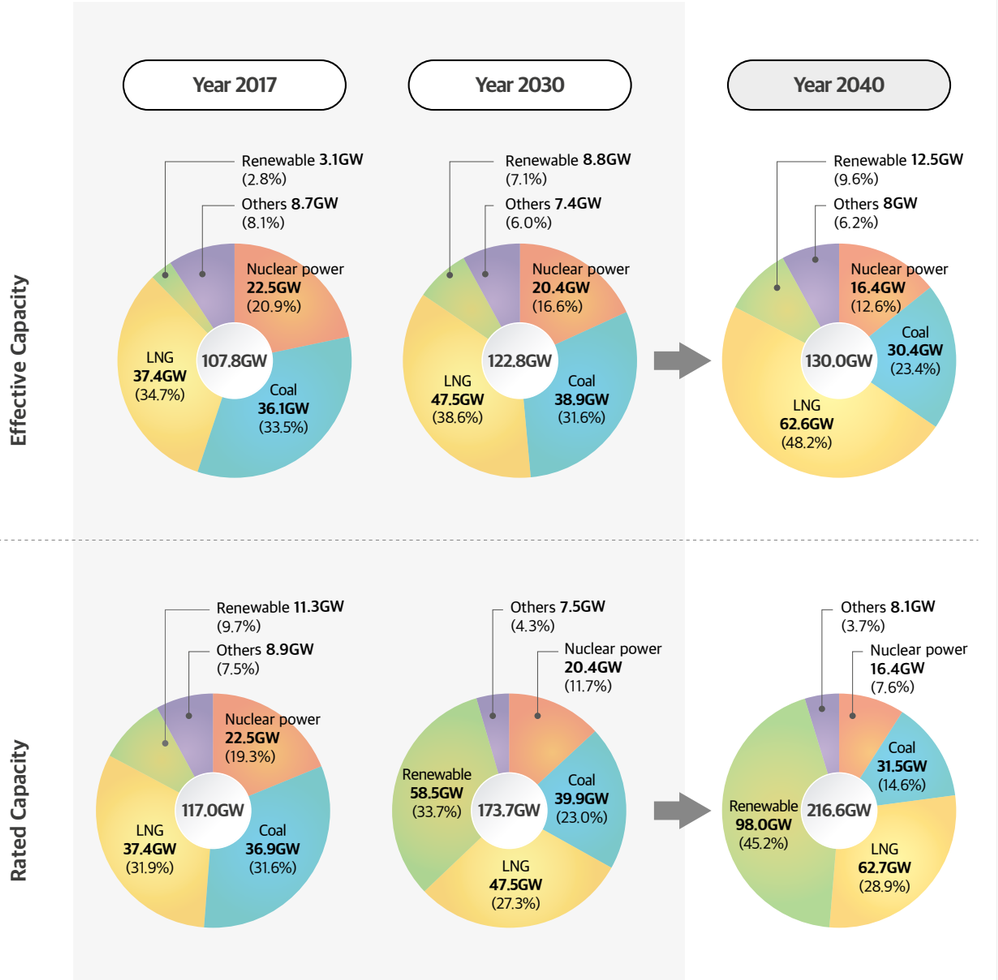
- When deciding a priority, the government reflects environmental cost such as GHG emission trading cost in order to reduce the cost gap between coal and LNG generations, and makes an additional tax rate adjustment by increasing special consumption tax of bituminous coal.
- Plan to shut down coal generators that are more than 30 years old in Spring and to further regulate the coal power generation within the region in case of fine dust alarm.

❸ As gradually expanding generation capacity and facility capacity of the renewable and LNG, achieve stable power supply and improve environment

- Due to sufficient facility compared to demand and phased-out nuclear plant reduction, stable power supply can be secured.
- It reduces fine dusts aggressively by 44% in 2022 and 62% in 2030. In 2030, GHG emission is also expected to decrease by 26.4% compared to the BAU, 237 million tons.

This plan ranges from 2017 to 2031. In terms of facility mix, nuclear energy and coal will be phased out while eco-friendly energy, mainly renewable energy, will largely increase. Accordingly, new nuclear power plant No.6 construction to be scheduled was canceled and the life extension of old nuclear reactor No. 10 was halted. Additionally, decrepit coal power plant No.10 will be abolished by 2022 and some of the coal power plant No. 6 will change its fuel as LNG under the coal generation reduction plan. In the meantime, in terms of renewable energy, 47.2GW new facilities will be added mainly with solar power and wind power, and by 2030, they will expand up to 58.5GW. Regarding this, the government proposed measures to reduce coal generation and increase LNG generation by making a balance between economic cost and environmental cost (see Figure 20).

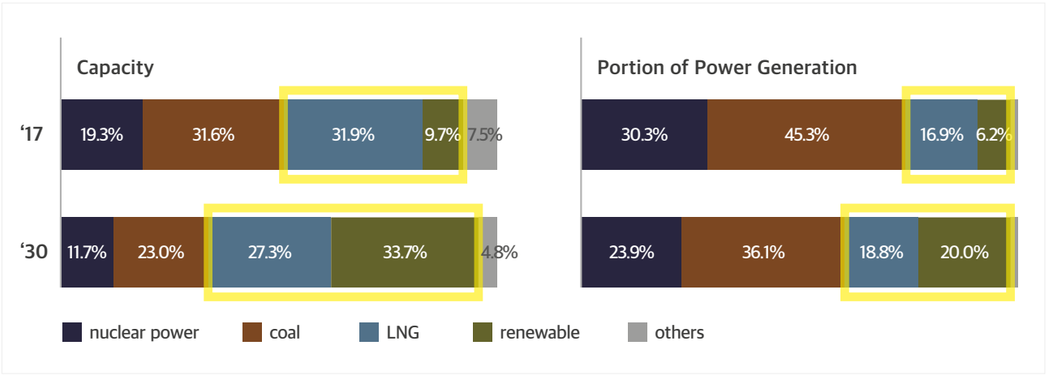
[Figure 20] Power Mix Prediction under the '8th Basic Plan for Power Supply and Demand'



Source : The 8th basic plan for power supply and demand

To this end, the Korean government will reflect environmental cost such as GHG emission trading cost when deciding a priority so as to reduce the cost gap between coal and LNG generations. It will also make an additional tax rate adjustment by increasing special consumption tax of bituminous coal. In particular, it plans to shut down coal generators that are more than 30 years old in Spring and to further regulate the coal power generation within the region in case of fine dust alarm under the concrete system. Through these efforts, as gradually expanding generation capacity and facility capacity of the renewable and LNG, the government will be able to achieve stable power supply and improve environment (see Figure 21).

[Figure 21] The Current status of Installed Capacity/ Power Generation Portion by Generation Resource and Its Plan



Source : The 8th basic plan for power supply and demand

At this time, thanks to sufficient facility compared to demand and phased-out nuclear plant reduction, stable power supply is expected to be secured. It is predicted that fine dusts will be aggressively reduced by 44% in 2022 and 62% in 2030. In 2030, GHG emission is also expected to decrease by 26.4% compared to the BAU, 237 million tons.

2-3. Expert's view on Current Energy Policy

With regard to the recently announced "8th basic plan for power supply and demand," experts assessed that the plan secures economy and goes along with the government guidelines of energy transition for safe, clean power mix. They, however, also noted that although renewable energy distribution policy has been materialized, since lack of implementation measures to increase renewable energy brings about uncertainty, there is a need for complementing the current scenario. While the current administration's policy is consistent with international circumstances in terms of environment, GHG, fine dust reduction, etc., lack of concrete measure failed to reflect strong willingness of the government to resolve environmental problems.

In particular, it is necessary to restrict the role of the government to the decision on power mix composition in planning process, and the government needs to avoid making direct decisions in the market. Against this backdrop, it will be necessary to actively solve the problems with proper solutions through the reduction of base equipment and improvement of the market system. Under the current Korean situation, since group energy and thermal energy by region, which have good energy efficiency, are being less used, efficient energy source has been required in nuclear and coal-oriented power generation. Based on this, Korea needs to consider energy efficiency of the society and expand renewable power and group energy to construct the energy of the society.

[Box 4] Experts' Opinion about Confirmed the "8th Basic Plan for Power Supply and Demand (2017~2031)"

※ Refer to Box 3

● **General Review**

A : The 8th basic plan for power supply and demand is in line with the government guidelines of energy transition, and distribution policy focusing on renewable power has been materialized.

B : With reduced demand, various policy goals were not included in the plan in terms of sufficient GHG reduction measures. Furthermore, since there is still a lot of uncertainty in reducing nuclear power plants and increasing renewable energy, there is a need to complement the current scenario.

C : This time's plan was established that renewable energy replaces nuclear power for energy supply amid lower electricity consumption. From the aspect of power supply source, since nuclear power is more stable than renewable energy, power supply is likely to be unstable.

D : The 8th plan lacks implementation measures following increased renewable energy and reduced coal and nuclear power. In terms of the coal, as the plan is completely contrary to the 7th basic plan for power supply and demand, long-term measures are required in terms of energy market and electricity market.

E : Citizens acquired insufficient information in that there is the lack of sufficient information disclosure and poor opinion sharing procedures with civic society such as consumers or civic groups in the course of establishment of the 8th basic plan for power supply and demand. The plan should have come out after publicizing with stakeholders.

F : Compared to what was presented in the early years of the government, the 8th plan is seen as a compromised plan. In addition, while its basic direction emphasizes "environment", "GHG", and "fine dust reduction", the policy to reduce coal power generation is insufficient, So the government's commitment to resolving environmental problems such as GHG has not been fully reflected.

● **Necessity of the Planning System of Market Regulation**

B : It is right for the state to set only power mix because it is not right for the government to designate capacity and region, including facilities, within the market, while excluding most regulations in the electricity market. Although there are reserves left now, since there are many people who want to build a power plant, the government's physical restrictions are not necessary. The government needs to change the supply plan outside the framework of market decision.

E : This is an institutional plan problem. In South Korea, the KEPCO leads electricity production and supply under the monopoly system rather than private sector's autonomy. Since electricity is an absolute energy source in Korea, in the current situation, it is right that the nation presents a certain direction. If it is left only to the market logic, small private power generators such as renewable energy will not survive.

C : There is no need for the government's intervention amid the power demand growth of 1%. When the power mix goes in the direction that the government does not want, the government will be able to do the regulation and support, not the direct planning.

● **Subsequent Follow-up Measures of the Basic Plan for Power Supply and Demand**

G : The fact that power supply and demand plan is built every two years does not guarantee immediate effects. The plan reflected nuclear policy, but in relation to environment, coal regulations are important. It would be more appropriate to announce the regulation figures than to include coal power generation.

A : In terms of power system, Korea's nuclear power generators do not have frequency control function, so it is difficult to maintain good frequency quality. In Japan, a pumped-storage power plant, which accounts for about 10% of the total capacity (about 50% of the capacity of nuclear power generators), allows for more flexibility, but in the case of South Korea, due to the high share of nuclear power generation, it is difficult to keep good frequency quality. Two-thirds of the planned back-up power sources come from nuclear power generators in the 8th basic plan. However, taking into account that France does not consider 100% de-nuclear power for the time being, due to the burden on the CO2 reduction target, Korea's policy change may be needed depending on the future CO2 reduction target.

● **Subsequent Follow-up Measures of the Basic Plan for Power Supply and Demand**

F : During the presidential election campaign, the president's pledge included a plan to raise gas utilization rate to the level of 60%. And the 8th plan also announced the "expansion of LNG". However, gas generators would have been frustrated by the 8th plan. Due to the massive inflow of base equipment, the share of gas power generation in 2030 is expected to be only 18.8%, even after reflecting the environmental cost and tax reforms. It is not desirable to turn the management aggravation of gas generation companies, which were built as a countermeasure in times of lack of facilities, to their responsibility. Therefore, aggressive solutions are needed through reduction of base facilities or market system improvement.

E : When the state talks about the GHG reduction plan, it should include the burden of our future generation. Accordingly, the 9th basic plan needs to be more concrete in terms of GHG reduction. At present, Korea less prefers group energy and thermal energy, which have good energy efficiency, leading to the collapse of energy efficient source with nuclear energy and coal-oriented electricity production. It is necessary to consider the energy efficiency of the society, and the government needs to create the energy system of society by expanding renewable energy and group energy, which are the main stay of the private sector, while appropriately compensating.

● **Subsequent Follow-up Measures of the Basic Plan for Power Supply and Demand**

F : According to the disclosed plan, there are few factors to raise electricity rates until 2022, and thereafter, the rate increase is only marginal. However, if such details are included in the basic plan, fixing the electric rates becomes policy goal, hindering other policies for energy transition. The past 6th and 7th plans only mention proper electric rates or realization, and never included the above. It is desirable to delete the part related to the rate hikes of this plan. At least under the certain circumstances such as the rise in international fuel prices, it needs to mention there could be a higher increase in the rates than suggested.

D : As the resources needed for the actual industry come from consumer rates, since most of the expenses will increase, the KEPCO will have to bear the burden without increasing electricity rates. A lot of problems so far have occurred without a rise in electricity rates. The rate hike is unavoidable to solve difficult gas generation problems or to invest in the expansion of renewable energy.

C : I cannot agree that the electricity rate increases by only 10%. By lowering the wholesale price of renewable energy with zero marginal cost and variable cost, the SMP decreases as the renewable energy increases. For now, Currently, SMP has been lowered due to the drop in gas prices, but as the renewable energy is expanded thanks to the adjustment of the energy mix composition, the SMP becomes lowered, If the pricing system and structure are not changed, the gas generators will face bankruptcy and the coal sector will be in danger, too.

● **Policy Issues**

B : As the 8th basic plan was announced, participants in the electricity market will also look for a balance of adequate profits based on the supply and demand plan. If problems in the electricity market are accumulated due to the current institutional problems, the government will ultimately need to find measures to solve them.

A : The basic plan for power supply and demand is a plan for minimum equipment, and how it operates, and how it compensates in the market is another story. If renewable energy is expanded, there is a limit to respond to the current electricity market system. Therefore, the need to improve the changes in the electric power market system and regulations is mentioned in the IEA Report. In the current CBP market, there is no way to solve the risk of profitability according to the changing environment. Therefore, it is necessary to introduce the regulatory contract first and discuss the improvement of the market system in the long term.

Academic circle (A, D), National R&D institutes (B, C, G), civic group (E), Legal circle (F)

Furthermore, the Korean government announced the "2030 basic roadmap of national GHG reduction." Since the roadmap adopted the national GHG reduction target based on predicted emission amount rather than the absolute value and there has been a controversy over the effectiveness of the foreign reduction of 11.3% and the ambiguity of the reduction target, problems of the procedural legitimacy of the basic roadmap has been raised along with the issue of the acceptability of the public. Hence, the Korean government plans to complete revision of the "2030 basic roadmap of national GHG reduction" in the first half of 2018 by reflecting de-coal and eco-friendly energy transition from the "energy transition roadmap", "renewable 3020 implementation plan", and the "8th basic plan for power supply and demand," which bolstered environment aspect and stability.

In the Korea's NDC submitted to the IPCC, Korea plans to reduce GHG by 37% compared to the BAU by 2030. Among them, although 11.3% was planned to use foreign reductions, if Korea raises the reduction targets and maximizes domestic implementation considering the BAU natural reductions due to the decline in electric power demand, Korea will be able to achieve the 37% reduction target by 2030 without foreign reductions. In addition, basic roadmap also needs to be set up by considering long-term reduction target and to assess 2030 reduction targets from the long-term reduction target of 2050. By 2030, it would be desirable to set up the total emissions of GHG and allocate them by every five years or annually.

This roadmap has close relations with key energy policies such as current "GHG cap and trade system," the existing "8th basic plan for power supply and demand" or the "3rd basic plan for energy". Accordingly, compatibility between policies and opinion sharing of stakeholders are crucial in achieving the comprehensive policy goal. This means that the "3rd basic plan for energy," the "8th basic plan for power supply and demand" and the "basic roadmap of national GHG reduction" should follow same direction with compatible policies and have same content regardless of the specific plan's confirmation or announcement through close negotiation among competent ministries. In addition, data used for relevant plans should be also coordinated. Each plan's competent ministry is different, and there could be political uncertainties due to the difference in details of statistics.

[Box 5] Expert Opinions of the "2030 Basic Roadmap of National GHG Reduction

A : The most concern of the industry in the reduction roadmap is if the industry might have to bear foreign reductions of 11.3%. The roadmap was created in Dec. 2016, and amended within less than 2 years. Frequent policy changes make it difficult for the government and industrial sector to build trust. It is important for the government to disclose basic data and establish a roadmap by enhancing the reliability of official data.

B : GHG draws less attention from the public compared to energy and fine dust issue. It is important to establish proper policies and implement them on a stable and consistent basis. The key point is how to secure compatibility among different energy transition policies including national GHG reduction target of 37% by 2030, the "8th basic plan for power supply and demand", 3020 renewable energy, etc. According to the 8th plan, reduction rate increased from 19.3% to 26.4%, which needs to be reflected in the roadmap. The 8th plan covers increased coal generation and decreased LNG generation, which is not desirable separate from the GHG reduction target. This roadmap should guide right direction in terms of GHG reduction.

C : Some insist that Korea reaches the peak of emission. Korea's GHG emission has steadily increased. Additionally, considering the fact that Korea's emission has not reached its peak, discussions are required regarding whether it is desirable to adopt the total amount target like advanced nations. Furthermore, 24.6% of the reduction rate in the power generation sector according to the 8th plan does not exceed the target of reducing GHG emissions because it includes indirect emissions from industrial and transportation sectors. The problem is that it is important to develop mitigation measures because there are few means to further reduce 5 million to 10 million tones.

D : In last December, the 8th basic plan for power supply and demand was announced, and basic roadmap of national GHG reduction is scheduled to be completed after revision in the first half of this year. Consequently, the 3rd basic plan for energy will need to reflect the previous two plans. The desirable direction would be to include "low carbon" concept, which was omitted in the 8th plan, in this time's basic roadmap, thereby reflecting it in the future energy basic plan and the 9th plan.

E : Do not separate 11.3% of overseas reductions and set the basic direction of revision that the whole nation will reduce the domestic reduction target of 37%. Also, considering the industrial competitiveness, the tacit condition to decrease the industrial reduction rate of 12% should be reconsidered. Since it is not appropriate to set a separate category for the energy new industry, it is necessary to remove this and to reset the sectoral reduction targets including this part. Also, it is necessary to adopt the already approved GHG reduction measures (eg, cogeneration, multi fuel fired power generation, etc.) to be utilized by corporations. Most importantly, the government needs to jointly consider the reduction roadmap, the emission trading system, the fine dust countermeasures, and the energy basic plan in an integrated manner.

Industrial sector (A), National R&D institutes (B, C), Private research institution (D), Civic group (E)

3. South Korea's Energy Transition and its implications for Energy Security

3-1. Conceptual transformation : From Energy Security to Energy Transition

Energy policy of Korean governments has emphasized energy security. Given that most energy sources are imported, securing reliable and affordable energy resources is critical policy aim. The question is how to secure reliable and affordable energy sources. Previous energy policy through Energy Basic Plans and Electricity Supply and Demand Plans enlarges nuclear energy in the energy mix. While there were efforts to increase the portion of renewable energy sources, energy statistics shows that biomass or waste to energy accounted for 85% of renewable energy consumption. In addition, previous governments intended to increase the portion from nuclear power. This tendency is different to energy transition efforts in Germany. German energy transition through the Energy Concept and the Energy Package declared moratorium of nuclear power and increase wind and solar energy in its energy mix.

Conceptual transformation takes place in current energy policy in Korea. 3020 policy and 8th Electricity Supply and Demand Plan aim to decrease nuclear power reliance and to increase wind and solar power in the

energy mix. To secure reliable and affordable energy, current energy policy transforms from fossil fuel and nuclear energy based system to decentralized renewable energy system. German experience in energy transition can provide the lessons for Korean energy transition. First, energy transition in Germany can provide lessens on how a country secure affordable energy sources. Pricing electricity is economically and political a sensitive issue. Second,

German experience in energy transition also suggests lesson how to secure reliable energy sources, given the intermittent attributes of renewable energy sources.

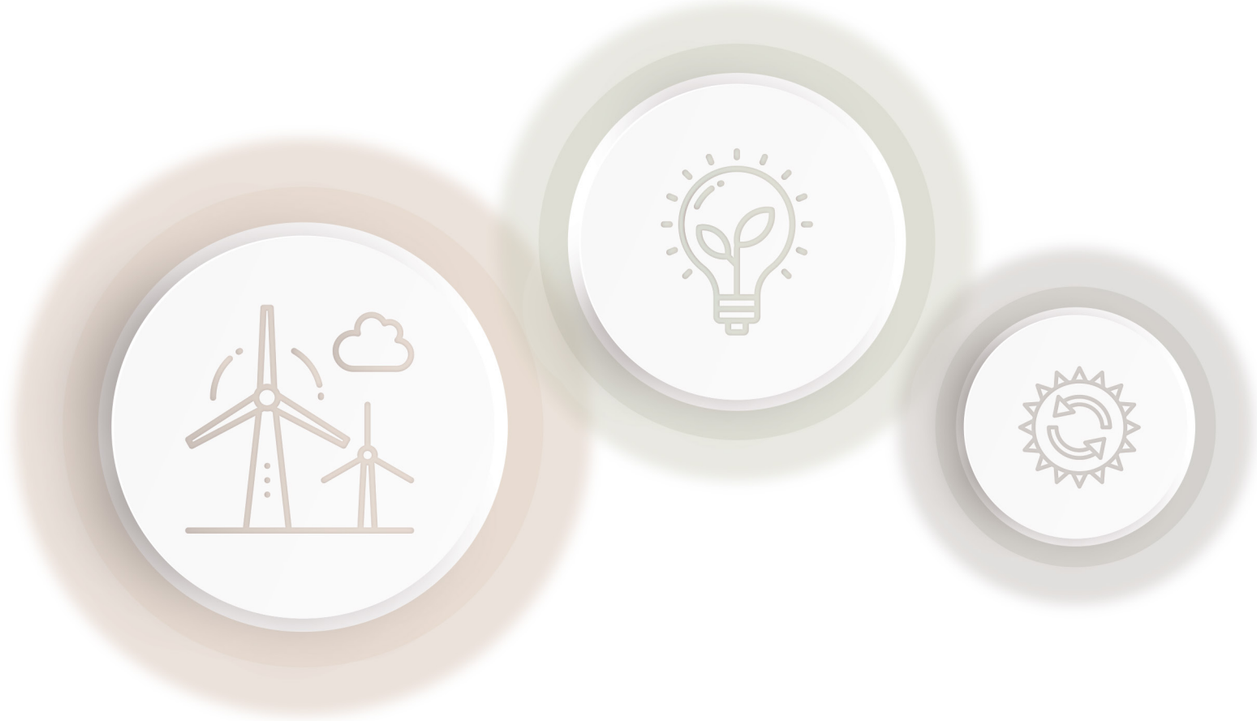
3-2. Regional Energy Cooperation for Energy Security

Regional energy cooperation for energy transition in Asia needs to focus national as well as local cooperation. As discussed above, energy transition aims to transform from centralized fossil fuel based energy system to decentralized and renewable oriented energy system. Cooperation over decentralized renewable energy system should be different conventional energy cooperation.

First, as energy transition aiming to build up decentralized and renewable oriented energy system, regional cooperation can be facilitated by cities and provinces. Some local governments around the world have formed climate change and energy policy networks for collective actions. In addition to national governments, local governments can become initiators in energy transition policies.

Second, regional energy transition cooperation focuses more on knowledge and experience cooperation rather than infrastructure connections. As its decentralized attributes which minimize the negative impacts of high voltage transmission powers and connection, regional cooperation of energy transition highlights the knowledge economy, encompassing best practices of energy transition policies, finance and governance. To this end, hosting regular regional energy transition conference with stakeholders can facilitate information, knowledge, and practice sharing.

Third, regional energy transition cooperation need to ensure civic participation in energy policy making process. Conventional energy policy making has been conducted by national government, experts, utility companies and industries. However, energy transition requires civic participation for wide adoption on renewable energy sources, smart grid and energy storage technologies. By having public-private-civic partnership and governance, regional cooperation can share the way to make decision on energy transition in Asia.



Chapter 3. Conclusion

1. Conclusion

Asian countries, particulary Korea, have heavily relied on imported energy sources more than 90 percent (94% of its primary energy). As seen in the inter-chapter, fossil fuels including oil, coal, and gas account for about 85%.

In addition, to support rapid economic growth and manufacturing industry, Korean government and utility companies have provided relatively cheap electricity resources. Electricity comes from fossil fuels (coal 39%, LNG 19%, oil 6%) and nuclear energy (31%). This results in large amount of GHG emissions. The portion of renewable energy and hydro energy is relatively low (4% and 1% respectively).

Increased coal consumption due to nuclear power plants safety test after 2011 begot environmental side effects such as particle matter air pollution. Power sector accounts for 60 % of coal consumption for baseload power; and industry does 38%.

Nuclear energy accounts for 33% of total electricity power generation (528,091 GW in 2015). Current Korean government announced energy transition policy aiming to reduce reliance on nuclear energy and coal power plants.

Renewable energy in Korea ranked low (lowest as 34 OECD countries). Only 4.5% of final energy consumption comes from renewable energy, but mostly from waste incineration (64%). Currently Korean government announce new renewable 3020 implementation plan to achieve 20% renewable power in energy mix by 2030. For this, 53GW of new renewable energy facilities need to be constructed. As policies tools, the government implements renewable portfolio standard (RPS) for the raise of obligation rate by 28% in 2030.

In summary, energy supply and demand in Korea requires energy transition. First, Korea imports most of energy sources (more than 95%). Second, imported energy sources are mostly fossil fuels including coal, gas, and oil. Third, nuclear energy accounts for large portion of electricity generation. Fourth, Korea declared 37% of GHG reduction as NDC under the Paris Agreement. Considering these factors, the current government proposed energy transition as national energy agenda. Energy transition aims to build up renewable energy oriented, decentralized, and smart energy system.

Qualitative interview of this study identified barriers for energy transition plan and implementation. First, lack of public support and participation in renewable energy policy can impede the advancement and adoption of renewable energy. German energy transition history began 1970s that resulted in the creation of political party such as Green Party. According to a public poll, 92% of Germans support the energy transition to phase-out nuclear energy and fossil fuel, and to reduce GHG emissions. However, energy transition has not been mainstreamed in South Korea. Second, lack of financial support and investment is a primary barrier against energy transition. Compared to German feed-in tariff (FIT), South Korea currently does not have FIT to provide financial incentives to install more renewable energy sources. Third, insufficient renewable policy hinders energy transition. Renewable portfolio standard (RPS), for example, is in favor of large companies, limiting small investors in financing from banks. Third, weak renewable energy policy implementation agency is also a barrier to deploy renewable energy for sustainable energy security. In addition, the link between climate change mitigation and renewable energy adoption in Korea has not developed yet. National government highlights market-oriented reduction mechanism (such as emission trading system) rather than renewable energy deployment for climate change mitigation. These barriers resulted in low renewable energy supply (1.24%, as of 2015) of total primary energy supply, comparted to 12.49% of renewable energy mix in Germany.

2. Policy Suggestions

The current Moon administration declared energy transition as national energy policy direction. The 3020 policy aims to raise the portion of renewable energy from 1.4 percent to 20 percent by 2030. Coal and nuclear energy portion in energy mix aims to be reduced to 22 percent and 21.6 percent respectively by the same due. The current South Korean government is receptive to the concept of energy transition. It would be significant opportunity for experts, civil society, and renewable energy industry to engage in energy transition policy making process.

Based on the identified problems of this study, we suggest following policy recommendations.

- Mainstream energy transition. The concept of energy transition is new to the public. It is critical to inform what it is, why it is important, and how we can achieve it. Debates, deliberative polls, participatory hearing and other public relations to persuade the public and stakeholder in energy arena would facilitate mainstreaming energy transition. Furthermore, mainstreaming strategy can emphasize co-benefits of energy transition including reducing particle matter from fossil fuel reduction.

- Provide financial supports. The feed-in-tariff scheme can provide stable incentives for renewable energy adoption. FIT is an effective measure to enhance small and medium sized renewable energy providers. National renewable energy fund would be to promote research, production, test, and deployment of renewable energy solutions.

- Establish an energy transition institution. Planning and implementing energy transition can be facilitated integrated energy transition institutions. An agency dedicated to energy transition is be to vision, frame, and implement policies and programs.

- Building up regional energy transition cooperation scheme. Countries in the East Asia do not have much experience of energy cooperation. Cooperation for energy transition can provide co-benefits of economic growth and environmental sustainability. Knowledge based cooperation scheme on energy transition can share success and failure of energy transition technologies and policies.

3. Call for future research

This study mainly focuses on the national level energy transition policies. Future research can highlight the importance of local level energy transition technologies and policies. Energy transition actually takes place in local areas (cities and community) with coordination of national policies. Particularly, cities become the centers of innovation in energy transition experiments. Cities are also forming transnational climate and energy governances. In the East Asian region, city networks including CityNet, C40 cities Climate Leadership Group, ICLEI-Local Government for Sustainability service their member technical and policy related information, provide discussion arena, and climate change and energy related standards to follow. How cities in Asia can cooperate in the topics of energy transition would be a good avenue for future research.

In addition, research can look at under what condition energy transition can achieve the proposed goals. To this end, future research can examine political economy, institutional setting, and technological development for successful energy transition in Asia. By doing this, countries in Asia and other regions can share the experiences of success and failure in energy transition process.

Reference

- Kim Yeongyu, Center for Energy Governance & Security, Lee Myung-bak Government's Energy Policy Assessment, 2012
- Kim Bonggeum, Korea Energy Economics Institute, Background and Prediction of Energy Transition Policy in Germany, 2013
- Jevin Fischer, Zandrabatge, The German Institute for International and Security Affairs of the Stiftung Wissenschaft und Politik (SWP), Germany's Energy Policy
- Between "Green Industry Policy" and Pragmatic Climate Policy, 2011
- Woo Cheongwon, Science & Technology Policy Institute, The Contrast of German Energy Transition Policy, 2017
- Song Yongju, Korea Economic Research Institute, Trends and Implications of Energy Transition Policy in Germany, 2016
- Yoo Dongheon, Korea Energy Economics Institute, Assessment and Implications of Energy Transition Policy in Germany, 2014
- Oh Jingyu, Korea Energy Economics Institute, Green Growth Strategy and Evaluation in the Energy Sector, 2010
- Choi Hyeonjeong, The Asan Institute for Policy Studies, Expectations and Suggestions for the New Government's Environmental and Energy Policies, 2017
- Woo Cheongwon, Science & Technology Policy Institute, The Contrast of German Energy Transition Policy, 2017
- Korea Energy Economics Institute, Analysis of the Effects of the Power Composition of the New Government, 2017
- Gang Byeonghui, Deloitte, The Energy Policy of the New Government and the 8th Basic Plan for Power Supply and Demand, 2017
- Lee, T., Lee, T., Lee, Y., 2014. An Experiment for Urban Energy Autonomy in Seoul: The One Less
- Nuclear Power Plant Policy. Energy Policy 74, 311-318.
- Morris, C., Pehnt, M., 2016. Energy Transition: The German Energiewende. Heinrich Böll Foundation, Berlin.
- Paul, H., Lee, T., 2017. Compliance with Climate Change Agreements: the Constraints of Consumption. International Environmental Agreements : Politics, Law and Economics 17, 779-794.

South Korea's Energy Transition
and ts Implications for Energy Security

기후변화센터
CLIMATECHANGECENTER

energy +climate

Konrad Adenauer Stiftung