Ministry of Trade, Industry and Energy No. 2017-611
(December 29, 2017)

The 8th Basic Plan for Long-term Electricity Supply and Demand (2017 - 2031)

December 29, 2017

산업통상자원부

Notice by the Ministry of Trade, Industry and Energy
No. 2017 - 611

Notice of the 8th Basic Plan for Long-term Electricity Supply and Demand (2017-2031)

The following is the 8th Basic Plan for Long-term Electricity Supply and Demand (BPLE) (2017 - 2031) pursuant to Article 25 of the Electric Utility Act.

December 29, 2017
Minister of Trade, Industry and Energy

Contents

I. Overview

1 Legal Background: The BPLE was established pursuant to **Article 25 of the Electricity Utility Act and Article 15 of the Electricity Utility Decree** biennially for **mid-to long-term forecast of electric power demand and the corresponding installation of more electric facilities**.

* The 1st Basic Plan for Long-term Electricity Supply and Demand was established in 2002 and a total of eight BPLEs have been released so far.

2 Period: 15 years (8th BPLE: 2017 – 2031)

3 Characteristics: Evaluation of the previous BPLE; long-term outlook for electric power demand; goals for the management of electric power demand; plans for facilities for power generation, transmission; and efforts to reduce greenhouse gas emissions

4 Procedures: Working-level plan (WG) → **Consultation among ministries** → government draft → **report to the National Assembly Standing Committee** → **public hearing** → **review by the EPRB (Electricity Policy Review Board)**

< History>

- Dec. 2016: BPLE Kick-off
- Jun. 2017: Subcommittee reorganized for the 8th BPLE
  - Six new working groups under the subcommittees for renewable energy, capacity margin, demand management, and other issues
- Dec. 2016 - Nov. 2017: A total of 43 rounds of review by the Integrated Supply-Demand Committee, subcommittees, and working groups
- Jul. - Aug. 2017: Release of drafts on demand forecast and facility plan
- Sep. 2017: Demand reforecast, capacity reserve, and strategy for renewable energy intermittency
- Sep. 2017: Report to the Trade and Energy Subcommittee under the National Assembly Industrial Committee
- Dec. 2017: Consultation with the ministries concerned
- Dec. 14, 2017: Report to the Trade and Energy Subcommittee under the National Assembly Industrial Committee
- Dec. 27, 2017: Report to the Trade, Industry, Energy, SMES, and Startups Committee(National Assembly)
- Dec. 28, 2017: Public hearing
- Dec. 29, 2017: EPRB review & conclusion

II. Status of Electricity Supply and Demand

◇ **The capacity margin has been maintained at 15% or above** since summer 2014 to provide a stable supply of electric power.

* Capacity margin at peak demand: (2013) 12.8% → (2014) 16.3% → (2015) 18.3% → (2016) 17.6%

◇ New power generation facilities increased faster than electricity demand.

* Growth rates of peak demand: (2007 - 2011) 4.4% > (2012 - 2016) 3.1%
  Growth rates of installed capacity: (2007- 2011) 3.9% < (2012 - 2016) 5.9%

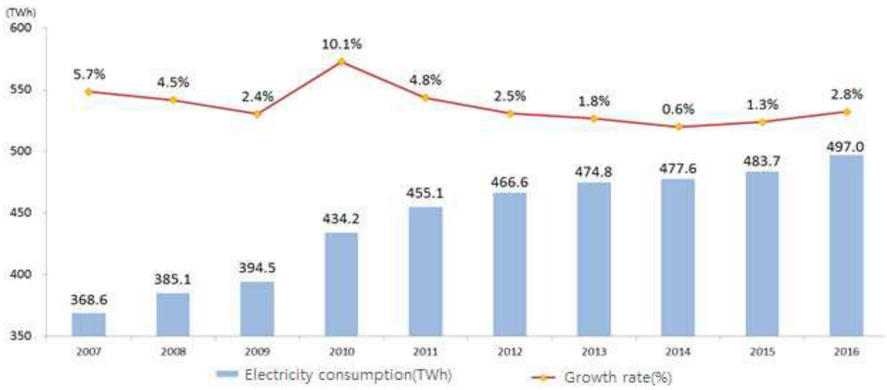
1 Electricity Demand

1. Electricity Consumption

1 Annual Trend: The total electricity consumption in 2016 amounted to 497.0TWh.

○ The annual average growth rate in the past five years (2012 – 2016) was 1.8%, which is one third of the average growth rate (5.5%) between 2007 and 2011.

< Trend of Electricity Consumption by Year >



○ Electricity consumption between 2012 and 2014 increased slowly because of the intensive management of electricity demand including forced demand curtailment and the rise in utility electric rates.*

* Growth rates in utility electric rates : (2012) 10.9%, (2013) 7.3%, (2014) 4.7%

○ The growth rate of electricity consumption recorded low in 2014 and jumped to 2.8% in 2016. The growth rate was 1.8% year on year from January 2017 to October 2017.

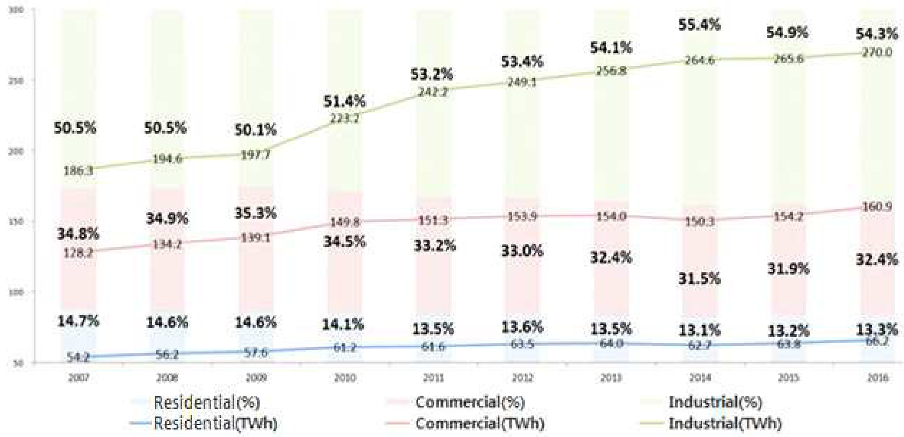
2 Electricity Consumption by Usage Type

○ In 2016, the electricity consumption for industrial, commercial, and residential usage increased 1.6% to 270.0TWh, 4.3% to 160.9 TWh, and 3.7% to 66.2TWh respectively.

○ Industrial electricity consumption hit 55.4% in 2014 and started to decline to around 50%.

○ By contrast, commercial electricity consumption fell to 31.5% in 2014 and is now on the rise. Residential electricity consumption exceeded 13% in 2011 and is on the increase.

< Trend for Electricity Consumption in the Past 10 Years by Usage Type >



3 Electricity Consumption in Final Energy Consumption

○ The share of electricity consumption in final energy consumption was rising sharply, but it has remained around 19% since 2010.

< Final Energy Consumption & elelctricity consumption share >

4 Electricity Consumption in OECD Countries

○ Electricity consumption is on the increase worldwide, but it has been on the decline in advanced countries such as the US, Japan, and Europe since 2010.

< Electricity Consumption in OECD countries (Unit: TWh) >

Country	1990	2000	2010	2015
United States	2,633.6	3,499.5	3,788.3	3,780.8
Japan	771.1	968.8	1,021.6	949.2
Germany	455.1	483.5	532.4	514.7
Canada	418.0	481.5	493.0	503.1
South Korea	94.4	239.5	434.2	483.7
France	302.2	384.9	444.1	424.9
United Kingdom	274.4	329.4	329.0	302.9
Italy	214.6	273.0	299.3	287.5
Mexico	100.2	145.4	215.7	257.5
Spain	125.8	188.5	244.8	232.0
Turkey	45.0	95.9	170.0	214.8
Australia	129.2	172.8	210.0	211.3

* Source: IEA, Electricity Information 2017
(For South Korea, *Statistics of Electric Power in Korea*)

2. Peak Load

1 Annual Trend: **The year 2016 saw peak load amounting to 85.2GW in August because of the unexpectedly high temperatures.**

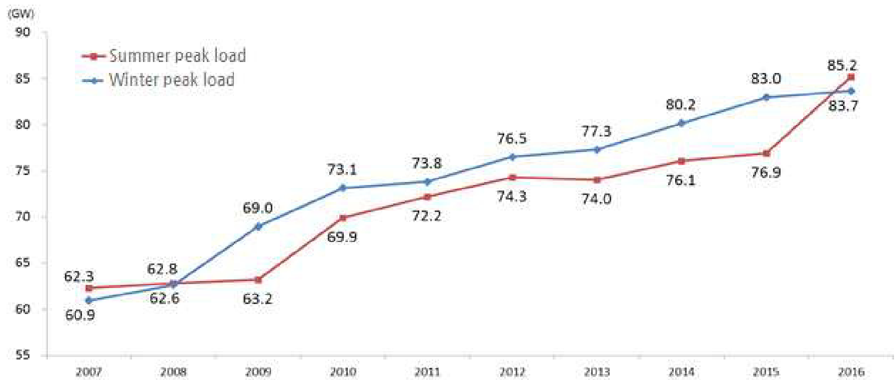
○ The peak load increased 10.7% year on year from 76.9 GW to 85.2GW, which was the most dramatic rise since 2000.

○ The annual peak load started to occur in winter instead of summer from 2009, but the peak load in 2016 took place in August because of the unexpectedly high seasonal temperatures.

* Seoul saw nine days of daily peak temperatures over 35℃ in August 2016 (none in August 2015).
* Seoul saw three days of daily lowest temperatures below -15℃ in January 2016 (none in January 2015).

○ The annual average growth rates of the past five years (winter from 2012 to 2016) were around 2.5%, lower than 5.9% in the previous five years (2007 – 2011).

< Peak Load in Summer and Winter by Year >



○ Peak load is rising more noticeably than electricity consumption. One of the main contributing factors is fluctuations in temperatures.

<Growth Rates of Electricity Consumption and Peak Load by Year (Unit: %)>

Classification	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Electricity Consumption	5.7	4.5	2.4	10.1	4.8	2.5	1.8	0.6	1.3	2.8
Summer Peak Load	5.6	0.8	0.7	10.6	3.3	2.9	-0.4	2.8	1.1	10.7
Winter Peak Load	9.8	2.8	10.1	6.1	1.0	3.6	1.0	3.7	3.5	0.8

2 Cooling Load and Heating Load

○ On the peak load days, the demand for cooling and heating accounted for 28.2% in summer and 25.2% in winter 2016.

* The cooling and heating loads were calculated based on the difference between the peak demand and the reference demand (per the lowest demand of the hours on business day in April and May or October and November).

○ The share of cooling load in 2016 rose dramatically because of the unexpectedly high summer temperatures. However, the share of heating load decreased at the time of winter peak demand.

<Cooling and Heating Loads on Peak Load Days in the Past Three Years>

Classification	2014	2015	2016
Cooling Load	20.8%	24.9%	28.2%
Heating Load	24.3%	26.6%	25.2%

3 Peak Load in OECD Countries

○ Peak loads in Japan and some European countries have been on the decline since 2010 while those in the US and Italy have been on the increase.

< Peak Loads in OECD Countries (Unit: GW) >

Country	1990	2000	2010	2015
United States	546.0	678.4	768.0	782.5
Japan	143.7	173.1	177.8	159.1
France	63.4	72.4	96.7	91.6
South Korea	17.3	41.0	71.3	78.8
Italy	36.3	-	56.4	60.5
United Kingdom	54.1	58.5	60.9	52.8
Turkey	9.2	19.4	33.4	43.3
Mexico	-	27.4	39.9	41.8
Spain	25.2	33.2	44.1	40.3
Australia	25.0	33.6	42.1	38.8

* Source: IEA, Electricity Information 2017
(For South Korea, *Statistics of Electric Power in Korea*)

2 Electricity Supply

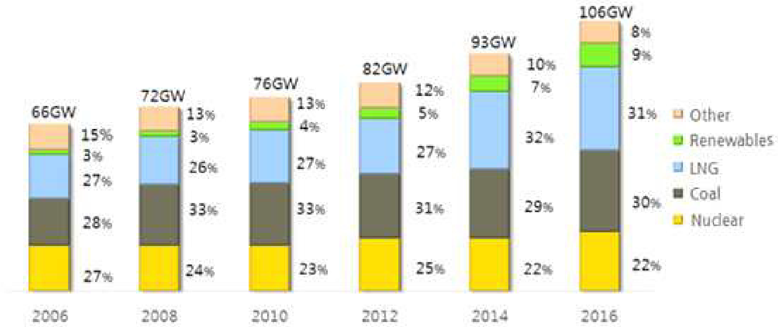
1 Installed Capacity: 106GW as of the end of 2016

○ The total installed capacity increased 62% compared with 65.5GW in late 2006 (4.9% in annual average growth rate) and 33% (5.9%in annual average growth rate) compared with 79.3GW in late 2011.

* The total installed capacity is the world's 12th (according to the U.S. EIA in 2014).

2 Capacity of generation source : LNG (31%), Coal (30%), and Nuclear (22%)

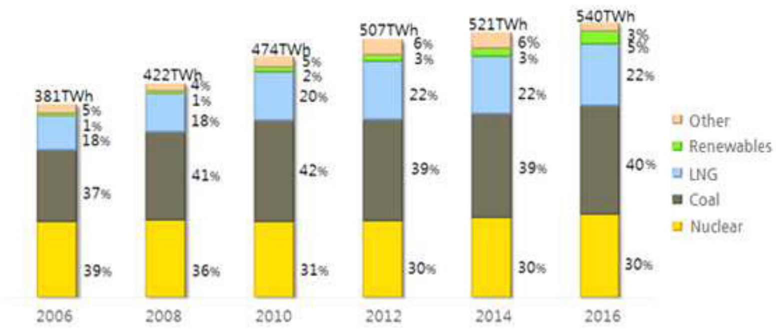
< Generating capacity by source >



*Source: Statistics of Electric Power in Korea, 2016(KEPCO)

3 Electricity generation by source : Coal (40%), Nuclear (30%), LNG (22%), Renewable (5%)

< Electricity generation by source >



*Source: Statistics of Electric Power in Korea 2016(KEPCO)

4 IPPs: Their share increased from 11.3% in 2006 to 25.2% in 2016.

< Installed Capacity by Public Sector and IPPs (Unit: GW, %) >

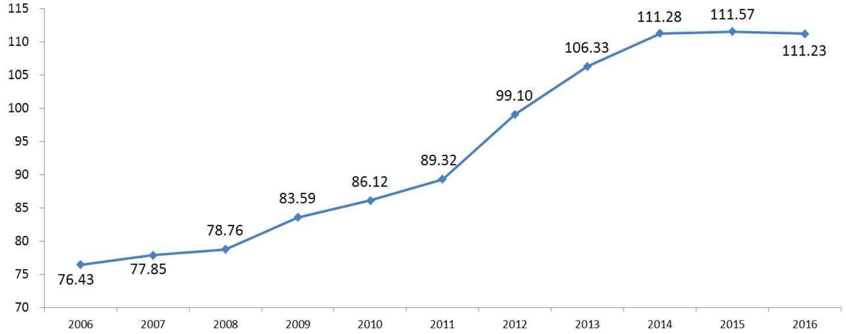
Year	Total Capacity		Public(GenCos/KEPCO)		IPPs	
	Capacity	Share	Capacity	Share	Capacity	Share
2006	65.5	100	58.1	88.7	7.4	11.3
2011	79.3	100	67.0	84.5	12.3	15.5
2016	106	100	79.2	74.8	26.6	25.2

3 Electricity Rates and Quality

1 Electricity Rates: Retail electricity rates has been on the rise since 2007.

○ KEPCO raised the electicity rates once or twice a year from 2007 to 2013.

< Average price per kWh by Year (Unit: won/kWh) >



○ The electricity rates were fixed in 2014 and 2015. In December 2016, the electricity rate system was reformed including the relaxed policy for progerssive rates for household.

< Electicity retail rates by Contract(sector) (Unit: won/kWh) >

By tariff	Industrial	Public & Service	Residential	Schools	Agricultura	Total
2006	61.92	97.91	114.33	77.48	42.96	76.43
2011	81.23	101.69	119.99	94.18	42.72	89.32
2016	107.11	130.41	121.52	111.51	47.41	111.23

* Source: Statistics of Electric Power in Korea 2016(KEPCO)

2 World-class Electricity Quality

○ System average interruption duration Index(2016) of South Korea was 9.6 minutes, which was the top class in the world.

< System average interruption duration Index by Country (Unit: minutes/year) >

Country	Korea	Germany	Japan	France	UK	US	Australia	Canada
Minutes per household	9.6('16)	15('12)	17('12)	63('12)	70('12)	138('12)	262('12)	311('12)

* Source: Statistics of Electric Power in Korea, and Global perspectives on smart grid opportunities (by Accenture in 2014)

○ The frequency maintenance rate has been maintained at 99.9% for three years, which is the top rate that is feasible technically and economically.

○ The transmission and distribution networks have been the most stable and efficient in the world and as of 2014, there was a transmission and distribution loss factor of 3.7%.

< Loss Factor(T&D) by country (Unit: %, 2014)>

Country	Korea	Japan	US	Canada	China	France	Germany	UK	Italy
Loss Rates	3.7	4.9	5.9	5.8	6.6	7.4	5.7	8.9	6.3

* Source: Statistics of Electric Power in Korea 2016(KEPCO)
* Transmission and distribution loss factor = {1 - (electricity consumption at the point of demand)/(transmission line capacity)}, electricity loss that occurs from power generation to final consumption through transformer, transmission and distribution lines.

Ⅲ. Evaluation of the 7th BPLE

1 Achievements

1 Strengthen fulfillment of Power plant construction projects

○ The legal grounds were established in the Electricity Utility Act from January 2015. The Act states that **once a project under the BPLE fails to be launched legally on time, its licensing may be canceled.**

○ The operator had been selected at the time of establishing every BPLE until the 6th BPLE. From the 7th, the operator is expected to **be selected at the time that a license is granted** to a generation project.

2 Basis for More Distributed Energy Resources (DERs)

○ **A detailed definition of DERs** was established for the first time.

* DERs mean resources that minimize the construction of transmission lines at a ① small-sized generation capacity (less than 40 MW) and ② generation source at the point of demand (less than 500 MW).

○ For DERs, the **status** (7.6% in 2013) and the **dissemination target by 2029** (12.5%) were also defined.

* Status and goals: 7.6% in 2013 → 10.1% in 2015 → 11.4% by 2020 → 12.5% by 2029

○ The DER strategy includes **promotion of the use of renewable energy** and **more incentives for sites near the points of demand.**

2 Limitations

1 Ongoing Debates over the Demand Forecast

○ Electricity consumption increased compared with the 6th BPLE, **but the actual consumption was less than the expected amount.**

<Electricity consumption forecast and actual consumption (TWh)>

Classification	2016	2017
7th Forecast vs. Actual	510 vs. 497 (△2.5%)	533 vs. 506e (△5.1%)

○ At the time when the BPLE was established, the growth rate of electricity consumption fell to 1%, but **the growth rates for the early stage (2016 – 2018) of the 7th BPLE were still estimated to be high (around 4%).**

* Average annual growth rates of electricity consumption (actual): (2007 - 2011) 5.5% → (2012 - 2016) 1.8%
* Forecast in the 7th BPLE: (2016) 4.1%, (2017) 4.5%, (2018) 4.3%

○ The demand response market was established in 2014, but it was not reflected to long term effective Demand Side Management. So, it **was not viable for implementation though political will and awareness about energy saving were included in Demand Side Management.**

2 Economy-focused Energy Mix and Lack of Consideration of the Environment and Safety

○ Two new nuclear power plants projects(3GW) were included in 7th BPLE despite public concerns over nuclear safety around the nation.
→ **bigger share of nuclear energy in the energy mix (23.4% by 2029) compared with the 6th BPLE (22.7% by 2027)**

○ **A lower target for renewable generation was set than in the 6th BPLE** although the OECD countries' energy policy trend(decreasing share of nuclear & coal, increasing share of renewables)

* Generation in OECD countries (2010 → 2014): (Nuclear) 20.9% → 18.2%, (Coal) 34.1% → 31.9%, (Renewable · Hydropower) 18.7% → 23.1%

< Share of Renewable Energy Generation (Unit: GWh, %) >

Plan	2015	2020	2025	2027 (6th) / 2029 (7th)
6th BPLE	24,664 (4.4%)	54,139 (8.4%)	77,364 (11.3%)	90,134 (12.6%)
7th BPLE	23,857 (4.5%)	50,655 (7.9%)	66,622 (9.7%)	83,090 (11.7%)

➡ Because the construction plans under past BPLEs were focused on nuclear and coal power plants, energy transition policies will be restricted. So, the effects of energy transition are expected to materialize by 2022 and beyond.

3 Limitations on Procedural Transparency

○ People said that the preparation of the BPLE did not involve **enough communication** with **various stakeholders** including environmental & citizen's groups and the energy industry.

IV. Basic Directions of the 8th BPLE

1 National Policy Changes

❶ The Government of Korea mandated that the environment and public safety are considered **under the amended Electricity Utility Act** in March 2017

– Thus Minister of Trade, Industry and Energy emphasized on **the environment and national public safety** through policy harmony based on the fundamental directions of the BPLEs toward stability and economy.

– In addition, considerations of **the effects on the environment and public safety** as well as the economy in **operating the electricity market and system** are mandated.

※ Electricity Utility Act Article 3 (Duties of Government, etc.) ② The Minister of Trade, Industry and Energy shall prepare fundamental and comprehensive policies in establishing measures stated in (1) and the BPLE according to Article 25 for electric economy, the environment and the impact on public safety.
③ Korea Power Exchange shall review economy, the environment, and public safety in the operation of electricity market and power system comprehensively.

❷ The public interest in an **electricity supply that is safety- and environment-conscious** grew.

– Concerns are rising over **the safety of nuclear power plants** across the nation because of the recent accident in Fukushima (March 2011), earthquakes in Gyeongju (September 2016), and Pohang (November 2017).

➡ **Energy Transition Roadmap** (Oct. 2017): This includes phasing out the use of nuclear energy and increasing the share of renewable energy to 20% of the generation output by the year 2030 under the basic energy policy of the Korean government.

– **The high density of fine dust is one of the emerging social issues,** and there is a growing demand for fundamental solutions for the emission sources of fine dust.

➡ **Comprehensive anti-fine dust measures** (Sep. 2017): These measures include reducing emissions by 30%, decommissioning of aging coal generators, and conversion from coal to LNG generation.

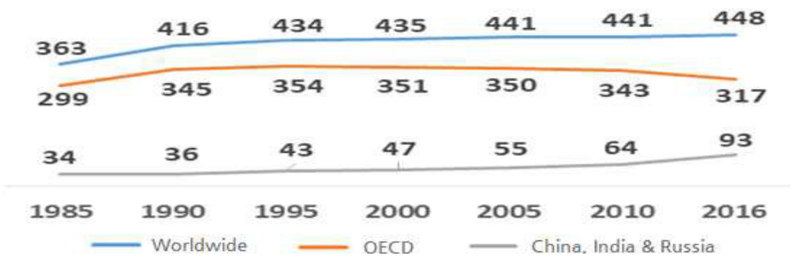
– The Paris Agreement set a global goal of reducing greenhouse gas emissions 37% BAU by 2030 and **reducing electricity generation by 19.9%.**

2 Global Trend Analysis

1 Analysis by generation source

● **Nuclear and Coal:** These shares are decreasing in the OECD countries, but they are rising in China and some countries.

< Number of Nuclear Power Plants Worldwide >



* Source: IAEA, PRIS

– Nuclear generation(OECD): 2,192 TWh('10) → 1,876 TWh('16) (△14%)

– Nuclear generation in China, India, and Russia: 251 TWh('10) → 417 TWh('16) (66%↑)

– Coal-fired generation in OECD: 3,741 TWh in 2010 →3,044TWh in 2016 (△19%)

* Source: IEA, Electricity Information 2017

● **Renewable Energy: The generation of renewables is growing while the generation cost is decreasing** worldwide. More and more new investment for power plant is focused on renewable energy.

– Renewable generation(OECD): 624 TWh('10) → 1,243 TWh('16) (100%↑)
Global renewable generation : 782 TWh('10) → 1,724 TWh('16) (120%↑)

– The electricity market price of photovoltaic and wind power is falling around the world. Their generation costs are expected to become cheaper than other fuel types **in the US by 2022 and in the UK by 2025.**

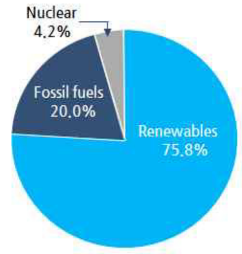
< PV LCOE Prospects by World's Major Organizations>

Org.	IRENA	BNEF NEO	OECD/IEA	KEEI	HRI
Criteria	World weighted average	South Korea	World average	South Korea	South Korea
Period	2015 ⇨ 2025	2017 ⇨ 2030	2015 ⇨ 2030	2016 ⇨ 2024	2016 ⇨ 2030
Decline	59%↓	66%↓	41~50%↓	36%↓	31%↓

– Renewable energy accounts for 75.8% of the total investment for new generation facilities in the OECD and 67.5% worldwide.

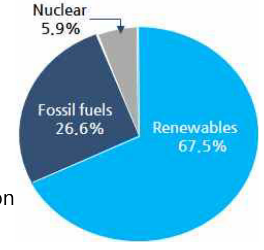
< New facility Investment(OECD, '16) >

Total $190 billion



< New facility Investment(World, '16) >

Total $440 billion



* Source: IEA, World Energy Investment 2017

2 Trend of developed countries : The shares of renewable energy are rising in developed countries.

< Generation Output by Country (TWh, %) >

Classification		Nuclear	Thermal			Hydro	Renewable	Total
			Coal	LNG	Oil			
Germany	2010	140.6 (22.2)	273.5 (43.2)	90.4 (14.3)	8.7 (1.4)	27.4 (4.3)	92.5 (14.6)	633.0 (100)
	2015	91.8 (14.2)	283.7 (43.9)	63.0 (9.7)	6.2 (1.0)	24.9 (3.8)	177.3 (27.4)	646.9 (100)
US	2010	838.9 (19.2)	1,994.2 (45.5)	1,017.9 (23.2)	48.1 (1.1)	286.3 (6.5)	193.0 (4.4)	4,378.4 (100)
	2015	830.3 (19.2)	1,471.0 (34.1)	1,372.6 (31.8)	38.8 (0.9)	271.1 (6.3)	333.3 (7.7)	4,317.2 (100)
France	2010	428.5 (75.3)	26.3 (4.6)	23.8 (4.2)	5.5 (1.0)	67.5 (11.9)	17.5 (3.1)	569.1 (100)
	2015	437.4 (77.0)	12.2 (2.1)	19.8 (3.5)	2.2 (0.4)	59.4 (10.4)	37.5 (6.6)	568.5 (100)
UK	2010	62.1 (16.3)	108.8 (28.5)	175.3 (45.9)	5.0 (1.3)	6.7 (1.8)	23.7 (6.2)	381.6 (100)
	2015	70.4 (20.7)	76.7 (22.6)	100.0 (29.5)	2.1 (0.6)	9.0 (2.7)	80.9 (23.8)	339.1 (100)
Japan	2010	288.2 (25.1)	309.6 (27.0)	318.6 (27.7)	100.2 (8.7)	90.7 (7.9)	41.3 (3.6)	1,148.5 (100)
	2015	9.4 (0.9)	343.2 (33.0)	409.8 (39.4)	102.5 (9.8)	91.3 (8.8)	85.1 (8.2)	1,041.3 (100)

* Source: IEA, Electricity Information 2012 - 2017

3 Implications

1 Declining Stability in the Supply of Baseload Generation Sources (Nuclear & Coal)

○ Legal obligations for the environment and public safety are being established.

○ Uncertainty over supply is escalating because of the delayed construction of power plants and transmission & transformation facilities, and costs are rising as well.

2 Developed Countries Leading the Use of Renewable Energy While Reducing the Use of Nuclear Energy and Coal

○ Generation cost is expected to fall because of the decreased production cost of renewable energy.

○ Renewable energy leads investment in new generation facilities.

3 The Best Time to Transform the Energy Mix Is When Electricity Supply and Demand Are Stable

○ The conventional energy mix is not effective for responding to changes in the environment at home and abroad.

* 7th BPLE: Nuclear energy and coal accounted for more than 60% while renewable energy accounted for merely 4.6% (on the effective capacity basis).

○ Electricity supply and demand are expected to be stable without additional facility installation through 2026.

4 Basic Directions of the 8th BPLE

Demand Forecast	○ **Rational demand forecast** to minimize forecast errors - Considered the **effects caused by the Fourth Industrial Revolution**
Demand Side Management	○ **Various ways to secure more viable** demand-side management (DSM)
Capacity Margin	○ **Securing proper capacity margin** for stable electricity supply - **Consideration of the changes in the energy mix** including the promoted use of renewable energy
Facility Plan	○ Economically viable energy mix **that is both safe and clean** - Phasing out the use of nuclear energy and coal while increasing the shares of renewable energy and LNG - Harmonizing economic load dispatch and environment-conscious dispatch - Steady increase in the use of distributed energy resources (DERs) ○ **Construction and operation of the electricity system supporting the energy mix** - Proactive infrastructure reinforcement needed to increase the use of renewable energy

□ Rational and Objective Demand Forecast

○ Review of the viability of adding **other models to the 7th BPLE electricity panel model** to enhance accuracy and objectivity of demand forecast

○ Used the latest data of key electricity demand variables, including the economic growth rate, population, and temperatures, released by Korea's most authoritative organizations

○ Considered demand-changing factors such as **the growing use of electric vehicles, the new progressive electricity billing, and the 4th Industrial Revolution**

□ More Viable DSM in the 4th Industrial Revolution

○ New ways for more effective DSM to **transform plant-focused supply policies into DSM-focused ones**

- Introduction of self-generated photovoltaic energy, demand response (DR), and EERS*

* EERS: Energy Efficiency Resource Standards

○ **Expansion of DSM infrastructure** including IoT and a big data-based energy management system (EMS) for more rational consumption of electricity

□ Proper Capacity Margin Setting for Stable Electricity Supply

○ Setting the annual capacity margin at **the best supply reliability** considering the **probability of outage, number of planned outage days, and schedule for coal power plant retrofits** for each generator

○ Using **flexibility backup facilities to troubleshoot renewable energy variability issues** and calculating effective capacity based on peak load contribution for stable electricity supply

□ Economical, Safe, and Clean Energy Mix

○ Phasing out the use of nuclear energy with the Energy Transition Roadmap (October 2017) and the plan to reduce coal-fired generation that causes fine dust and greenhouse gas

○ Increasing the shares of renewable energy and LNG in line with global trends and OECD practices and giving more incentives for DER

○ **Harmonizing economic load dispatch and environment-conscious dispatch** in operating the electricity market and establishing supplementary measures to **minimize the burden of electricity rates on the public**

☐ System Infrastructure Construction That Supports an Environmentally Friendly Energy Mix

○ Swiftly reinforcing system infrastructure to solve the delays in renewable energy networks and proactively investing in promising areas for renewable energy

– Introduction of transmission voltage for renewable energy, construction of small-sized substations, and construction of substations for the planned renewable energy sites

○ Development and operation of a comprehensive control system for renewable energy variability and institutional improvements in the electricity market for more use of backup facilities with flexibility resources

○ Stable electricity supply with timely installation of transmission and transformation facilities and a cross-border electricity system (Super Grid in Northeast Asia) to escape from issues of the system island

☐ Transparent Information Disclosure and Public Hearings

○ Increasing the number of working groups (WG) and establishing a wide pool of experts* for in-depth discussion on demand forecast, renewable energy, and other issues

* Experts in economic forecast, statistics, renewable energy, electricity systems, demand side management, and civic group members as well as environmentalists

○ Releasing the drafts and final versions of demand forecast, demand side management, and capacity margin and collecting opinions from various stakeholders for more than five months

Ⅴ. Demand Forecast & DSM Goals

◇ Used Electricity Panel Model and four other models, input Variables from reliable organizations to improve objectivity of demand forecast

◇ Target demand* adjusted in accordance with the latest economic growth rate: 100.5GW by 2030

* 87GW in 2018 → 93GW in 2022 → 98GW in 2026 → 100.5GW in 2030

○ 14.5% of the consumption and 12.3% of the peak load in final year to be reduced through demand-side management

1 Demand Forecast Model

Input Variables (GDP, electricity prices, population, temperatures, etc.) ➡ **Demand Forecast Model** ➡ **Reference Demand (BAU)**

1 Electricity Consumption Forecast Model: the same Electricity Panel Model used in the 7th BPLE

○ The Electricity Panel Model was used as a main model and four additional models were adopted to enhance the accuracy and objectivity of the demand forecast, it was finally reviewed its feasibility with additional models.

2 Peak Power Model: the same macro model used in the 7th BPLE

○ A Macro Model was used as a main model to maintain integrity in the forecast of electricity consumption, and two additional models were used to reviewed its feasibility.

○ In the macro model, peak ~~load~~ demand was calculated using input variables including annual electricity consumption and temperature changes.

Attachment 1 Electricity Consumption and Peak Demand Forecast Models

☐ **The average error rate* of the Electricity Panel Model proved lower than those of the four additional models** as a result of the forecast model reviews conducted between 2001 and 2016.

* Average error rate: Electricity Panel Model (1.7%) < Four additional models (2.0% - 3.1%)

< Overview of Electricity Consumption Forecast Models >

Model	Features	Note
Electricity Panel Model	ㅇ Electricity consumption was forecast based on the panel data analysis on about 100 countries and changes in GDP and electricity prices.	Main in the 7th and 8th
Gross Energy Panel Model	ㅇ Electricity consumption was forecast based on the relative prices (electricity price/total energy prices) instead of absolute prices in the similar electricity panel model.	New
Structural Break model	ㅇ Electricity consumption was forecast based on economic and social changes (demography and alternative energy prices).	New
Time Series Model	ㅇ Electricity consumption was forecast on the assumption that future electricity demand follows the patterns and trends of the past demand data.	New
Micro Model	ㅇ Sum of the forecasts in residential, commercial (two parts) and industrial (10 parts) areas	Main from 1st to 5th

* The 6th BPLE adopted a Macro Model, which was a precursor of the Electricity Panel Model for electricity consumption forecast.

< Overview of Peak Demand Forecast Models >

Model	Features	Note
Macro Model	ㅇ This model was developed to identify the relationship between peak load and electricity consumption. Temperature variability in peak load was also considered in this model.	Main from 6th to 8th
Time Series Model	ㅇ The annual peak value from the hourly forecast data of electricity demand.	New
Micro Model	ㅇ The peak demand was calculated by dividing the annual electricity consumption by the hourly demand at the time of peak load.	Main from 1st to 5th

Attachment 2 Forecast Models Adopted in the Previous BPLEs

☐ Models have been developed and used to enhance the accuracy of demand forecast.

< Use of Electricity Demand Forecast in the BPLEs >

Plan/Model	Electricity Consumption Forecast		Peak Demand Forecast	
	Main	Sub	Main	Sub
1st	Micro	-	Micro	-
2nd				
3rd		Macro (Gap & Catch-up in one country)		Macro
4th				
5th				
6th	Macro (Gap&catch-up model in one country)	Micro	Macro	Micro
7th	Electricity Panel	-		-
8th		Gross Energy Panel Structural Break Time Series Micro		Time Series Micro

* The Macro Model for electricity consumption forecast (gap & catch-up model in one country) is a former Electricity Panel Model, in which the number of countries surveyed differ.

☐ Micro Models were adopted until the 5th BPLE, but the 6th BPLE started to use Macro Models.

ㅇ Compared with the Micro Model, the Macro Model recorded fewer errors in terms of electricity consumption (Macro: 0.7%, Micro: 2.3%) and peak demand (Macro: 1.0%, Micro: 1.4%).

< Forecast Methods in the Micro and Macro Models >

Model	Micro	Macro
Electricity Consumption	Forecast based on added value for each industry, statistics and public data (home appliance distribution rates, tap water usage, etc.)	Modeling based on the relationship between macroeconomic variables(GDP and etc.) and electricity consumption, and forecast
Peak demand	Electricity consumption is converted into peak demand based on the hourly load patterns.	Modeling based on the relationship between electricity consumption and peak demand as well as temperature effects, and forecast

2 Input Variables

1 Expected GDP: GDP forecast by KDI in September 2017

○ GDP forecast is the most critical factor in determining the demand forecast in macro forecast models including the Electricity Panel Model.

○ The 2017 forecast is based on the "Economic Policy Directions from the New Administration (July 2017)" and the mid-term forecast (2018 – 2021) is based on the forecast by the Ministry of Strategy and Finance (August 2017).

< Forecast Economic Growth Rates (Unit: %) >

Year	2016	2017	2022	2026	2030	2031	Annual Average
Reference Forecast	2.8 (actual)	3.0	2.6	2.2	1.8	1.6	2.43 (2017 - 2031)

2 Expected Electricity Prices: based on KEPCO's total costs

○ The electricity purchase cost from power market is calculated by the generation output by fuel type and year, and the settlement costs by energy source. Other costs including the depreciation cost are based on the latest data.

3 Expected Population: based on the forecast by the Statistics Korea (December 2016)

< Future Demography Outlook (Unit: thousand persons) >

Year	2016	2017	2022	2026	2030	2031	Annual Average Growth(%)
Median	51,246	51,446	52,261	52,704	52,941	52,958	0.2 (2017 - 2031)

4 Expected Temperatures: Long-term climate change scenario* by the Korea Meteorological Administration (2011)

* This is the same scenario used in the 7th BPLE (the next scenario will be released by 2019 or 2020).

Attachment 3 GDP Forecasts in the Previous BPLEs and Performances

< GDP forecasts and performances (Unit: %) >

<table>
<tr><th>Year</th><th>1st</th><th>2nd</th><th>3rd</th><th>4th</th><th>5th</th><th>6th</th><th>7th</th><th>8th</th><th>Actual</th></tr>
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4.5</td><td rowspan="5">'08~'12
4.5</td><td></td><td></td><td></td><td></td><td>2.8</td></tr>
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<tr><td>2010</td><td rowspan="5">'10~'14
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<tr><td>2011</td><td rowspan="5">'11~'15
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4.2</td><td rowspan="5">'13~'17
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3.9</td><td></td><td>2.8</td></tr>
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4.1</td><td></td><td>2.8</td></tr>
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<tr><td>2031</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

* Data used: 1st and 2nd: 1968SNA (as of 1995), 3rd and 4th: 1993SNA (as of 2000), 5th and 6th: 1993SNA (as of 2005), 7th and 8th: 2008SNA (as of 2010)

3 Reference Demand Forecast

1 Electricity Consumption: 667.0 TWh by 2030

○ Annual average growth rate is expected to be 2.1% between 2017 and 2031.

2 Peak Demand : 113.4GW by winter 2030

○ Annual average growth rate is expected to be 2.1% between 2017 and 2031.

< Forecast Reference Demand >

Year	Electricity Consumption (TWh)	Peak Demand (GW)	
		Summer	Winter
2017	509.0	84.6(actual)	86.5
2018	523.5	87.5	88.9
2019	538.0	89.8	91.3
2020	552.3	92.0	93.6
2021	566.7	94.2	96.0
2022	579.6	96.2	98.1
2023	592.1	98.1	100.3
2024	604.1	100.0	102.3
2025	615.8	101.8	104.4
2026	627.1	103.6	106.3
2027	637.9	105.3	108.2
2028	647.9	106.9	110.0
2029	657.7	108.5	111.8
2030	667.0	110.0	113.4
2031	675.4	111.3	114.9
Annual Average Growth	2.1%	1.8%	2.1%

4 DSM Targets

1 Basic Direction: Securing effective Demand-Side Management methods of switching from supply-oriented electricity policies to demand-oriented ones

○ **Now is the time to overhaul supply-intensive policies** as public acceptance is a top priority with power plant constructions and transmission lines expansion.

○ **The decoupling* of electricity consumption and peak demand** continues, and thus DSM for peak demand is becoming more important than supply policy (expansion power plant).

* Average annual growth rate of electricity consumption (2012 – 2016) : 1.8% vs. Average annual growth rate of peak load : 3.1%

2 DSM Plan focusing on peak demand reduction

Use of Earlier DSM Measures

❶ **Enhanced Energy Efficiency :** Reducing peak demand by 4.15GW by increasing the number of efficiency device items and strengthening efficiency criteria

– Minimum Energy Performance Standards* applicable to major industrial equipment and prohibition of production and sales of products proven to be inefficient

* Now applied to transformers and three-phase induction motors, and applicable to compressors and refrigerators (a research and public opinion gathering project is under way to be completed in 2019)

– Four additional items for the efficiency device replacement and dissemination project

* (Five old items) LED, electric motor, inverter, heat pump, refrigerator + (Four new items) transformer, turbo blower, regenerative braking device, and thermohydrostat

– Strengthening the insulation and energy-saving design for buildings and making zero-energy buildings mandatory

❷ **Energy Management System (EMS):** A reduction of 2GW by disseminating this system to energy-intensive buildings and factories

– **(Factories) Smart plants (20,000 by 2022) and Factory Energy Management System (FEMS)** to be developed to aggressively reduce factories' electricity consumption

– **(Buildings) Integration of Building Energy Management System (BEMS) and ESS** for the reduction of electricity consumption

* BEMS to be mandatory for new and renovated public buildings from January 2017

– **(Homes)** Dissemination of AMI to all homes by 2020 for real-time management of electricity consumption

Introduction of New DSM Methodologies

❶ **Self-generation for Solar PV:** Projects for renewable energy subsidies and Solar PV rental business and the introduction of “Distributed energy resource market" under the revised Electricity Utility Act

– A reduction of 0.32GW by disseminating self-generation for Solar PV to about one of 15 households by 2030

* Financial support for renewable energy: 86 billion won in 2017 → 176 billion won in 2018
* Support for renewable energy promotion: 100 billion won in 2017 → 190 billion won in 2018

❷ **Demand Response Market:** A curtailment of 3.82GW by creating the "Home DR market" away from the current DR market

* The curtailment volume was expected to be 3.82GW based on the DR target capacity of 5.7GW by 2030 and capacity credit(70%).

– The current DR system is under improvements in 2018 including enhancement of the standard for demand curtailment announcement, diversification of demand resources, and stronger operator management standards for higher performance rates.

– All the participants' assets are involved in "Home DR" nationwide in 2018 including stores, houses, and buildings to review technology, pay system, and accessibility through demonstration projects.

❸ **Stronger DSM System:** Introduction of EERS* and "Energy Champion" certification system

* Energy Efficiency Resource Standards (EERS): A mandatory system enacted in 2018 that obliges energy suppliers to disseminate highly efficient devices to secure a certain reduction in electricity consumption.

❹ **ICT:** A more active Demand-Side Management service based on big data for electricity, and the step-by-step introduction of ESS in public organizations from January 2017

– **Development of technology for a Demand-Side Management system and more vital value-added services including electricity information consulting** for industrial complexes

* Pilot project under review for a smart DSM system in industrial complexes (from 2017, 11.3 billion won)
* KEPCO is collaborating with Samsung Electronics and LG Electronics in a pilot project for peak load management in 134 households in the Seoul metropolitan area. An energy-saving consulting service is also available including an electronic home economics ledger.

New Electricity Rate Scheme

○ Differential adjustment of industrial electricity rates, centering on ‘off-peak load’ rates in the existing scheme for efficient consumption of industrial electricity

* Peak load during ‘off-peak load’ hours (10,000kW): 6,373 in 2009 → 7,284 in 2012 → 7,847 in 2016

○ In the long run, reform the rate scheme to tighten up its role as DSM; expand the coverage of ‘Schedule of the Season & Time’ rate.

3 Targets of Reduction in Peak Demand and Electricity Consumption: Upgraded from the 7th BPLE

○ The targets of the final year include a reduction of peak demand amounting to 14.2GW, 12.3% of the reference demand, and electricity consumption of 98.1TWh, 14.5% of the reference demand.

* 7th BPLE: the targets were reducing peak demand by 12% and electricity consumption by 14.3% compared with the reference demand.

< **Targets of Peak Demand Reduction** (Unit: GW) >

Year	Existing		New		Total
	Energy Efficiency	EMS	Self-generation for Solar PV	DR Market	
2022	0.92	1.34	0.10	2.58	4.9
2026	2.36	3.21	0.20	3.19	9.0
2030	4.15	4.92	0.32	3.82	13.2
2031	4.60	5.28	0.32	3.97	14.2

< **Targets of Electricity Consumption Reduction** (Unit: TWh) >

Year	Existing		New	Total
	Energy Efficiency	EMS	Self-generation for Solar PV	
2022	13.65	9.77	1.05	24.5
2026	34.70	19.35	2.00	56.1
2030	62.14	25.00	3.15	90.3
2031	69.28	25.63	3.16	98.1

5 Other Demand-changing Factors

1 The diffusion of Electric Vehicles (EVs): Peak demand expected to rise about 0.3GW by 2030 winter peak

○ Outlook based on government goal to supply a million EVs by 2030

< **Deployment Scenario of EVs** >

Year	2017	2022	2026	2030	2031
Accumulated Number of EVs (10,000)	4.6	33.4	62.9	100.0	110.8

○ Electricity demand was estimated by reflecting the hourly charging patterns in Jeju Island, and California, regions where electric vehicles are prevalent.

– **Generally, people charge their EVs after work.** EVs are thus expected to have a limited effect on electricity demand at peak time (around 15:00 in summer and around 11:00 in winter).

< **Impact of EVs on Electricity Demand** >

Year	2017	2022	2026	2030	2031
Electricity Consumption (TWh)	0.1	1.0	1.8	2.8	3.2
Peak Demand (summer, GW)	0.02	0.14	0.23	0.38	0.42
Peak Demand (winter, GW)	0.02	0.11	0.18	0.29	0.32

2 Effects of the reformed progressive electricity billing system (December 2016) : Not reflected in long-term demand forecast

○ Simplified billing scheme is expected to **temporarily increase electricity demand.** Over the long term, it is not expected to affect demand.

* The rationale here is that the effects will be included in the BAU without continuous price discounts.

○ **Peak demand is expected to take place in winter**, but **the effects of the new billing scheme are intensive in summer, when the heavy cooling load creates a high electricity demand.**

3 Effects of the 4th Industrial Revolution: EVs and other confirmed factors

< Definition of the 4th Industrial Revolution >

- This term was coined in the World Economic Forum in Davos in January 2016. It refers to a technological revolution toward an ultraconnected, ultrasmart world through the convergence of physical, biological, and digital technologies.
- This shift was defined as the 4th Industrial Revolution since it will cause unprecedented industrial innovation and social changes through IoT, automation and system of artificial intelligence.

○ At the height of the 4th Industrial Revolution, **electricity demand is expected to both rise and fall.**

【Demand-increasing factors】 IoT, data centers, EVs and dissemination of other devices

【Demand-decreasing factors】 Smart homes and factories, smart grids, and other energy-efficient systems

○ Both demand-increasing and demand-decreasing factors **contain uncertainty, which is hard to translate numerically. These factors were not included in the demand forecast of the 8th BPLE.**

- The 4th Industrial Revolution has just started to emerge in Korea, so experts say that there is much uncertainty in forecasting its general effects.

○ **EVs, however, were reflected in the 8th BPLE** and other factors will be further reviewed in the next BPLE as the 4th Industrial Revolution progresses.

Attachment 4 Research Project on the 4th Industrial Revolution and Electricity Demand (Deloitte)

□ Methods: Electricity demand was forecasted in light of the 4th Industrial Revolution from the **absolute and relative demand** perspectives.

○ **Absolute Demand Perspective:** This perspective reviewed the direct impact of the 4th Industrial Revolution on electricity demand.

- Forecast on the electricity usage level of a core technology-based single device and a device system

* Core technologies: AI, IoT, big data, robots, and 3D printing

○ **Relative Demand Perspective:** Direct demand is a constant, but changes resulting from relative factors were forecast.

- Relative factors include ESS and smart grids.

□ Results: **Unit electricity consumption** is expected to increase with the emergence of **new devices** at the onset of the 4th Industrial Revolution. **Overall consumption is expected to decrease** with the advent of **the self-supplied electricity ecosystem.**

< Research Results of the 4th Industrial Revolution and Future Electricity Demand by Factor >

Classification		Single Device	Device System	Overall
Absolute Demand	Residential	Home appliances and robots ↑	Smart Home (HEMS) ↓	↑
	Commercial	Data centers ↑	Smart Building (BEMS) ↓	↓
	Industrial	Smart Factory (FEMS) ↓		↓
	Transport	EVs and drones ↑		↑
Relative Demand	ESS	Stabilization of renewable energy output, peak demand responses ↓		↓
	Smart grid	Smart transmission and distribution, and dissemination of AMIs ↓		↓

6 Target Demand Forecast

Target Demand = **Reference Demand (BAU)** − **DSM Volume** + **Other Factors** (EVs, etc.)

1 Electricity Consumption : 579.5TWh by 2030

○ There is expected to be an average annual increase of 1.0% in the BPLE period (2017 − 2031).

2 Peak Demand : 100.5GW by winter 2030

○ There is expected to be an average annual increase of 1.3% in the BPLE period (2017 − 2031).

<Target Demand Outlook>

Year	Electricity Consumption (TWh)	Peak Demand (GW)	
		Summer	Winter
2017	507.0	84.6 (actual)	85.2
2018	519.1	86.1	**87.2**
2019	530.4	87.1	**88.5**
2020	540.1	88.8	**90.3**
2021	548.9	90.4	**92.1**
2022	556.1	91.5	**93.3**
2023	561.7	92.6	**94.5**
2024	566.2	93.5	**95.7**
2025	569.8	94.4	**96.7**
2026	572.8	95.1	**97.6**
2027	575.2	95.8	**98.4**
2028	577.0	96.4	**99.1**
2029	578.5	97.0	**99.8**
2030	579.5	97.5	**100.5**
2031	580.4	98.0	**101.1**
Annual average growth in the BPLE period	1.0%	0.9%	1.3%

Attachment 5 Demand Forecast in the 8th BPLE

Demand Planning Subcommittee	Date	Agenda	Remark
1st Demand Forecast Working Group	January 20, 2017	o Consistency with the superior plans o Demand forecast direction o How to obtain major forecast input data	-
2nd Demand Forecast Working Group	March 31, 2017	o Basic plan for climate change solutions o Results of major forecast input data	-
Forecasts Using Various Models (April - June 2017)			
1st Demand Forecast Working Group	July 13, 2017	o Comparison of electricity consumption o Comparison of peak demand o Draft of demand forecast	**Release of Draft of Demand Forecast**
2nd Demand Forecast Working Group	July 26, 2017	o Impact of EVs on electricity demand o How to reflect the effects of the reformed billing scheme	-
Demand Forecast & DSM Joint Working Group	August 4, 2017	o Impact of EVs on electricity demand o Effect of the o Draft of DSM targets reformed billing scheme	-
3rd Demand Forecast Working Group	August 31, 2017	o How to reflect the 4th Industrial Revolution trends o Impact of microwaves and electric dryers on electricity demand o Demand forecast draft by area	-
3rd Demand Planning Subcommittee	September 15, 2017	o Result of reforecasting GDP o Result of reforecasting BAU o Result of recalculating target demand	**Release of Demand Re-forecast**

VI. Installed Capacity Planning

◇ **Proper capacity reserve set to 22%** as a result of reviewing the generation mix, generator characteristics, renewable energy variability, and the uncertainty of electricity supply and demand

◇ **Step-by-step reduction in the use of nuclear energy and coal along with a significant increase in the use of renewable energy at 20% of the total generation output by 2030** for an environmentally friendly energy mix

1 Planning Procedures

【Proper Installed Capacity】 Calculated by considering the target demand and capacity reserve rate

【Confirmed Installed Capacity】 Calculated by estimating the step-by-step phaseout of the use of nuclear power plants and aging coal plants

【Newly Required Capacity】 Deducted the proper installed capacity by the confirmed installed capacity

< Annual New Capacity Formula >

Newly Required Capacity = <u>{Target Demand x (1 + Proper Capacity Reserve)}</u> - Confirmed Installed Capacity
└ Proper Installed Capacity

【Energy Mix】 Newly required capacity set by considering policy goals, and stable electricity supply and demand

< Installed Capacity Planning Procedures >

BAU Forecast ⇨ Target Demand
⇩
Proper Capacity with Reserve ⇨ Existing Plan Facility review ⇨ Proper Mix (Fuel/Yearly)
⇩
Capacity Planning

2 Proper Installed Capacity & Reserve

1 Proper Capacity Reserve: 22% by 2030

◇ **This reserve refers to the share of backup facilities for future peak demand** in a certain period of time

◇ 22% = ❶ Minimum reserve 13% + ❷ Reserve for uncertainty 9%

< Proper Capacity Reserve by Period >

Year	2018 - 2025	2026 - 2031
Proper Capacity Reserve	19%	22%

❶ Minimum Reserve Rate : **Set to 13%** after a comprehensive review of the generation mix, generator characteristics, coal-fired power plant retrofits, and responses to renewable energy variability

– Calculation of the yearly capacity reserve with **supply reliability*** based on generators' outage probability, the number of planned outage days, and the schedule for coal-fired power plant retrofits

* Criteria for supply reliability: Loss of Load Expectation (LOLE) 0.3 day/year

– Backup facilities considered together to respond to output variations of renewables such as wind power and photovoltaic energy and forecast uncertainty

– **The minimum capacity reserve slightly decreased from that of the 7th BPLE (15%) along with the number of nuclear power plants with large unit capacity, the number of planned outage days, and high outage rates.**

❷ **Reserve Rate for Uncertainty: Set to 9% for uncertainty in annual demand and possible supply delays** during installation of generation facilities

– The BPLEs have applied the same uncertainty probability (7% in the 7th BPLE), but uncertainty is escalating in this BPLE.

2 Proper Installed Capacity: 122.6GW by 2030

○ The proper installed capacity is 22% larger than the target demand of 100.5GW by 2030.

3 Confirmed Installed Capacity and Considerations

1 Classification Criteria for confirmed capacity

Item	Classification
Confirmed Facilities	○ Generation capacity with operating permits ○ Capacity subject to decommissioning ○ Power supply sources driven by the government policy goals

2 Considerations

【Nuclear Power plant】

2017		2022		2030
22.5GW	➡	27.5GW	➡	20.4GW

○ Implementation of the Energy Transition Roadmap (October 2017) and generation facility status review

○ 2017 – 2022: Wolsong Unit 1 was excluded from the electricity supply capacity from 2018 because of rising uncertainty ahead of its early shutdown. Shin Hanwool Units 1 & 2 and Shin Kori Units 4 & 5 are under construction with a capacity of 5.6GW.

※ Wolsong Unit 1: The shutdown period will be determined after a comprehensive feasibility review for continued operation, including economic factors and public acceptance, in the first half of the next year. → Legal procedures are under way with an application for a change of operating license for a permanent shutdown submitted to the Nuclear Safety Commission.

○ 2023 – 2030: 10 aging generators will not be used and six planned generators* will not be built. Shin Kori Unit 6 will be under construction with a capacity of 1.4GW.

* Shin Hanwool Units 3 & 4, Cheonji Units 1 & 2, and new nuclear power plants Units 1 & 2

※ In June 2016, the Energy Transition Roadmap calls for a thorough review of the implementation of the measures for stronger nuclear safety standards including the mandatory submission of an accident management plan, covering severe accidents at all nuclear power plants by June 2019.

【Coal–fired power plant】

2017		2022		2030
36.9GW	➡	42GW	➡	39.9GW

○ Implemented anti–fine dust measures in September 2017 and the generation facility status review

○ 2017 – 2022: Seven aging generators (2.8GW) will not be used*, and seven new coal–fired plants under construction with a capacity of 7.3GW out of nine with low processing rate

* Three out of the 10 aging coal-fired generators eligible for early shutdown were shut down in 2017.

※ **Additional Actions for Samcheok Thermal Power Plant : ① Top-notch environment management, ② LNG conversion from four coal-powered generators, ③ Harmony of environmentally friendly dispatch and economic load dispatch**

○ 2023 – 2030: Fuel conversion into LNG (2.1GW) at Dangjin Eco Units 1&2, Taean Units 1&2, and Samcheonpo Units 3 & 4

【Renewable Energy】

2017		2022		2030
11.3GW	➡	23.3GW	➡	58.5GW

○ **The use of photovoltaic energy and wind power are to be promoted** according to the Renewable Energy 3020 plan.

* Photovoltaic energy (33.5GW) and wind power (17.7GW) are expected to account for 88% of total renewable energy by 2030.

< Renewable Energy Capacity by 2030 (Unit: MW) >

Energy	Photovoltaic	Wind	Hydro	Waste	Oceanic	Bio/Landfill gas	Byproduct	Fuel cell	IGCC	Subtotal
Rated Capacity	33,530	17,674	2,105	323	255	1,705	1,377	746	746	58,461
Peak Contribution	15.6%	1.9%	28.1%	24.2%	1.1%	29.2%	75.5%	73.5%	60.0%	-
Effective Capacity	5,231	336	591	78	3	498	1,040	548	448	8,772

< Renewable Generation Output and Installed Capacity >

Year	2017		2022		2026		2030		2031	
Output (TWh)	34.4	(6.2%)	58.3	(9.6%)	89.5	(14.4%)	125.8	(20.0%)	126.0	(19.9%)
Capacity (GW)	11.3	(9.7%)	23.3	(16.4%)	38.8	(25.4%)	58.5	(33.7%)	58.6	(33.6%)

* Project facility criteria

【LNG Powr plant】

2017: **37.4GW** ➡ 2022: **42GW** ➡ 2030: **44.3GW**

○ An additional supply of 0.125GW (June 2020) to respond to electricity demand* on Jeju Island

* The growth rate of electricity consumption in the past five years was 5.0% (1.8% nationwide) → New facilities need to be installed by June 2020.

○ Tongyoung Eco has been excluded from the supply capacity because of the uncertainty of its supply contribution due to litigation.

○ The fuel of six facilities changed from coal to LNG.

【Other】

2017: **8.9GW** ➡ 2022: **7.5GW** ➡ 2030: **6.1GW**

○ The oil-powered plant under the 7th BPLE was shut down (2.8GW).

3 Confirmed Installed Capacity: 118.3GW by 2030

Energy	Nuclear	Coal	Renewable	LNG	Other	Total
Effective Capacity (GW)	20.4	38.9	8.8	44.3	6.0	118.3
Rated Capacity (GW)	20.4	39.9	58.5	44.3	6.1	169.2

* Peak contribution applied to non-scheduled generators

○ A comprehensive review and implementation of government policies including the Energy Transition Roadmap and anti-fine dust measures, renewable energy promotion goals, and the review of generation facility status

* Facilities excluded from the confirmed capacity because of uncertainty in supply and demand can be reflected in the next plan as confirmed capacity if this uncertainty is cleared up.

** In case of any change in the fuel conversion after the energy supply plan, the plan may have to be revised.

4 New Facilities and Generation Mix

1 New Required Capacity: 4.3GW by 2030 (5GW by 2031)

○ The confirmed facility of 118.3GW was excluded from the proper capacity of 122.6GW by 2030.

2 Capacity Mix Principles

【Electricity Demand and Generation Facilities】 For Electricity demand and facilities excluding self-generators and CES

【Reference Period for Capacity Reserve and Capacity Mix】

○ Year-end installed capacity (December) and winter demand (from December to February of the following year)

【New Facilities】

○ **Installed Capacity :** Nominal capacity is applied in principle; capacity credit is applied to renewable energy and IE facilities.

○ **Capacity Mix :** More facilities for renewable energy variability

– Gas turbine mode-operable LNG generators: 3.2GW

* LNG Combined Cycle plants(actual capacity : 0.5/0.9GW) shall operate by GT Mode their total capacity is calculated as 3.2GW

– Pumped-storage generators: 1.4GW (2.0GW by 2031)

○ **Survey of Construction Intent :** The survey for construction intent of new facilities will be conducted in the next BPLE.

– Consideration was taken of the fact that new generation facilities need to be installed by 2027 and that both the legal preparation period* and the generation project preparation period** are shorter than 10 years under the Electricity Utility Act.

* Electricity utility Act Article 10 ① An operator of the Electricity utility business shall set up electric installations necessary to operate the Electricity utility and commence the business within the period for preparation determined by the Minister of Trade, Industry and Energy. ② The period for preparation referred to in paragraph may not exceed ten years.

** (Nuclear) 10 years, (coal) 7 - 8 years, (natural gas) 6 years, (hydropower) 10 years, (renewable) within 10 years

3 Electricity Supply and Demand Outlook

○ The capacity reserve is expected to be above 22% and the electricity supply is expected to be stable through 2026. The capacity reserve is expected to hit a record high at 31.4% by 2022.

* In case of renewable energy, Aggressive investment will be continued even during the period of high capacity reserve between 2017 and 2022 to secure industrial competitiveness in technology and prices and to stimulate the reduction of generation costs.

○ The capacity reserve of 22% will be met in 2027 through the installation of new facilities.

< Annual Electricity Supply Outlook (Unit: GW) >

Year	Peak Power	Confirmed Facilities	Proper Facilties	Over & Shortage	New Facilities		Final Capacity	Capacity Reserve
					LNG	Pumped-storage		
2017	85.2	107.8	101.4	6.4			107.8	26.5%
2018	87.2	110.7	103.7	7.0			110.7	27.1%
2019	88.5	113.4	105.4	8.0			113.4	28.0%
2020	90.3	116.9	107.5	9.4			116.9	29.4%
2021	92.1	119.9	109.6	10.3			119.9	30.2%
2022	93.3	122.6	111.0	11.5			122.6	31.4%
2023	94.5	121.9	112.5	9.4			121.9	29.0%
2024	95.7	122.2	113.8	8.3			122.2	27.7%
2025	96.7	120.7	115.0	5.7			120.7	24.9%
2026	97.6	119.5	119.0	0.5			119.5	22.5%
2027	98.4	118.4	120.1	△1.7	1.8		120.2	22.1%
2028	99.1	117.9	120.9	△3.0	1.4		121.1	22.1%
2029	99.8	117.7	121.8	△4.1		0.8	121.7	21.9%
2030	100.5	118.3	122.6	△4.3		0.6	122.8	22.2%
2031	101.1	118.3	123.3	△5.0		0.6	123.5	22.2%
Subtotal	-	-			3.2	2.0	-	-

< Installed Facilities and New Capacity by Year >

Year	Planned	In Operation	New Installed Capacity			
			Renewable	Integrated Energy	LNG	Pumped-storage
2017	LNG 6 units (3,904) Coal 6 unts (5,114) Island area generators (190)	Kori #1 (Jun., -587) Coal 3 units (-525) Seoul #5 (Apr., -250) Pyeongtaek C..C #1(Dec., -480)	408	1,640		
2018	Shin Kori #4 (Sep., 1,400) Shin Hanwool #1 (Dec., 1,400) Jeju CC (Jun., 240)	Wolsong #1 (Jan., -679)	299	121		
2019	Shin Hanwool #2 (Oct., 1,400) Seoul CC #1·2 (Aug., 800) Shin Pyeongtaek #1 (Nov., 951)	Youngdong #2 (Jan., -200) Samcheonpo #1·2 (Dec., -1,120) Hanlim CC (LNG-switched, 105) Jeju GT #3 (Dec., -55)	340	515		
2020	Shin Seocheon #1 (Mar., 1,000) Yeoju CC (Jun., 1,000) Jeju (emergency) (Jun., 125)		341	1,085		
2021	Goseong Hi #1 (Apr., 1,040) Goseong Hi #2 (Oct., 1,040) Tongyoung CC (Dec., -) Samcheok Thermal #1(Dec., 1,050)	Honam #1·2 (Jan., -500)	353			
2022	Shin Kori #5 (Jan., 1,400) Shin Hanwool #3 (Dec., -) Gangneung Anin #1·2 (Jun., 2,080) Samcheok Thermal #2 (Jun, 1,050)	Ulsan #4~6 (Jan., -1,200) Boryeong #1·2 (May, -1,000)	357			
2023	Shin Kori #6 (Jan., 1,400) Shin Hanwool #4 (Dec., -)	Kori #2 (Apr., -650) Seoincheon CC #1~8 (Dec., -1,800)	361			
2024	Dangjin Eco #1·2 (LNG-switched, 1,940)	Kori #3 (Sep., -950) Pyeongtaek Thermal #1~4 (Dec, -1,400) Samcheonpo #3·4 (LNG-turned, 1,120)	682			
2025		Kori #4 (Aug., -950) Hanbit #1 (Dec., -950) Taean #1·2 (LNG-switched, 1,000)	446			
2026	Cheonji #1 (Dec., -)	Hanbit #2 (Sep., -950) Wolsong #2 (Nov., -700)	446			
2027	Cheonji #2 (Dec., -)	Wolsong #3 (Dec., -700) Hanwool #1(Dec., -950)	500		1,800	
2028	New nuclear power plant #1 (Dec., -)	Hanwool #2 (Dec., -950)	508		1,350	
2029	New nuclear power plant #2 (Dec., -)	Wolsong #4 (Feb., -700)	508			800
2030			565			600
2031			23			600

1) The companies of six units (Dangjin Eco Units #1 & 2, Taean Units #1 & 2 (EWP), Samcheonpo Units #3 & 4 (KOEN) expressed intentions of changing fuel from coal to gas and those are applied. The sites and capacity are subject to review and approval in the new or updated licensing process.
2) Tongyoung Eco was excluded from the supply measure because of the uncertainty of its supply contribution according to ongoing litigation and delay in construction.
3) Wolsong Unit 1 was also excluded from the supply measure because of the uncertainty of its supply contribution. It is difficult to anticipate how its litigation will end, and a review about the feasibility of its continued operation is scheduled.
4) The shutdown of Jeju GT #3 was delayed from 2018 to 2019, ensuring a stable supply of electricity in the short- and middle-terms in Jeju.

4 Generation Mix

○ The shares of rated capacity by 2030 are renewable energy (33.7%), LNG (27.3%), coal (23.0%), and nuclear energy (11.7%).

* By applying capacity credit, the shares are: LNG (38.6%), coal (31.6%), nuclear energy (16.6%), and renewable energy (7.1%).

< Generation Mix Outlook by Year (norminal capacity) (Unit: GW) >

Year	Item	Nuclear	Coal	LNG	Renew able	Oil	Pumped -storage	Total
2017	Capacity	22.5	36.9	37.4	11.3	4.2	4.7	117.0
	Share	19.3%	31.6%	31.9%	9.7%	3.5%	4.0%	100%
2022	Capacity	27.5	42.0	42.0	23.3	2.8	4.7	142.4
	Share	19.3%	29.5%	29.5%	16.4%	2.0%	3.3%	100%
2026	Capacity	23.7	39.9	44.3	38.8	1.4	4.7	152.8
	Share	15.5%	26.1%	29.0%	25.4%	0.9%	3.1%	100%
2030	Capacity	20.4	39.9	47.5	58.5	1.4	6.1	173.7
	Share	11.7%	23.0%	27.3%	33.7%	0.8%	3.5%	100%
2031	Capacity	20.4	39.9	47.5	58.6	1.4	6.7	174.5
	Share	11.7%	22.9%	27.2%	33.6%	0.8%	3.8%	100%

< Generation Mix Outlook by Year (effective capacity) (Unit: GW) >

Year	Item	Nuclear	Coal	LNG	Renew able	Oil	Pumped -storage	Total
2017	Capacity	22.5	36.1	37.4	3.1	4.0	4.7	107.8
	Share	20.9%	33.5%	34.7%	2.8%	3.7%	4.4%	100%
2022	Capacity	27.5	41.0	42.0	4.8	2.7	4.7	122.6
	Share	22.4%	33.4%	34.3%	3.9%	2.2%	3.8%	100%
2026	Capacity	23.7	38.9	44.3	6.7	1.3	4.7	119.5
	Share	19.8%	32.5%	37.1%	5.6%	1.0%	3.9%	100%
2030	Capacity	20.4	38.9	47.5	8.8	1.3	6.1	122.8
	Share	16.6%	31.6%	38.6%	7.1%	1.0%	5.0%	100%
2031	Capacity	20.4	38.9	47.5	8.8	1.3	6.7	123.5
	Share	16.5%	31.5%	38.4%	7.1%	1.0%	5.4%	100%

5 Harmony of Environmentally Friendly Dispatch and Economic Load Dispatch

1 Alternatives for the Reduction in volume of Coal-powered Generation

【Reduction of Gap in Coal and LNG Generation Costs】

❶ **Including the Environment Cost** : Need to **enhance the price competitiveness of LNG** by including environmental costs systemically in determining the dispatch priority

– **Environmental costs** include the cost of chemicals and waste management for **pollutant reduction** and **the cost of Emission Trading***

*Inflation of generation cost when environmental costs are included: (Coal) 19.2 won/kWh↑, (LNG) 8.2 won/kWh↑

❷ **Adjustment to Tax Scheme for Coal and LNG**

– **The special consumption tax on coal is going to be raised by 6 won/kg** from April 2018 pursuant to the Special Consumption Tax Act, which was enacted in December 2017.

– Additional adjustment of the tax rates has been discussed among the ministries concerned since September 2017, and this discussion is expected to end in May 2018.

❸ **Calculation of the Levelized Cost of Electricity (LCOE) :** The levelized cost by fuel type will be set periodically in consideration of the social cost in Korea like environment cost.

【Physical Constraints in Coal-powered Generation】

❶ **Discontinuance of Aging Coal Generators:** Starting next year, all coal generators aged over 30 years (there are currently eight units and will be 22 units in 2030) are going to cease their operations during the spring (March – June).

– The legal framework will be clarified* to stop the operation of these generators for protection of the environment and supplementary measures will be taken for the electricity supply and system operation

* Enforcement decree of the Electricity utility Act valid from December 2017

❷ **Coal Power Generation Cap:** Mayors and governors take measures in case of severe air pollution and fine dust in compliance with the Clean Air Conservation Act.

– The criteria and procedures for the generation cap will be established after discussion with the ministries concerned

【Improved Profitability of Renewables & DERs】

❶ **Increasing the capacity payment (CP) for environmentally friendly energy and distributed energy resources (DERs)**

* Generation resources with low emissions of greenhouse gas and fine dust : Adjustment of fuel switching factor (FSF) for environmentally friendly energy
Generators near the large demand area : Improvement of location factor

❷ **Rationalization of LNG Generation Cost Settlement:** settlement based on the actual generator efficiency

* (Current) Efficiency calculated based on a single cost function → Some generators' earnings were less than their fuel cost
(Future) Usage of cost functions that reflect actual generator efficiency related with operating conditions → settlement based on actual fuel cost

6 Electricity Generation Outlook

◇ The outlooks consist of two scenarios. The target scenario reflects the trading cost of greenhouse gas emissions and the other scenario(base scenario) is based on the current electricity market.

1 Target Scenario: Adjustment of generation costs based on environmental costs

* The generation cost of renewable energy was estimated to fall 35.5% by 2030, while other fuel costs and inflation were assumed to be fixed.

* The generation fuel tax scheme was adjusted (bituminous coal 30 → 36 won/kg, LNG 60 → 12 won/kg), and the cost of emission trading and chemicals for pollutant reduction were also taken into consideration.

[Key Features]

– The cost of partial coal-fired generation rose above the LNG generation cost **with the introduction of environmentally friendly dispatch.**

– Compared with the base scenario, **the share of coal-fired generation decreased further while the share of LNG generation increased.**

*** Share of generation by 2030 (base scenario → target scenario): coal (40.5% →36.1%), LNG (14.5% → 18.8%)**

< Outlook of Generation Output Shares >

Year	Nuclear	Coal	LNG	Renewable	Oil	Pumped-storage	Total
2017	30.3%	45.4%	16.9%	6.2%	0.6%	0.7%	100%
2030	23.9%	36.1%	18.8%	20.0%	0.3%	0.8%	100%

2 Base Scenario: Based on the current electricity market system and generation fuel cost in 2017

[Key Features]

– Shares of renewable energy and LNG at 23.1% (2017) → up to 34.5% by 2030

– Shares of nuclear energy and coal at 75.7% (2017) → down to 64.4% by 2030

< Outlook of Generation Output Shares >

Year	Nuclear	Coal	LNG	Renewable	Oil	Pumped-storage	Total
2017	30.3%	45.4%	16.9%	6.2%	0.6%	0.7%	100%
2030	23.9%	40.5%	14.5%	20.0%	0.3%	0.8%	100%

7 Environment Improvement Effects (in Target Scenario)

【fine dust】 Reduction of about 62% by 2030

* About 62% of pollutants will be removed including sulfur oxides, nitrogen oxides and dusts.

– For reduction of pollutants and fine dust, Implementation of early disuse of 10 aging coal–fired generators and improvement of environmental facilities is included.

– In addition, The reduction of gap in the generation costs of coal and LNG, seasonal shutdown of coal–fired generators aged over 30 years in spring, converting fuel from coal to LNG are introduced as new measures for reduction of pollutants.

< Outlook on fine dust and Pollutant Emissions by Year (Unit: 10,000 t) >

Year	2017	2022	2030
fine dust	3.4	1.9 (44%↓)	1.3 (62%↓)
Pollutants	17.4	9.4 (46%↓)	6.5 (62%↓)

【Greenhouse Gas】 Expected reduction of 26.4% compared with the BAU of 322 million tons by 2030

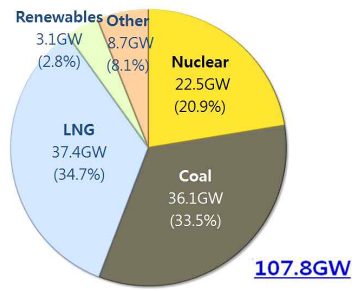
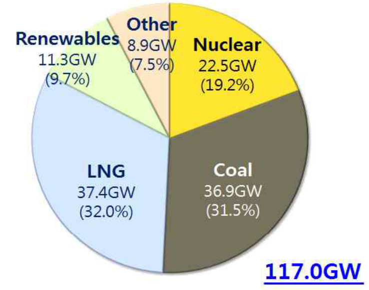
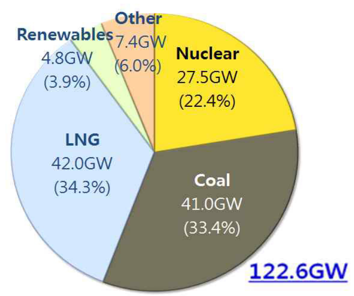
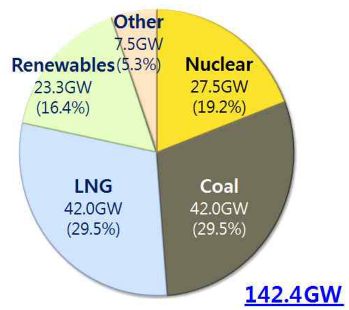
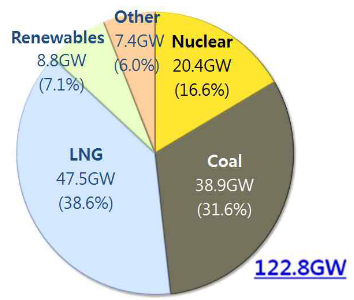
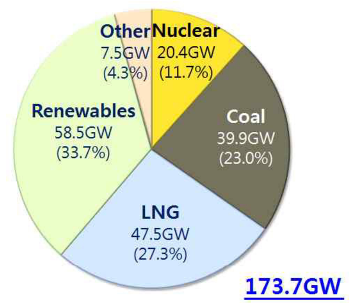
* Reduction target in power generation sector by 2030: BAU 322 million tons, and reduction target: 19.9% (64 million tons)

– (Target for emissions released in power generation sector) 258 million tons → **(8th BPLE) 237 million tons**

– Because **Renewable generation is rising faster than nuclear power generation is shrinking** and coal–fired generation is decreased by the introduction of environmentally friendly dispatch.

※ In the 8th BPLE, fine dust and greenhouse gas emissions were calculated by the generation output forecast
→ The emission volume may be different by object and calculation method in anti-fine dust measures announced in September 2017 and the 2030 national roadmap for greenhouse gas reduction released in December 2016. Therefore, it may be changed by revising the national roadmap for greenhouse gas reduction.

Attachment 6 Generation Mix Outlook

Year	Effective Capacity	Nominal Capacity
2017		
2022		
2030		

Attachment 7

Installed Capacity Status in the 8th BPLE

Committee	Date	Agenda	Remark
1st Capacity Planning Subcommittee	February 10, 2017	o Actions for electricity supply and demand in the 8th BPLE o Major issues and key assignment review in the 8th BPLE	-
Review of proper capacity reserve level, renewable energy backup facilities (April - July, 2017)			
2nd EPRB Meeting	August 11, 2017	o 8th BPLE progress review o Mid-to-long-term electricity supply forecast (tentative) o Actions to promote renewable energy	**Release of the capacity planning draft**
2nd Capacity Planning Subcommittee	September 8, 2017	o 8th BPLE proper reserve margin o Backup facility scale for the promoted renewable energy o Renewable energy utilization in Jeju	
6th Reserve Margin Working Group	September 13, 2017	o Proper reserve margin o Renewable energy backup facilities	**Release of proper reserve margin**
5th Renewable Energy Working Group	September 19, 2017	o Responses to renewable energy variability in major countries and its implications o Action plan for renewable energy variability	**Release of the action plan for renewable energy variability**
4th Generation Mix Working Group	September 20, 2017	o Forecast of electricity supply and demand in Jeju o Plan for renewable energy backup facilities o Plan for survey of construction intent	
6th Generation Mix Working Group	October 27, 2017	o Plan for reflecting the survey results of generation facilities o Hearing for operators' opinions about generation plant construction	-
7th Generation Mix Working Group	November 23, 2017	o Plan for reflecting the survey results of nuclear power plants	

VII. Promotion of Renewable Energy and DERs

1 Outlook of DER Distribution

1 Criteria for DERs

○ **(Definition)** Distributed energy resources (DERs) refer to small−sized generation facilities and generation facilities applicable to points of demand with minimal construction of transmission lines.

○ **(Detailed Criteria)** The scale of DER facilities is defined according to the "plant system connection criteria" under the "Provision for Transmission Facilities Use" (the same with the 7th BPLE).

< Detailed Criteria for DERs >

Facilities	Criteria Description	Line Construction
Small-sized generation facilities (below 40 MW)	The maximum capacity connectable to the 22.9 kV distribution line (two lines) is 40 MW.	No additional transmission line needed
Generation facilities near points of demand (below 500 MW)*	The maximum capacity connectable to the 154 kV transmission line (two lines) is 500 MW.	

* Note that one of the following should be applicable: a) integrated energy facilities with heat supply, b) community energy system (CES) operators, or c) self-generators (with no additional transmission line construction needed)

2 DER Distribution Outlook

○ With the share of renewable energy on the increase, the share of DERs is expected to account for **18.4% of the total generation output by 2030.**

< DER Outlook >

Year			2017	2022	2026	2030	2031
Generation Output of DERs (TWh)	Renewable (biz.)		12.2	27.3	41.8	59.3	61.8 (9.4%)
	self-generation	Renewable	13.9	14.9	15.9	17.1	17.1 (2.6%)
		other	7.3	7.3	7.3	7.3	7.3 (1.1%)
	Integrated Energy (incl. CES)		31.0	37.3	37.3	37.3	37.3 (5.6%)
	Total		64.4	86.7	102.2	120.9	123.4
Share of DERs			11.2%	13.8%	15.7%	18.4%	18.7%

* Offshore wind energy and other renewable energy above 40 MW, away from the point of demand, were not included in this energy table.

2 Institutional Improvement Status

1 Renewable Energy Programs

○ **REC Issued to Renewable Energy Self-generators** (September 2016, revised public notice)

– This issuance is designed to support the profitability of renewable energy from self-generators that is traded in the electricity market.

○ **Expanded Capacity of Photovoltaic Energy (PV) Generation Facilities for Net Metering** (February and October 2016, revised public notice)

– The installed capacity of net metering-based PV was upgraded twice from 10 kW to 1,000 kW.

* Feb. 2016 (10 kW → 50 kW), Oct. 2016 (50 kW → 1,000 kW), and generation facilities other than PV maintained at 10 kW

– The scope of net metering is now broader; it can be applied to households, large buildings, hospitals, and schools.

○ **Guaranteed Grid Connection to Small-sized (below 1MW) Renewable Energy Power Plants** (October 2016, revised KEPCO regulations)

– KEPCO is making this guarantee* as a responsible leader in strengthening the public electricity grid for renewable energy providers.

* Grid connection is one of the requirements for small-sized generators to join the electricity market or trade with KEPCO.

○ **Connection Capacity per Transformer for Renewable Energy Generators Increased** (March 2017)

– Connection capacity upgraded from 25 MW to 50 MW per transformer and support provided by installing additional transformers and distribution lines for seamless grid connection

○ **No Limit on Electricity Trading Volume for PV Self-generators** (March 2017)

– The percentage of the total annual generation output that could be used in electricity trading had been limited to 50%. But following the amendment of an enforcement decree and public notice under the Electricity Utility Act, all extra electricity can now be traded.

– The increased electricity trading volume is making PV self-generators more profitable.

2 Institutional Improvements in the Electricity Market

○ Rationalization of Capacity Payment (October 2016)

【 Key note 】
■ Inflation-adjusted capacity payment, and the introduction of location factor and the fuel switch factor (FSF)

– Capacity payment was rationalized by reflecting inflation and differentiating the payment depending on the plant locations and the amount of greenhouse gas emissions

– Compensation for LNG-based generators located near points of demand was expanded, which contributes to the promotion of DERs.

○ **More Compensation to Generators under System Constraint** (May 2016)

【 Key note 】
■ More compensation to be provided to generators in the low-output operation section (below 50%) because of the system constraints

– In case of additional dispatch orders for system operation, the units will be compensated for the fuel cost incurred because of low efficiency in the low-output section (less than 50%).

○ **More Compensation to Heat Constraint Operation at Combined Heat and Power Plants** (May 2016)

【 Key note 】
■ Additional fuel cost compensation for combined heat and power plants to produce heat

– No-load cost paid for generator operation in case of generating heat and power simultaneously near the points of demand

– Compensation for the contribution of CHP to the electricity market as DER to increase the financial support for integrated energy

3 Renewable Energy Targets and Promotion Plan (Summary of Renewable Energy 3020)

1 Target: 20% (132TWh*) of the total generation output by renewable energy by 2030

* The target is the sum of renewable energy generation for business purposes(115 TWh) and self-generation(17 TWh), but does not include new energy such as IGCC and fuel cells.

○ The generation target of 20% was set by considering system stability, the domestic situation, and renewable energy potential.

* Korea Environment Institute (KEI, 2014): The potential capacity at PV and wind power sites in Korea reaches 162 GW.

○ There is expected to be 48.7 GW of new installed capacity in renewable energy to be supplied by 2030.

* Short-term (2018 - 2022): 12.4 GW, and medium-to-long term (2023 - 2030): 36.3 GW

2 Strategy

【Areas】 Wastes and bio-focused → Clean energy-oriented including PV and wind power

※ Reducing REC-weighted values for combustion-based renewable energy such as wastes and wood pellets is now under consideration.

【Solutions】 Business- and individual site-focused → Focused on public engagement and planed development

【Economic Feasibility】 No large-scale projects → Deregulation and other support for large-scale projects

3 Plan of Supplying Renewable Energy Facilities by Consumer

< Supply Plan (Unit: GW) >

Year	2018 - 2022	2023 - 2030	Total
❶ self-generation including houses and buildings	0.7	1.7	2.4
❷ Cooperatives and small projects	3.4	4.1	7.5
❸ PV in farmland	3.3	6.7	10.0
❹ Large-scale projects	5.0	23.8	28.8
Subtotal	12.4	36.3	48.7

❶ More PV Self-generation for Urban Area

- **More funds allocated to promote** this type of generation and **cash payment for extra electricity**

* Offset and use of extra electricity: (Current) Carried forward to next month → (Future) + Carried forward to next month and make cash payment
* Offset available in: (Current) Single residences → (Future) Single residences and community residences

- Step-by-step increase of mandatory* certification of zero-energy buildings

* (2020) Public construction (gross floor area (GFA) of below 3,000 ㎡) → (2025) Private/public construction (GFA below 5,000 ㎡) → (2030) All construction

❷ Strengthened Support for Cooperatives and Small-sized Projects

- Guaranteed profitability and simplified procedures **with the introduction of Korea's FIT system**

* Mandatory purchase of six GenCos under earlier RPS → Steady profitability for 20 years
* Omission of REC issuance and bidding

- **REC weighted values and other incentives** provided to cooperatives and civic fund-based projects

❸ More PV in Farmland

- Use of photovoltaic energy in **farmland except areas reserved for agriculture and reclaimed land** (10 GW by 2030)

* Legal evidence (2018): Deregulation of farmland, tax cuts for farmland preservation, and others

- Introduction of a new model called **"Agriculture-compatible PV model"**

❹ Large Projects in Consideration of Public Acceptance and Eco-friendliness

- **Step 1 (2018 - 2022)**: Focused on 5 GW projects out of all public and private projects in progress*

* These include a 21.3 GW project submitted as one of 40 MW-plus projects in the survey on renewable energy projects in September 2017.

→ Plan approval* and support for proactive system interconnection for some projects with high public acceptance of the licensed projects

* Approval plan: PV and wind power projects with public 154kV-plus transmission lines (above 40 MW) or fuel switching PV and wind power projects.

* Selective approval to be given to projects licensed in the future considering public acceptance and other factors

- **Step 2 (2023 - 2030)**: Focused on projects related to offshore wind power (about 10 GW) and floating PV solar systems and step-by-step quota raising for large generation companies in RPS

4 Investment Plan for Renewable Energy

○ About 100 trillion won including 18 trillion won from the central government budget is expected to be invested in the Renewable 3020 plan.

< Investment in Facilities for Renewable Energy 3020 >
(Unit: trillion won)

2018	2019	2020	2021	2022	2023	2024
2.8	4.9	4.9	5.1	5.8	6.5	7.8
2025	**2026**	**2027**	**2028**	**2029**	**2030**	**Total**
8.4	8.2	8.5	9.8	9.6	9.9	92.4

*This does not include the Korean government's R&D budget.

4 Renewable Energy Variability Solutions

1 Backup Facilities to Relieve Output Variability Included in Minimum Capacity Reserve

○ Preparation of backup facilities including quick output−controllable ESS, pumped−storage, single cycle gas turbine−operable LNG CC, etc.

– Review of how many backup facilities are needed to maintain system frequency to respond to renewable energy variability that occurs every minutes or hours

– With the consideration of backup facilities including variability response time, economic feasibility, installation period, **the backup facilities for LNG are now 3.2 GW and those for pumped−storage are 2GW.**

* Aside from the pumped storage backup, about additional 0.7 GW is expected to be required for ESS.

○ As a proper amount of backup facilities applied to minimum capacity reserve, it will ensure a stable system operation for the expansion of renewable energy.

○ Promote the revision of regulations to necessarily secure the flexible reserve in real−time operation.

* A review is in progress to add pumped-storage facilities to the current operating reserve (4 GW) for swift responses. The additional capacity is subject to a further review.

2 Establishment of Renewable Energy Control System

○ Plan to establish an integrated renewable energy control system for stable system operation as demonstrated in the exemplary use cases of renewable energy in other countries

* Countries with high proportion of renewable energy such as Germany, Spain, and the United States are mostly operating a system to enhance accuracy in forecasting renewable generation output and strengthening responses to output variability.

– The control system will include the renewable generation forecast, real−time output measurement, and control of fluctuation, and others.

○ The system is planned to be test−run from 2018 and fully operated in 2020.

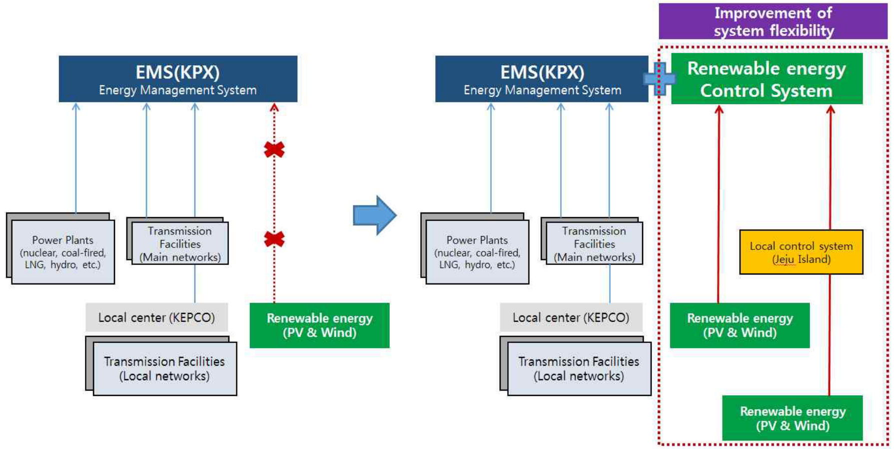
< Key Functions and Structure of Renewable Energy Management System >

① Wind speed, solar isolation, and other weather information → **Generation Forecasts** of wind farms and PV plants

② **Forecast and Analysis on national and local generation output** based on information of Generators (by time, day, week, and month)

③ **Real-time Measurement and Analysis** on renewable generation output

④ EMS-linked renewable generation control for stability in the entire power system operation



3 **Promote improvement of electricity market framework** to integrate more Flexibility Facilities

○ Under the current electricity market system that is driven by generation−cost, flexible resources which is key role to stabilize the power system is hard to get rewarded and regulated.

○ It needs to be considerate of incentives or mandatory quota for generator's owners so that flexible resources can enter the electricity market.

– Review of the Real−time Power Market that is reasonably compensate for flexible back−up power on variable renewable energy

5 Promotion of Other DERs

1 Improvements in Compensation

❶ Rational Compensation: Public values of CHP need to be compensated in more organized ways. The values include energy efficiency and benefits of distribution.

* In the US, the incentives are provided based on the amount of fuel saved by CHP operating in combined cycle, compared with CHP in single mode. (Alternative Energy Portfolio Standard (AEPS))

❷ **Differential expansion of Capacity Payment:** More benefits to generators **environmentally friendly** and **located near points of demand**

– Locational factor(LF) is applied depending on **the distance from the point of demand and capacity**. To promote the use of eco-friendly fuel, contribution to the environment in Fuel Switching Factor(FSF) is going to be weighted.

– **Capacity payment for CES is now under review so that they are paid** when certain conditions* are met in case of **capacity over the local demand.**

* Certain conditions include that the generator should be above 20 MW in capacity, and there should be facilities that can respond to dispatch orders by KPX.

2 Contribution of DERs to the Environment

○ Given the proximity of the residential area, DERs need to be further eco-friendly and public hearing process should be strengthened at the licensing phase.

○ Fuel switch may be discussed with the operator when residents claim often about any generation project.

Ⅷ. Plan for Transmission & Transformation Facilities

1 Evaluation on Korean Electricity System

1 Delayed Construction of Transmission & Transformation Facilities to Supply Electricity to Large Points of Demand

* Many large generation complexes are located in the ocean in Chungchungnam-do, Gangwon-do, and the southeastern part of Korea (65GW, 52%).

○ **Transmission constraints are being experienced with some transmission line constructions behind the schedule** in Bukdangjin – Seoanseong (West Sea → Seoul metropolitan area) and Shin Hanwool – Shin Gapyeong (East Sea → Seoul metropolitan area)

< Construction Delays in Major Transmission Lines >

Location	Expected Completion	Transmission Constraint	Remark
Bukdangjin - Seoanseong	June 2021	3,000 MW	Complaints and request of underground installation of transmission lines from some residents
Shin Hanwool - Shin Gapyeong	December 2021	900 MW*	Fuel plan update and complaints from some residents

* Transmission constraints will increase when the construction of Shin Hanwool Units 1&2, Gangneung Anin Units 1&2, and Samcheok Units 1&2 is completed.

2 Construction Delays Resulting from Low Public Acceptance of Transmission & Transformation Facilities

○ **Public acceptance is still low* about transmission and transformation facilities despite the enactment of the Act on Transmission Facilities and Assistance to Adjacent Areas in 2015. Conflict resolution is not satisfactory among the local government and many stakeholders.**

* According to the Act on Transmission Facilities and Assistance to Adjacent Areas, support has been provided in the areas with 345 kV facilities. Opposition to additional installations of large transmission and transformation facilities is escalating in Dangjin where the facilities are concentrated.

○ **Site selection has been operator-led** and **public hearing was not enough for residents.** The opposition of stakeholders is strong and they have been requesting underground installation of transmission lines.

3 Infrastructure in Transmission and Transformation Facilities required to Support Promotion of Renewable Energy Generation

○ It takes two to three years in the installation of small-sized renewable generation facilities. Reinforcement of electricity system takes six years or longer; therefore, **there is a time gap between renewable generation and system reinforcements.**

○ Renewable energy is expected to be generated mainly in rural and mountainous areas; **transmission lines need to be additionally installed in the points of demand and build new substations need to be built**

2 Direction and Tasks

1 Enhanced System Capacity for Promoted Use of Renewable Generation and Enhanced System Capacity

❶ (Short Term) System reinforcements to be were completed earlier than expected to **relieve the long standby of renewable energy grid connection.**

– **By 2018, 58 distribution lines and 31 transformers** are expected to be installed to connect **3.2GW** out of the total 3.3GW*.

* This refers to the standby capacity as of October 2017 after the guaranteed system connection (since October 2016) for small-sized renewable energy (less than 1 MW).

– **Integrated control center up and operating for disclosure of regional system information*** for the use of renewable energy and to monitor, forecast and control renewable energy

* This information includes substation transformers, extra capacity for system connection in distribution lines, and conditions for breaker connection.

– **Introduction of the brand-new technology for system stability** including FACTS*(Flexible AC Transmission System)

* FACTS refers to facilities specially designed to enhance system stability by efficiently controlling electric current and voltage.

❷ (Mid to Long Term) Timely reinforcements of transmission & transformation facilities **in the areas where renewable energy generation is expected to be intensive**

– Proactive construction of transmission and transformation facilities at the sites **designated for planned renewable generation and a large renewable energy project**

< Mid to long Term Estimate of Transmission & Transformation Facilities Requirement>

Item	Substations	Transformer	Transmission Lines	
			Substation Connection	Regional Swapping
2018 - 2022	38	81	76 lines (760 km)	-
2023 - 2031	5	8	10 lines (100 km)	8 lines (700 km)
Total	43	89	86 lines (860 km)	8 lines (700 km)

* This demand estimate is based on the survey of renewable energy project planning in September 2017. The estimate is subject to change depending on the size and sites of projects.

– **New voltage standard** (70kV) to be established to introduce small substations designed for DERs (renewable energy).

2 Timely System Reinforcements and Improved Stability for Stable Electricity Supply

○ **Intensive management of facilities in delay** so that transmission and transformation facilities are installed in time and **a alternative plan to be set for the delay of construction***

* A plan will be established for 10 core units (six transmission lines and four transformers) by the first half of 2018.

– In particular, #3HVDC construction in Jeju is expected to be completed by 2020 (originally scheduled by 2025) to preemptively relieve uncertainty in electricity supply.

< Demand for Transmission Line Installations and Reinforcements >

Purpose	Route	Completion	Voltage	Description
Key Tasks	Bukdangjin - Godeok #1	Dec. 2019	500 kV HVDC	Use of generation power and increasing supply networks in Chungnam
	Bukdangjin - Godeok #2	June 2021		
	Shin Hanwool #1 - Shin Gapyeong	Dec. 2021		System interconnection using large-scale generation power* in East Sea * Shin Hanwool #1,2m Bukpyeong, Samcheok Green, Gangneung Anin, and Samcheok
	Shin Hanwool #2 - Metropolitan area #2	Dec. 2022		
	Bukdangjin - Shintangjeong	Dec. 2018	345 kV	Use of generation power and increasing supply networks in Chungnam
	Gwangyang C/C-Shinyeosu	Oct. 2020		Clearing generation constraints in Yeosu and electricity supply to industrial complexes
	Dangjin T/P - Shinsongsan	June 2021		Use of generation power and increasing supply networks in Chungnam
	Godeok - Seoansung	June 2021		More power interchanged lines and increasing supply networks in the Seoul metropolitan area
Timely Tasks	Shinbupyeong #2 - Shingwangmyeong	Dec. 2019	345 kV	Use of generation power in Incheon and electricity supply in the Southern part of Gyeonggi-do
	Seojeonnam branch	Apr. 2021		Electricity supply to Gwangju and Jeollahnam-do
	Dongducheon C/C - Yangju	Dec. 2022		Use of generation power and system reinforcements in the Northern part of Seoul metropolitan area
	Jeju - Inland #3	Dec. 2020	150kV HVDC	Stable electricity supply and renewable energy system interconnection in Jeju

* ❶ Key tasks: Early completion of construction needed to clear generation constraints
❷ Timely tasks: Timely completion of construction needed to enhance reliability

* The plan of 345 kV-plus transmission and transformation facilities is reflected in this BPLE and the detailed plan, including 154 kV-below facilities, is going to be validated in the so-called "long-term plan of transmission and transformation facilities" by operators based on this BPLE after the review of the Electricity Committee.

< **Demand for Substation Constructions and Reinforcements** >

Purpose	Substation	Completion	Voltage	Description
Key tasks	Shinjungbu	June 2019	765 kV	Electricity supply and voltage troubleshooting in midland
	Bukdangjin C/S, Godeok C/S	Dec. 2019	500 kV HVDC	Use of generation power and supply network reinforcements in Chungnam
	Shin Hanwool #1C/S, Shingapyeong C/S	Dec. 2021		System interconnection using large-scale generation power in East Sea
	Shin Hanwool #2C/S, Seoul metropolitan area #2C/S	Dec. 2022		
	Godeok	June 2018	345 kV	Electricity supply to Pyeongtaek and the Southwestern part of Gyeonggido
Timely tasks	Gangneung T/P7	Oct. 2024	765 kV	System interconnection in Gangneung Anin Thermal
	Shinsongsan	Dec. 2018	345 kV	Electricity supply to Songsan industrial complex
	Namulsan	Dec. 2019		Electricity supply to the Southern part of Ulsan
	Shinsiwha	Apr. 2020		Electricity supply to Siheung and Ansan
	Seojeonnam	Apr. 2021		Electricity supply to Gwangju and Jeollahnam-do
	Shinsongdo	June 2023		Electricity supply to Songdo and the Southwestern part of Incheon
	Shinjeongeup	Oct. 2023		Electricity supply to Jeongeup
	Shindalseong	Apr. 2024		Electricity supply to the national industrial complex in Dalseong, Daegu

* The plan of 345 kV-plus transmission and transformation facilities was laid out here. The entire demand for new and reinforced substations is going to be described in the so-called "long-term plan of transmission and transformation facilities".

○ The transmission lines **for system interconnection of new power plants** under this BPLE must **be completed in time.**

< **Plant-System Interconnection Plan** >

Fuel	Plant	Operator	Installed Capacity (MW)	Location	Completion	System Interconnection
Coal	Shinseocheon	KOMIPO	1,000	Seocheon	2020	Installed line
	Goseong Hi #1・2	Goseong Green Power	1,040×2	Goseong	2021	Goseong Hi T/P - Euiryeong Goseong Hi T/P- Samcheonpo T/P
	Gangneung Anin #1・2	Gangneung Eco Power	1,040×2	Gangneung	2022	Shintaebaek - Shingapyeong branch Gangneung T/P3・7 - Gangneung open/closing gate East Sea - Yangyang pumped-storage (Shinyangyang) branch East Sea - Seoul metropolitan HVDC
	Samcheok Thermal #1・2	POSPower Co., Ltd.	1,050×2	Samcheok	2022	Samcheok T/P - Shintaebaek East Sea - Seoul metropolitan HVDC
LNG	Jeju	KOMIPO	240	Jeju	2018	Installed line
	Seoul #1・2	KOMIPO	400×2	Seoul	2019	Installed line
	Shin Pyeongtaek #1	SPCC	951	Pyeongtaek	2019	Pyeongtaek T/P - Hwaseong
	Yeoju #1	SK E&S	1,000	Yeoju	2020	Yongmun - Jije (Moonmak) branch
Nuclear	Shin Hanwool #1・2	KHNP	1,400 ×2	Uljin	2018, 2019	Use of installed line and East Sea - Seoul metropolitan HVDC
	Shin Kori #4・5・6	KHNP	1,400 ×3	Ulsan	2018, 2022, 2023	Installed line
Renewable	Offshore Wind Farm Complex in Southwestern Sea	TBD	2,000	TBD	2023	Offshore wind power - Saemangeum

* Transmission interconnection of new facilities to be determined in the licensing process.

3 Higher Social and Environmental Acceptance about Transmission and Transformation Facilities

○ **Extra high-voltage direct current (HVDC) lines** to be installed that long-distance large-scale transmission is available, requiring smaller iron towers and emitting less electronic wave with relatively high public acceptance

– **Continued R&D investment** for localization of HVDC technology **and technology transfer from China, Germany and Canada**

* Multi-terminal HVDC system project for transmission and distribution (124.4 billion won, November 2017 - October 2021)

○ **Proactive review for better public acceptance including underground installation of transmission lines** in populated areas or environmentally degradable areas from the planning stage

– **Invite more residents to the site selection process** including open site selection* and residents-led site selection**, and raise public acceptance fundamentally with residence-friendly substations and other acceptable facilities

* Site selection for transmission and transformation facilities through opening to the public (ex.: 345kV Seojeonnam, April 2021)

** Site information disclosure, invitation of residents to site selection (ex.: two 154 kV transmission lines in Namgongju branch, 2022 - 2023)

○ 「**Plan on Substantial Support for Areas near Transmission and Transformation Facilities**」 to be laid out based on the survey* on the satisfaction level of the Act on Transmission Facilities and Assistance to Adjacent Areas by the second half of 2018

* (Period) December 201 - March 2018, (Details) field investigation and interviews for satisfaction level insights

4 Overcoming Independent System's Limitations through 「Super Grid in Northeast Asia」

○ Interstate use of clean energy (natural gas · wind power) from Siberia in the Far East and the Gobi Desert in Mongolia through the **construction of transmission lines between Korea and Russia as well as Korea, China, and Japan**

– The geographical limitation as a "system island" can be overcome **by sharing capacity reserve with neighboring countries to clear concerns over electricity supply and form detente in Northeast Asia.**

< Super Grid Flow in Northeast Asia >

○ Fully fast-tracking the process with the goals of **❶ construction by track, ❷ completion of Korea-Russian joint research by 2022**

– **Building robust public-private cooperation in countries**, working-level review* after a consensus on Super Grid in Northeast Asia (by 2019)

* (Technical aspect) technical potentials and problem analysis, (Economic) business models and benefit-cost analysis

– **The establishment of special purpose corporation (SPC)** will spearhead this plan and **a joint offshore survey and a financing program** will be conducted as follow-up measures by the first half of 2020.

3 Establishment of Detailed Plan

□ The **「Long-term Plan of Transmission & Transformation Facilities*」** will be established **based on the criteria and plan of strengthening transmission and transformation facilities under this BPLE and the following actions will be taken.**

* The Plan is established every 15 years as in this BPLE and it is subject to the Electricity Committee review.

○ The **「Annual Plan of Transmission & Transformation Facilities」** is also established based on the latest investment plan and construction status to enhance efficiency of the 「Long-term Plan of Transmission & Transformation Facilities」.

Attachment 8 Criteria for Transmission Expansion Planning

◈ **The detailed criteria** is based on the 「**Criteria for Reliability and Quality of Electricity System**」(Notice by the Ministry of Trade, Industry and Energy)

1. Reliability Limit in Contingencies

□ Acceptable Fault Range

* Allowed overload in transmission lines is defined as a condition wherein the power supply can be restored in a short period at the rated capacity of 120% or below

Voltage	Fault	Issues		System Interconnection	Load Supply System	Main Systems
765 kV	Single	Extent of Failure	Overload	Not allowed	-	Allowed
			Load drop	Not allowed	-	Not allowed
			Generator dropout	Not allowed	-	Not allowed
		Actions	Adjustment of generation power	Not allowed	-	Allowed
			Load shifting	-	-	-
	Double	Extent of Failure	Overload	Allowed	-	Allowed
			Load drop	Not allowed②	-	Not allowed②
			Generator dropout	Allowed	-	Allowed
		Actions	Adjustment of generation power	Allowed	-	Allowed
			Load shifting	-	-	-
345 kV	Single	Extent of Failure	Overload	Not allowed	Allowed	Allowed
			Load drop	Not allowed	Not allowed	Not allowed
			Generator dropout	Not allowed	Not allowed	Not allowed
		Actions	Adjustment of generation power	Not allowed	Allowed	Allowed
			Load shifting	-	Allowed	Allowed
	Double	Extent of Failure	Overload	Allowed	Allowed	Allowed
			Load drop	Not allowed	Allowed①	Not allowed
			Generator dropout	Allowed	Allowed	Not allowed
		Actions	Adjustment of generation power	Allowed	-	Allowed
			Load shifting	-	Allowed	-
154 kV	Single	Extent of Failure	Overload	Allowed	Allowed	Allowed
			Load drop	Not allowed	Not allowed	Not allowed
			Generator dropout	Not allowed	Not allowed	Not allowed
		Actions	Adjustment of generation power	Allowed	Allowed	Allowed
			Load shifting	-	Allowed	Allowed

Voltage	Fault	Issues		System Connection	Load Supply System	Main Systems
	Double	Extent of Failure	Overload	Allowed	Allowed	Allowed
			Load drop	Not allowed	Allowed①	Allowed①
			Generator dropout	Allowed	Allowed	Not allowed
		Actions	Adjustment of generation power	Allowed	-	Allowed
			Load shifting	-	Allowed	Allowed
70 kV	Single	Extent of Failure	Overload	Allowed	Allowed	Allowed
			Load drop	Not allowed	Not allowed	Not allowed
			Generator dropout	Not allowed	Not allowed	Not allowed
		Actions	Adjustment of generation power	Allowed	Allowed	Allowed
			Load shifting	-	Allowed	Allowed
	Double	Extent of Failure	Overload	Allowed	Allowed	Allowed
			Load drop	Not allowed	Allowed①	Allowed①
			Generator dropout	Allowed	Allowed	Not allowed
		Actions	Adjustment of generation power	Allowed	-	Allowed
			Load shifting	-	Allowed	Allowed

☐ **Transformer 1 Bank Fault Range**

Issues	765 kV	345 kV	154 kV	70 kV
Overload	Not allowed	Not allowed	Not allowed③	Not allowed③
Load drop	Not allowed	Not allowed	Allowed①	Allowed①
Generator dropout	Not allowed	Not allowed	Allowed	Allowed
Adjustment of generation power	Not allowed	Not allowed	-	-
Load shifting	-	-	Allowed	Allowed

① Conditions wherein the power supply can be restored in a short period of time following an interruption using means such as a load reallocation to other substations without repairing the facilities that failed
② Conditions wherein load drop is unavoidable to avoid any large-scale interruptions in supply affected by failures
③ Overload is allowed in the scope where load shifting is available in distribution lines

2. Criteria for the Power Plant Interconnection

☐ Interconnection Principles

○ Decided by the contract between the generation company and the transmission company as per the "Provision for Transmission Facilities Use"

☐ **Criteria for Power Plant Interconnection Configuration**

○ Interconnected with more than two lines in principle.
Note that one-line interconnection available if there is no particular impact on the system.

< **Plant Interconnection Configuration by Capacity** >

Capacity	Detailed Criteria
Over 1,000 MW	Over 345 kV
Below 1,000 MW	345 kV or 154 kV
Below 100 MW	154 kV or 70 kV

* If connected to HVDC, the AC requires the equivalent capacity.

3. Criteria for the Construction and Expansion of a Transmission System

☐ Roles by Voltage

Voltage	Role
765 kV	▪ Electricity transmission between large-unit power generation complexes and areas with large capacity load
345 kV	▪ Building inter-regional main system network or electricity supply to downtown areas
154 kV	▪ System configuration in the 345 kV areas or electricity supply to distribution systems
70 kV	▪ Small-scale load and system interconnection or electricity supply to areas in low demand

☐ Criteria for Transmission System Construction

Voltage	Detailed Criteria
765 kV	▪ 765 kV shall be installed in case it is more advantageous than 345 kV and a large-scale interchange of electricity is in demand ▪ System shall be reinforced to prevent any large-scale power supply problem or extended failure spread due to a two-line failure
345 kV	▪ 345 kV shall be installed when it is more appropriate than 154 kV, such as when a large increase in demand is expected or the interchange and supply of electricity is not enough with new 154 kV lines ▪ Main transmission systems shall consider two-line failures, while singular systems and underground systems shall consider one-line failures

Voltage	Detailed Criteria
154 kV	▪ 154 kV shall be installed if the existing interconnection cannot be maintained adequately due to the increase in generation capacity and power demand ▪ In principle, four-line branch off is considered for the existing lines, and two-line branch off can be considered only if there are no problems in load characteristics, short circuit currents, overloads, etc. ▪ If possible, 345 kV substation network should be configured with the line size of 410 ㎟ × 2B (over 2,000 ㎟ for underground), considering the power flow and the increasing load in the substation ▪ Underground lines should be configured to the largest scale, taking the increasing load demand into account, and regional networks close to downtown areas should be configured by installing power tunnels depending on the power system expansion ▪ Main lines such as regional networks supplied by a 345 kV substation take two-line failures into account, while underground and other lines are expanded while taking one-line failure into account
70 kV	▪ 70 kV shall be installed if it is more appropriate than 154 kV for interconnection with small-sized renewable energy power plants, low-demand areas, and electricity supply to voltage-low areas
HVDC	▪ HVDC shall be installed when direct current transmission is appropriate for large-scale long-distance transmission, electricity flow control, and fault current suppression

☐ Criteria for Substation Construction & Expansion

Voltage	Detailed Criteria
765 kV	▪ In principle, the final size of extra high voltage transformers is five banks, while the number of initial banks is decided by considering load supply, generation facilities, and economic efficiency ▪ 765 kV substations shall be installed in cases where the transmission requirement more than 345 kV or a large-scale interchange of electricity is in demand, or where performance improvement is needed ▪ Transformers shall be added in case one bank fails and the other bank exceeds the rated capacity (100%)
345 kV	▪ In principle, the final size of 345 kV transformers is four banks, while the number of initial banks is decided by considering load supply and economic efficiency ▪ 345 kV substations shall be installed when a large increase in demand is expected, but the expansion of existing substations is not expected to accommodate it, performance improvement is needed, or 345 kV is more advantageous than 154 kV ▪ Transformers shall be added in case one bank fails and the other bank exceeds the rated capacity (100%)
154 kV	▪ In principle, the size is four banks, while the number of initial banks is two, in consideration of future expansion and no more installations exceeding final size ▪ 154 kV substations shall be installed in case where a 22.9 kV distribution system constraint is expected, or where new load supply or additional installation of generation facilities is expected ▪ Substations shall be installed in cases where the capacity of a transformer exceeds the rated capacity (100%) or the scale of generation facilities increases significantly. Load shifting in the distribution lines should be considered.
70 kV	▪ In principle, the final size of 70 kV transformers is three banks, while the number of initial banks is more than two. ▪ 70 kV shall be installed if it is more appropriate than 154 kV for interconnection with small-sized renewable energy power plants, low-demand areas, and electricity supply to voltage-low areas

IX. Follow-up Plan

1 Refinement and Verification Improvement in Demand Forecast Model

○ **This model needs to be localized so that the characteristics of the Korean industry and electricity consumption pattern are directly reflected**

* Macro models typically reflect industrial structures indirectly; the models fail to incorporate the manufacturing sector-driven Korean economy.

– More and more home appliances that consume electricity such as electric ranges and electric dryers are widely used.

○ Improvements will be made under the 8th BPLE using the **upgraded Electricity Panel Model** and **supplementary models with high accuracy in prediction**

* Another available techniques can also be reviewed.

2 Reflecting Impact of the 4th Industrial Revolution in Demand Forecast

○ The impact was generally reviewed, but only several factors such as electric vehicles were reflected because of uncertainty of the forecast

* The peak demand is expected to increase about 0.3GW if one million electric vehicles are on the road by 2030

○ The effects of the 4th Industrial Revolution will be reviewed intensively in the next BPLE

– The impact of the core technologies will be reviewed in depth, including AI, IoT, big data, and robots

3 Strengthening Demand Side Management with the 「Basic Plans for Rationalization of Energy Use」

○ Demand Side Management actions toward energy–efficient society, including sectoral efficiency improvements (industries and buildings), ICT–based Demand Side Management, and optimized load management

○ More accurate performance verification and verification(M&V) on load management, efficiency improvements and other Demand Side Management methods

○ Urban regeneration project and smart city projects, and introduction of smart energy system in the industrial complex

4 Management Plan of Aging Thermal Power Plants (Coal, LNG, and Oil)

- A comprehensive review of stronger standards for economic lifetime and environmental regulations will be made to retire aging generators or align replacements in organized ways
  - The standard for replacement of aging generators is now being revised in the detailed generation project licensing standard

5 Follow-up Actions for Environmentally Friendly Dispatch

- Institutional improvements are on the way including the revision of the Electricity Market Rules to incorporate environmental costs and adjustment of fuel tax rates
- Consultation with the Ministry of Environment and local governments regarding the **introduction of coal-fired generation cap** from January 2018

6 More Viable Actions for Promotion of Renewable Energy

- Establishment of **"long-term plan of transmission and transformation facilities"** and **"annual plan of transmission and transformation facilities"** to prevent investment delays in renewable energy system reinforcements
  - KEPCO, KPX and KEMCO will jointly form **a task force called "Renewable Energy System Interconnection" only for the single task.**

  * The actions include information disclosure of local renewable energy system, establishment of renewable energy management center, problem-finding in renewable energy system interconnection, and training programs & public relations for operators

- Public-private council will be formed for **distribution of renewable energy** and each participant will be assigned to a role, which is going to be periodically reviewed and checked.

7 Institutional Support for DERs

- The distributed energy resources were defined in the Electricity Utility Act and the subordinate enforcement decrees. Promotion of DERs is going to be institutionalized further.
- Review use of the "Electrical Industry Foundation Fund" is also on the agenda

APPENDIX

1 Details of Establishing BPLE

☐ Working subcommittees were formed under the basic directions of BPLE (December 2016)

* The Electricity Policy Review Board (EPRB) meeting was held with the agenda of the 8th BPLE directions

☐ The Integrated Supply-Demand Committee, two working subcommittees, and six working groups were operated from December 2016 to November 2017.

○ Meetings held: Integrated Supply-Demand Committee (4 times),
2 working subcommittees (5 times),
and 6 working groups (33 times)

* Six working groups: Demand forecast, Demand side management, Generation mix, Capacity reserve, Renewable energy, and Power system

☐ The main BPLE agenda was reviewed and released along with the hearing from stakeholders (July 2017 – September 2017)

○ Release of the demand forecast draft (Demand Forecast Working Group, July 2017)

○ Release of the capacity expansion plan draft (EPRB, August 2017)

○ Announcement of proper capacity reserve (Capacity Reserve Working Group, September 2017)

○ Announcement of demand forecast reprepared by changes in GDP forecast (Electricity Demand Subcommittee, September 2017)

○ Announcement of action plans for renewable energy intermittency (Renewable Energy Working Group, September 2017)

☐ Consultation of the Ministries concerned regarding the 8th BPLE draft (December 2017)

☐ Report to the Trade, Industry, Energy, SMES, and Startups Committee regarding the 8th BPLE draft (December 2017)

☐ Public hearing convened regarding the 8th BPLE draft (December 2017)

☐ EPRB review and conclusion of the 8th BPLE (December 2017)

☐ Issuance of the 8th BPLE and distribution to the Ministries concerned (December 2017)

2 Electricity Demand Outlook

A. Reference Demand

☐ Nationwide

Year	Consumption		Peak Demand			
	GWh	Increase (%)	Summer (MW)	Increase (%)	Winter (MW)	Increase (%)
2016 (Actual)	497,039	2.8	85,183	10.7	83,657	0.8
2017	508,994	2.4	84,586 (Actual)	-0.7	86,546	3.5
2018	523,505	2.9	87,523	3.5	88,907	2.7
2019	537,973	2.8	89,750	2.5	91,262	2.6
2020	552,291	2.7	91,955	2.5	93,594	2.6
2021	566,714	2.6	94,173	2.4	95,991	2.6
2022	579,611	2.3	96,174	2.1	98,148	2.2
2023	592,145	2.2	98,122	2.0	100,251	2.1
2024	604,066	2.0	99,985	1.9	102,325	2.1
2025	615,788	1.9	101,819	1.8	104,369	2.0
2026	627,064	1.8	103,591	1.7	106,342	1.9
2027	637,866	1.7	105,297	1.6	108,241	1.8
2028	647,946	1.6	106,902	1.5	110,023	1.6
2029	657,725	1.5	108,466	1.5	111,759	1.6
2030	666,955	1.4	109,954	1.4	113,407	1.5
2031	675,367	1.3	111,327	1.2	114,922	1.3
'17～'31	-	2.1	-	1.8	-	2.1

* Peak demand basis: (Summer) July - August, (Winter) December - February of the next year

□ Maximum & Minimum Peak Demand Expected

Year	Maximum				Minimum			
	Summer (MW)	Increase (%)	Winter (MW)	Increase (%)	Summer (MW)	Increase (%)	Winter (MW)	Increase (%)
2016 (Actual)	85,183	10.7	83,657	0.8	85,183	10.7	83,657	0.8
2017	84,586 (Actual)	-0.7	86,585	3.5	84,586 (Actual)	-0.7	86,503	3.4
2018	87,580	3.5	88,985	2.8	87,444	3.4	88,787	2.6
2019	89,876	2.6	91,415	2.7	89,528	2.4	90,968	2.5
2020	92,148	2.5	93,820	2.6	91,667	2.4	93,209	2.5
2021	94,412	2.5	96,267	2.6	93,828	2.4	95,473	2.4
2022	96,509	2.2	98,531	2.4	95,740	2.0	97,599	2.2
2023	98,458	2.0	100,635	2.1	97,579	1.9	99,643	2.1
2024	100,397	2.0	102,790	2.1	99,341	1.8	101,600	2.0
2025	102,336	1.9	104,954	2.1	101,028	1.7	103,472	1.8
2026	104,248	1.9	107,091	2.0	102,700	1.7	105,329	1.8
2027	106,054	1.7	109,106	1.9	104,289	1.5	107,090	1.7
2028	107,803	1.6	111,057	1.8	105,750	1.4	108,705	1.5
2029	109,483	1.6	112,929	1.7	107,230	1.4	110,342	1.5
2030	111,055	1.4	114,676	1.5	108,532	1.2	111,772	1.3
2031	112,518	1.3	116,297	1.4	109,741	1.1	113,095	1.2
'17∼'31	-	1.9	-	2.2	-	1.7	-	2.0

□ Seoul Metropolitan Area

Year	Consumption		Peak Demand	
	GWh	Increase (%)	MW	Increase (%)
2016 (Actual)	179,773	3.5	32,773	0.2
2017	185,707	3.3	35,494	8.3
2018	190,753	2.7	36,297	2.3
2019	195,778	2.6	37,094	2.2
2020	200,744	2.5	37,877	2.1
2021	205,741	2.5	38,662	2.1
2022	210,204	2.2	39,361	1.8
2023	214,537	2.1	40,036	1.7
2024	218,654	1.9	40,676	1.6
2025	222,699	1.8	41,303	1.5
2026	226,586	1.7	41,903	1.5
2027	230,307	1.6	42,476	1.4
2028	233,777	1.5	43,009	1.3
2029	237,141	1.4	43,524	1.2
2030	240,313	1.3	44,009	1.1
2031	243,203	1.2	44,450	1.0
'17∼'31	-	2.0	-	2.1

☐ Jeju Island

Year	Consumption		Peak Demand	
	GWh	Increase (%)	MW	Increase (%)
2016 (Actual)	4,738	7.0	849	5.6
2017	4,957	4.6	921(Actual)	8.5
2018	5,193	4.8	962	4.5
2019	5,441	4.8	996	3.5
2020	5,699	4.7	1,032	3.5
2021	5,969	4.7	1,067	3.5
2022	6,212	4.1	1,100	3.0
2023	6,454	3.9	1,132	2.9
2024	6,696	3.7	1,163	2.7
2025	6,935	3.6	1,193	2.6
2026	7,171	3.4	1,223	2.5
2027	7,403	3.2	1,253	2.4
2028	7,631	3.1	1,281	2.3
2029	7,853	2.9	1,309	2.2
2030	8,068	2.7	1,335	2.0
2031	8,263	2.4	1,359	1.8
'17～'31	-	3.8	-	3.2

B. Target Demand

☐ Nationwide

Year	Consumption		Peak Demand			
	GWh	Increase (%)	Summer (MW)	Increase (%)	Winter (MW)	Increase (%)
2016 (Actual)	497,039	2.8	85,183	10.7	83,657	0.8
2017	506,981	2.0	84,586 (Actual)	-0.7	85,206	1.9
2018	519,069	2.4	86,114	1.8	87,155	2.3
2019	530,358	2.2	87,084	1.1	88,538	1.6
2020	540,054	1.8	88,779	1.9	90,342	2.0
2021	548,898	1.6	90,382	1.8	92,104	2.0
2022	556,088	1.3	91,464	1.2	93,314	1.3
2023	561,700	1.0	92,553	1.2	94,525	1.3
2024	566,228	0.8	93,527	1.1	95,672	1.2
2025	569,824	0.6	94,359	0.9	96,670	1.0
2026	572,800	0.5	95,104	0.8	97,568	0.9
2027	575,229	0.4	95,797	0.7	98,404	0.9
2028	577,029	0.3	96,399	0.6	99,131	0.7
2029	578,515	0.3	96,986	0.6	99,839	0.7
2030	579,547	0.2	97,533	0.6	100,498	0.7
2031	580,443	0.2	98,010	0.5	101,065	0.6
'17～'31	-	1.0	-	0.9	-	1.3

* Peak demand basis: (Summer) July - August, (Winter) December - February of the next year

□ Seoul Metropolitan Area

Year	Consumption		Peak Demand	
	GWh	Increase (%)	MW	Increase (%)
2016 (Actual)	179,773	3.5	32,773	0.2
2017	184,947	2.9	34,940	6.6
2018	189,090	2.2	35,575	1.8
2019	192,933	2.0	35,975	1.1
2020	196,186	1.7	36,544	1.6
2021	199,150	1.5	37,078	1.5
2022	201,546	1.2	37,403	0.9
2023	203,373	0.9	37,730	0.9
2024	204,828	0.7	38,013	0.7
2025	205,949	0.5	38,238	0.6
2026	206,853	0.4	38,427	0.5
2027	207,563	0.3	38,597	0.4
2028	208,051	0.2	38,731	0.3
2029	208,416	0.2	38,859	0.3
2030	208,598	0.1	38,969	0.3
2031	208,776	0.1	39,057	0.2
'17～'31	-	1.0	-	1.2

□ Jeju Island

Year	Consumption		Peak Demand	
	GWh	Increase (%)	MW	Increase (%)
2016 (Actual)	4,738	7.0	849	5.6
2017	5,019	5.9	921 (Actual)	8.5
2018	5,303	5.7	970	5.3
2019	5,615	5.9	1,003	3.5
2020	5,949	5.9	1,051	4.7
2021	6,199	4.2	1,086	3.3
2022	6,420	3.6	1,111	2.3
2023	6,634	3.3	1,138	2.4
2024	6,819	2.8	1,161	2.0
2025	6,996	2.6	1,182	1.9
2026	7,172	2.5	1,204	1.8
2027	7,352	2.5	1,227	1.9
2028	7,546	2.6	1,252	2.0
2029	7,769	3.0	1,282	2.4
2030	8,050	3.6	1,321	3.1
2031	8,253	2.5	1,348	2.1
'17～'31	-	3.8	-	3.1

3 Demand Side Management Targets

A. Peak Demand Reduction Plan

(Unit: MW)

Year	Energy Saving (Enhanced Efficiency)				Peak Reduction (Load Management)			Total
	EERS	EMS	Efficiency mng.	Self-generated PV	ESS	Load Devices	DR Market	
2017	0	22	55	16	35	118	1,616	1,863
2018	62	53	70	31	76	207	1,804	2,304
2019	147	103	105	48	90	328	1,960	2,781
2020	255	182	163	67	105	447	2,120	3,338
2021	368	297	270	86	150	522	2,288	3,981
2022	548	457	368	107	266	622	2,577	4,944
2023	733	670	501	129	324	751	2,745	5,853
2024	920	924	639	152	431	853	2,876	6,795
2025	1,195	1,190	752	177	560	955	3,029	7,858
2026	1,467	1,436	889	203	711	1,061	3,185	8,952
2027	1,734	1,639	1,050	230	882	1,158	3,342	10,035
2028	2,023	1,795	1,212	259	1,068	1,259	3,498	11,114
2029	2,285	1,911	1,407	289	1,262	1,361	3,656	12,171
2030	2,520	1,996	1,628	320	1,455	1,463	3,815	13,198
2031	2,814	2,058	1,791	321	1,640	1,580	3,973	14,177

B. Energy Saving Plan

(Unit: GWh)

Year	EERS	EMS	Enhanced Efficiency	Self-generated PV	Total
2017	0	852	1,136	156	2,144
2018	760	2,166	1,473	310	4,709
2019	1,798	3,822	1,993	476	8,088
2020	3,123	6,103	3,069	655	12,949
2021	4,471	8,151	5,121	847	18,590
2022	6,663	9,765	6,993	1,052	24,473
2023	8,884	11,874	9,557	1,269	31,584
2024	11,126	14,356	12,199	1,499	39,180
2025	14,516	16,952	14,313	1,742	47,523
2026	17,925	19,351	16,779	1,998	56,054
2027	21,351	21,354	19,700	2,267	64,672
2028	25,176	22,907	22,579	2,548	73,211
2029	28,737	24,083	26,114	2,842	81,777
2030	32,020	24,968	30,118	3,149	90,255
2031	36,438	25,634	32,844	3,162	98,079

4 Renewable Capacity Plan

A. Overall Renewable Capacity Expansion Plan (2017 - 2031)

(Unit: MW)

Year	Projects										Self-generation	Total
	Renewable Energy							New		Total		
	PV	Wind	Hydro	Off-shore	Bio	Burned Wastes	Byproduct Gas	Fuel Cell	IGCC			
2017	5,030 (785)	1,174 (22)	1,795 (504)	255 (3)	725 (212)	323 (78)	1,377 (1,040)	291 (214)	346 (208)	11,316 (3,065)	2,770	14,086
2018	6,330 (987)	1,374 (26)	1,810 (509)	255 (3)	825 (241)	323 (78)	1,377 (1,040)	371 (272)	346 (208)	13,011 (3,364)	2,893	15,904
2019	7,830 (1,221)	2,024 (38)	1,830 (514)	255 (3)	925 (270)	323 (78)	1,377 (1,040)	451 (331)	346 (208)	15,361 (3,704)	3,025	18,386
2020	9,330 (1,455)	2,724 (52)	1,850 (520)	255 (3)	1,025 (299)	323 (78)	1,377 (1,040)	531 (390)	346 (208)	17,761 (4,045)	3,168	20,929
2021	11,130 (1,736)	3,474 (66)	1,870 (525)	255 (3)	1,105 (323)	323 (78)	1,377 (1,040)	571 (419)	346 (208)	20,451 (4,398)	3,320	23,772
2022	12,930 (2,017)	4,424 (84)	1,890 (531)	255 (3)	1,185 (346)	323 (78)	1,377 (1,040)	611 (449)	346 (208)	23,341 (4,756)	3,483	26,824
2023	14,730 (2,298)	5,574 (106)	1,910 (537)	255 (3)	1,265 (369)	323 (78)	1,377 (1,040)	651 (478)	346 (208)	26,431 (5,117)	3,656	30,087
2024	17,130 (2,672)	6,924 (132)	1,935 (544)	255 (3)	1,335 (390)	323 (78)	1,377 (1,040)	671 (493)	746 (448)	30,696 (5,799)	3,838	34,534
2025	19,530 (3,047)	8,474 (161)	1,960 (551)	255 (3)	1,405 (410)	323 (78)	1,377 (1,040)	691 (508)	746 (448)	34,761 (6,245)	4,031	38,792
2026	21,930 (3,421)	10,024 (190)	1,985 (558)	255 (3)	1,475 (431)	323 (78)	1,377 (1,040)	711 (522)	746 (448)	38,826 (6,691)	4,233	43,059
2027	24,730 (3,858)	11,624 (221)	2,015 (566)	255 (3)	1,535 (448)	323 (78)	1,377 (1,040)	721 (530)	746 (448)	43,326 (7,191)	4,446	47,772
2028	27,530 (4,295)	13,624 (259)	2,045 (575)	255 (3)	1,595 (466)	323 (78)	1,377 (1,040)	731 (537)	746 (448)	48,226 (7,699)	4,668	52,894
2029	30,330 (4,731)	15,624 (297)	2,075 (583)	255 (3)	1,655 (483)	323 (78)	1,377 (1,040)	741 (544)	746 (448)	53,126 (8,208)	4,901	58,027
2030	33,530 (5,231)	17,674 (336)	2,105 (591)	255 (3)	1,705 (498)	323 (78)	1,377 (1,040)	746 (548)	746 (448)	58,461 (8,772)	5,143	63,605
2031	33,680 (5,254)	17,674 (336)	2,105 (591)	255 (3)	1,705 (498)	323 (78)	1,377 (1,040)	746 (548)	746 (448)	58,611 (8,796)	5,153	63,765

* The values in ( ) indicate effective capacity.
* Wastes were divided into burned wastes and byproduct gas in the table above.
* More than 99% of self-generated energy consists of renewable energy.

B. Renewable Generation Outlook by Year (2017 - 2031)

(Unit: GWh)

Year	Projects										Self-generation	Sum (%)
	Renewable Energy							New		Total		
	PV	Wind	Hydro	Offshore	Bio	Burned Wastes	Byproduct Gas	Fuel Cell	IGCC			
2017	5,871	1,994	2,880	496	9,028	2,267	7,757	1,737	2,351	34,382 (6.2)	13,915	48,297 (8.3)
2018	7,534	2,397	2,936	496	9,729	2,267	7,757	2,382	2,351	37,849 (6.7)	14,081	51,929 (8.8)
2019	9,453	3,921	3,009	496	10,430	2,267	7,757	3,027	2,351	42,710 (7.4)	14,259	56,970 (9.4)
2020	11,371	5,576	3,083	496	11,131	2,267	7,757	3,671	2,351	47,704 (8.1)	14,451	62,154 (10.1)
2021	13,673	7,333	3,156	496	11,692	2,267	7,757	3,994	2,351	52,719 (8.8)	14,655	67,374 (10.8)
2022	15,975	9,615	3,230	496	12,252	2,267	7,757	4,316	2,351	58,259 (9.7)	14,872	73,131 (11.5)
2023	18,277	12,422	3,303	496	12,813	2,267	7,757	4,638	2,351	64,326 (10.6)	15,101	79,427 (12.4)
2024	21,347	15,756	3,395	496	13,303	2,267	7,757	4,800	5,067	74,188 (12.1)	15,344	89,532 (13.9)
2025	24,416	19,614	3,487	496	13,794	2,267	7,757	4,961	5,067	81,860 (13.2)	15,599	97,459 (15.0)
2026	27,486	23,473	3,579	496	14,284	2,267	7,757	5,122	5,067	89,532 (14.4)	15,867	105,399 (16.2)
2027	31,067	27,433	3,690	496	14,705	2,267	7,757	5,202	5,067	97,684 (15.6)	16,148	113,832 (17.4)
2028	34,648	32,443	3,800	496	15,125	2,267	7,757	5,283	5,067	106,887 (17.1)	16,442	123,329 (18.8)
2029	38,229	37,454	3,911	496	15,546	2,267	7,757	5,364	5,067	116,090 (18.5)	16,748	132,838 (20.1)
2030	42,322	42,566	4,021	496	15,896	2,267	7,757	5,404	5,067	125,795 (20.0)	17,067	142,863 (21.6)
2031	42,514	42,566	4,021	496	15,896	2,267	7,757	5,404	5,067	125,987 (20.0)	17,080	143,067 (21.6)

* Wastes were divided into burned wastes and byproduct gas in the table above.

5 Integrated Energy(IE) capacity Plan

☐ Integrated energy(IE) Capacity Expansion Outlook by Year (2017 – 2031)

Power Plant Name	8th BPLE		Company	Remark
	Completion	Capacity (MW)		
Wirye Combined Heat & Power Plant (CHP)	April 2017	412.6	Wirye Energy Service	Completed
Chuncheon CHP	May 2017	431.2	Chuncheon Energy	Completed
Gunjang Energy #5	May 2017	28.5	Gunjang Energy	Completed
Osan CHP (retired)	Sept. 2017	-24.0	-	Retired
Dongtan CHP #1	Nov. 2017	378.4	Korea District Heating Corporation	Completed
Dongtan CHP #2	Dec. 2017	378.4	Korea District Heating Corporation	Completed
Hanhwa Energy Gunsan	Dec. 2017	99	Hanhwa Energy	
Asan National Industry Complex (Poseung district)	June 2018	75	Poseung Green Power	
Pocheon CHP	Aug. 2018	169.9	GS E&R	
Sejong CHP (2 steps)	Nov. 2019	515	Korea District Heating Corporation, KOMIPO, KOSPO	
Yangsan CHP	May 2020	114	Korea District Heating Corporation	
Yeosu Green Energy	July 2020	250	Yeosu Green Energy	
Anyang CC (expanded)	Dec. 2020	465	GS Power	
Magok City Development District	Dec. 2020	285	SH Corporation	
Chungnam Provincial Government Relocation New City	Dec. 2020	97	Naepo Green Energy	
Gwangju Jeonnam CHP*	Dec. 2017	19.1	Korea District Heating Corporation	
Wonju CHP*	Aug. 2019	32.3	Wonju Energy	
IE Total		3,675*	-	-

* Gwangju-Jeonnam CHP and Wonju CHP were classified into renewable energy; excluded from the IE capacity.
* Fuel switch is under review for Chungnam Provincial Government Relocation New City and the details are tentative.

6 Power plant excluded on supply

(Unit: MW)

Year	Nuclear	Bituminous	Anthracite	LNG	Oil	Total
2017	Kori #1 (587) (Jun.)		Youngdong #1 (125) (Apr.) Seocheon #1,2 (400) (Jul.)	Seoul Thermal #5 (250) (Apr.) Pyeongtaek CC (480) (Dec.)		1,842 (6 units)
2018	Wolsong #1 (679) (Jan.)					679 (1 unit)
2019		Samcheonpo #1,2 (1,120) (Dec.)	Youngdong #2 (200) (Jan.)		Hanlim CC (105) (Nov.) *LNG-switched Jeju GT #3 (55) (Dec.)	1,480 (5 units)
2021		Honam #1,2 (500) (Jan.)				500 (2 units)
2022		Boryeong #1,2 (1,000) (May)			Ulsan #4 - 6 (1,200) (Jan.)	2,200 (5 units)
2023	Kori #2 (650) (Apr.)			Seoincheon CC #1 - 8 (1,800) (Dec.)		2,450 (9 units)
2024	Kori #3 (950) (Sep.)	Samcheonpo #3,4 (1,120) (Mar.) * LNG-switched			Pyeongtaek #1~4 (1,400) (Dec.)	3,470 (7 units)
2025	Kori #4 (950) (Aug.) Hanbit #1 (950) (Dec.)	Taean #1,2 (1,000) (Dec.) * LNG-switched				2,900 (4 units)
2026	Hanbit #2 (950) (Sep.) Wolsong #2 (700) (Nov.)					1,650 (2 units)
2027	Wolsong #3 (700) (Dec.) Hanwool #1 (950) (Dec.)					1,650 (2 units)
2028	Hanwool #2 (950) (Dec.)					950 (1 unit)
2029	Wolsong #4 (700) (Feb.)					700 (1 unit)
Total ('17 - '31)	9,716 (12 units)	4,740 (10 units)	725 (4 units)	2,530 (10 units)	2,760 (9 units)	20,471 (45 units)

* 19 retired facilities of 5,772 MW in the 7th BPLE (Kori #1, Seoul #5, Pyeongtaek CC, Seoincheon CC #1 - 8, Jeju GT #3, Ulsan #4 - 6, Pyeongtaek #1 - 4)
* 10 facilities by anti-particulate matter measures of 3,345 MW (Youngdong #1·2, Seocheon #1·2, Samcheonpo #1·2, Honam #1·2, Boryeong #1·2)
* 15 policy-driven units of 11,249 MW (11 aging nuclear power generators: 9,129 MW, and Coal → LNG 4 units: 2,120 MW)
* Other (Oil → LNG Hanlim CC 1 unit: 105 MW)

7 Capacity Mix Outlook

A. By Nominal Capacity

☐ Nationwide

(Unit: MW, %)

Year	Nuclear	Coal	LNG	Renewable	Oil	Pumped storage	Total
2016	23,116	32,023	32,602	9,284	4,141	4,700	105,866
	21.8	30.2	30.8	8.8	3.9	4.4	100
2017	22,529	36,920	37,353	11,316	4,151	4,700	116,968
	19.3	31.6	31.9	9.7	3.5	4.0	100
2018	24,650	37,351	37,593	13,011	4,151	4,700	121,455
	20.3	30.8	31.0	10.7	3.4	3.9	100
2019	26,050	36,031	39,964	15,361	3,991	4,700	126,096
	20.7	28.6	31.7	12.2	3.2	3.7	100
2020	26,050	37,281	42,050	17,761	3,991	4,700	131,832
	19.8	28.3	31.9	13.5	3.0	3.6	100
2021	26,050	39,911	42,050	20,451	3,991	4,700	137,152
	19.0	29.1	30.7	14.9	2.9	3.4	100
2022	27,450	42,041	42,050	23,341	2,791	4,700	142,372
	19.3	29.5	29.5	16.4	2.0	3.3	100
2023	28,200	42,041	40,250	26,431	2,791	4,700	144,412
	19.5	29.1	27.9	18.3	1.9	3.3	100
2024	27,250	40,921	43,310	30,696	1,391	4,700	148,267
	18.4	27.6	29.2	20.7	0.9	3.2	100
2025	25,350	39,921	44,310	34,761	1,391	4,700	150,432
	16.9	26.5	29.5	23.1	0.9	3.1	100
2026	23,700	39,921	44,310	38,826	1,391	4,700	152,847
	15.5	26.1	29.0	25.4	0.9	3.1	100
2027	22,050	39,921	46,110	43,326	1,391	4,700	157,497
	14.0	25.3	29.3	27.5	0.9	3.0	100
2028	21,100	39,921	47,460	48,226	1,391	4,700	162,797
	13.0	24.5	29.2	29.6	0.9	2.9	100
2029	20,400	39,921	47,460	53,126	1,391	5,500	167,797
	12.2	23.8	28.3	31.7	0.8	3.3	100
2030	20,400	39,921	47,460	58,461	1,391	6,100	173,732
	11.7	23.0	27.3	33.7	0.8	3.5	100
2031	20,400	39,921	47,460	58,611	1,391	6,700	174,482
	11.7	22.9	27.2	33.6	0.8	3.8	100

* Based on year-end installed capacity; renewable as per nominal capacity
* Jeju GT #1,2 (110 MW) used as sync. compensators are included in the nominal capacity
* Back up power plants for intermittent renewable energy included in the pumped-storage capacity

☐ Seoul Metropolitan Area

(Unit: MW, %)

Year	Nuclear	Bituminous coal	Anthracite coal	LNG	Renewable	Oil	Pumped storage	Inter regional transfer power	Total
2016	-	5,157	-	20,491	1,113	1,474	400	12,700	41,335
	-	12.5	-	49.6	2.7	3.6	1.0	30.7	100
2017	-	5,157	-	23,476	1,378	1,480	400	12,921	44,812
	-	11.5	-	52.4	3.1	3.3	0.9	28.8	100
2018	-	5,402	-	23,476	1,552	1,480	400	14,059	46,368
	-	11.6	-	50.6	3.3	3.2	0.9	30.3	100
2019	-	5,402	-	25,227	1,743	1,480	400	14,197	48,448
	-	11.1	-	52.1	3.6	3.1	0.8	29.3	100
2020	-	5,402	-	26,977	1,934	1,480	400	14,639	50,832
	-	10.6	-	53.1	3.8	2.9	0.8	28.8	100
2021	-	5,402	-	26,977	2,114	1,480	400	15,810	52,183
	-	10.4	-	51.7	4.1	2.8	0.8	30.3	100
2022	-	5,402	-	26,977	2,294	1,480	400	17,442	53,995
	-	10.0	-	50.0	4.2	2.7	0.7	32.3	100
2023	-	5,402	-	25,177	2,474	1,480	400	19,428	54,361
	-	9.9	-	46.3	4.6	2.7	0.7	35.7	100
2024	-	5,402	-	25,177	2,676	80	400	20,214	53,948
	-	10.0	-	46.7	5.0	0.1	0.7	37.5	100
2025	-	5,402	-	25,177	2,878	80	400	20,116	54,052
	-	10.0	-	46.6	5.3	0.1	0.7	37.2	100
2026	-	5,402	-	25,177	3,079	80	400	20,017	54,155
	-	10.0	-	46.5	5.7	0.1	0.7	37.0	100
2027	-	5,402	-	25,177	3,300	80	400	19,919	54,278
	-	10.0	-	46.4	6.1	0.1	0.7	36.7	100
2028	-	5,402	-	25,177	3,521	80	400	19,820	54,399
	-	9.9	-	46.3	6.5	0.1	0.7	36.4	100
2029	-	5,402	-	25,177	3,742	80	400	19,722	54,522
	-	9.9	-	46.2	6.9	0.1	0.7	36.2	100
2030	-	5,402	-	25,177	3,984	80	400	19,543	54,585
	-	9.9	-	46.1	7.3	0.1	0.7	35.8	100
2031	-	5,402	-	25,177	3,993	80	400	19,620	54,672
	-	9.9	-	46.1	7.3	0.1	0.7	35.9	100

☐ Jeju Island

(Unit: MW, %)

Year	Nuclear	Bituminous coal	Anthracite coal	LNG	Renewable	Oil	Pumped storage	HVDC	Total
2016	-	-	-	0	380	706	-	400	1,487
	-	-	-	0.0	25.6	47.5	-	26.9	100
2017	-	-	-	0	405	706	-	400	1,511
	-	-	-	0.0	26.8	46.7	-	26.5	100
2018	-	-	-	240	514	706	-	400	1,861
	-	-	-	12.9	27.6	38.0	-	21.5	100
2019	-	-	-	345	795	546	-	400	2,087
	-	-	-	16.5	38.1	26.2	-	19.2	100
2020	-	-	-	470	1,098	546	-	600	2,715
	-	-	-	17.3	40.5	20.1	-	22.1	100
2021	-	-	-	470	1,385	546	-	600	3,002
	-	-	-	15.7	46.2	18.2	-	20.0	100
2022	-	-	-	470	1,777	546	-	600	3,394
	-	-	-	13.8	52.4	16.1	-	17.7	100
2023	-	-	-	470	1,886	546	-	600	3,503
	-	-	-	13.4	53.9	15.6	-	17.1	100
2024	-	-	-	470	1,976	546	-	600	3,593
	-	-	-	13.1	55.0	15.2	-	16.7	100
2025	-	-	-	470	2,366	546	-	600	3,983
	-	-	-	11.8	59.4	13.7	-	15.1	100
2026	-	-	-	470	2,646	546	-	600	4,263
	-	-	-	11.0	62.1	12.8	-	14.1	100
2027	-	-	-	470	2,926	546	-	600	4,543
	-	-	-	10.3	64.4	12.0	-	13.2	100
2028	-	-	-	470	3,206	546	-	600	4,823
	-	-	-	9.7	66.5	11.3	-	12.4	100
2029	-	-	-	470	3,486	546	-	600	5,103
	-	-	-	9.2	68.3	10.7	-	11.8	100
2030	-	-	-	470	3,782	546	-	600	5,399
	-	-	-	8.7	70.1	10.1	-	11.1	100
2031	-	-	-	470	4,062	546	-	600	5,679
	-	-	-	8.3	71.5	9.6	-	10.6	100

* #3 HVDC interconnected line (200 MW) expected to be installed by Dec. 2020
* LNG-based emergency facility (125 MW) expected to be completed by Jun. 2020

B. Effective capacity(Applied capacity credit)

☐ Nationwide

(Unit: MW, %)

Year	Nuclear	Coal	LNG	Renewable	Oil	Pumped storage	Total
2016	23,116	31,279	32,599	2,658	4,003	4,700	98,354
	23.5	31.8	33.1	2.7	4.1	4.8	100
2017	22,529	36,111	37,350	3,065	4,013	4,700	107,768
	20.9	33.5	34.7	2.8	3.7	4.4	100
2018	24,650	36,418	37,590	3,364	4,013	4,700	110,735
	22.3	32.9	33.9	3.0	3.6	4.2	100
2019	26,050	35,098	39,961	3,704	3,853	4,700	113,366
	23.0	31.0	35.2	3.3	3.4	4.1	100
2020	26,050	36,222	42,047	4,045	3,853	4,700	116,917
	22.3	31.0	36.0	3.5	3.3	4.0	100
2021	26,050	38,852	42,047	4,398	3,853	4,700	119,901
	21.7	32.4	35.1	3.7	3.2	3.9	100
2022	27,450	40,982	42,047	4,756	2,653	4,700	122,588
	22.4	33.4	34.3	3.9	2.2	3.8	100
2023	28,200	40,982	40,247	5,117	2,653	4,700	121,899
	23.1	33.6	33.0	4.2	2.2	3.9	100.0
2024	27,250	39,862	43,307	5,799	1,253	4,700	122,171
	22.3	32.6	35.4	4.7	1.0	3.8	100
2025	25,350	38,862	44,307	6,245	1,253	4,700	120,717
	21.0	32.2	36.7	5.2	1.0	3.9	100
2026	23,700	38,862	44,307	6,691	1,253	4,700	119,513
	19.8	32.5	37.1	5.6	1.0	3.9	100
2027	22,050	38,862	46,107	7,191	1,253	4,700	120,164
	18.3	32.3	38.4	6.0	1.0	3.9	100
2028	21,100	38,862	47,457	7,699	1,253	4,700	121,072
	17.4	32.1	39.2	6.4	1.0	3.9	100
2029	20,400	38,862	47,457	8,208	1,253	5,500	121,680
	16.8	31.9	39.0	6.7	1.0	4.5	100
2030	20,400	38,862	47,457	8,772	1,253	6,100	122,845
	16.6	31.6	38.6	7.1	1.0	5.0	100
2031	20,400	38,862	47,457	8,796	1,253	6,700	123,468
	16.5	31.5	38.4	7.1	1.0	5.4	100

* Based on year-end installed capacity; renewables and IE applied to capacity credit)
* Jeju GT #1,2 (110 MW) used as sync. compensators are excluded in the effective capacity
* Back up power plants for intermittent renewable energy included in the pumped-storage capacity

☐ Seoul Metropolitan Area

(Unit: MW, %)

Year	Nuclear	Bituminous coal	Anthracite coal	LNG	Renewable	Oil	Pumped storage	Inter regional transfer power	Total
2016	-	5,118	-	20,488	269	1,474	400	12,700	40,449
	-	12.7	-	50.7	0.7	3.6	1.0	31.4	100
2017	-	5,118	-	23,473	356	1,480	400	12,921	43,747
	-	11.7	-	53.7	0.8	3.4	0.9	29.5	100
2018	-	5,240	-	23,473	417	1,480	400	14,059	45,069
	-	11.6	-	52.1	0.9	3.3	0.9	31.2	100
2019	-	5,240	-	25,224	481	1,480	400	14,197	47,022
	-	11.1	-	53.6	1.0	3.1	0.9	30.2	100
2020	-	5,240	-	26,974	545	1,480	400	14,639	49,278
	-	10.6	-	54.7	1.1	3.0	0.8	29.7	100
2021	-	5,240	-	26,974	590	1,480	400	15,810	50,494
	-	10.4	-	53.4	1.2	2.9	0.8	31.3	100
2022	-	5,240	-	26,974	635	1,480	400	17,442	52,170
	-	10.0	-	51.7	1.2	2.8	0.8	33.4	100
2023	-	5,240	-	25,174	680	1,480	400	19,428	52,401
	-	10.0	-	48.0	1.3	2.8	0.8	37.1	100
2024	-	5,240	-	25,174	720	80	400	20,214	51,827
	-	10.1	-	48.6	1.4	0.2	0.8	39.0	100
2025	-	5,240	-	25,174	760	80	400	20,116	51,769
	-	10.1	-	48.6	1.5	0.2	0.8	38.9	100
2026	-	5,240	-	25,174	800	80	400	20,017	51,710
	-	10.1	-	48.7	1.5	0.2	0.8	38.7	100
2027	-	5,240	-	25,174	838	80	400	19,919	51,650
	-	10.1	-	48.7	1.6	0.2	0.8	38.6	100
2028	-	5,240	-	25,174	876	80	400	19,820	51,589
	-	10.2	-	48.8	1.7	0.2	0.8	38.4	100
2029	-	5,240	-	25,174	914	80	400	19,722	51,529
	-	10.2	-	48.9	1.8	0.2	0.8	38.3	100
2030	-	5,240	-	25,174	953	80	400	19,543	51,389
	-	10.2	-	49.0	1.9	0.2	0.8	38.0	100
2031	-	5,240	-	25,174	954	80	400	19,620	51,468
	-	10.2	-	48.9	1.9	0.2	0.8	38.1	100

☐ Jeju Island

(Unit: MW, %)

Year	Nuclear	Bituminous coal	Anthracite coal	LNG	Renewable	Oil	Pumped storage	HVDC	Total
2016	-	-	-	-	14	596	-	400	1,010
	-	-	-	-	1.4	59.0	-	39.6	100
2017	-	-	-	-	17	596	-	400	1,013
	-	-	-	-	1.7	58.9	-	39.5	100
2018	-	-	-	240	27	596	-	400	1,263
	-	-	-	19.0	2.1	47.2	-	31.7	100
2019	-	-	-	345	41	436	-	400	1,223
	-	-	-	28.2	3.4	35.7	-	32.7	100
2020	-	-	-	470	56	436	-	600	1,562
	-	-	-	30.1	3.6	27.9	-	38.4	100
2021	-	-	-	470	71	436	-	600	1,577
	-	-	-	29.8	4.5	27.7	-	38.1	100
2022	-	-	-	470	84	436	-	600	1,590
	-	-	-	29.6	5.3	27.4	-	37.7	100
2023	-	-	-	470	96	436	-	600	1,602
	-	-	-	29.3	6.0	27.2	-	37.5	100
2024	-	-	-	470	105	436	-	600	1,612
	-	-	-	29.2	6.5	27.1	-	37.2	100
2025	-	-	-	470	116	436	-	600	1,622
	-	-	-	29.0	7.2	26.9	-	37.0	100
2026	-	-	-	470	126	436	-	600	1,632
	-	-	-	28.8	7.7	26.7	-	36.8	100
2027	-	-	-	470	135	436	-	600	1,641
	-	-	-	28.6	8.2	26.6	-	36.6	100
2028	-	-	-	470	144	436	-	600	1,650
	-	-	-	28.5	8.7	26.4	-	36.4	100
2029	-	-	-	470	154	436	-	600	1,660
	-	-	-	28.3	9.3	26.3	-	36.1	100
2030	-	-	-	470	164	436	-	600	1,670
	-	-	-	28.1	9.8	26.1	-	35.9	100
2031	-	-	-	470	174	436	-	600	1,680
	-	-	-	28.0	10.3	26.0	-	35.7	100

* #3 HVDC interconnected line (200 MW) expected to be installed by Dec. 2020
* LNG-based emergency facility (125 MW) expected to be completed by Jun. 2020

8 Power plant construction plan

☐ Nationwide

Year	M	Power plant	Effective Capacity (MW)	Total effective Cap. (MW)		Peak (MW)		Reserve margin (%)	
				Summer	Year-end	Summer	Winter	Summer	Winter
2016				93,328	98,354	85,183	83,657	9.6	17.6
2017				105,652	107,768	84,586	85,206	24.9	26.5
	1	Dangjin #9 (expanded)	90						
	1	Island	10						
	2	Paju Moonsan CC #1	848						
	3	Bukpyeong #1	595						
	3	Pocheon Cheonyeon CC #1	874						
	3	Paju Moonsan CC #2	848						
	4	(Youngdong #1)	-125						
	4	GS Dangjin CC #4	846						
	4	(Seoul #5)	-250						
	4	Wirye CHP (IE)	413						
	5	Chuncheon CHP (IE)	431						
	5	Dangjin #10 (expanded)	90						
	5	Gunjang Energy #5 (IE)	14						
	6	Samcheok Green #2	1,022						
	6	Taean #10	1,050						
	6	Shinboryeong #1	926						
	6	(Kori #1)	-587						
	6	Renewable Energy	204						
	7	(Seocheon #1)	-200						
	7	(Seocheon #2)	-200						
	7	Busan Jeonggwan Energy #1	46						
	8	Bukpyeong #2	595						
	9	Shinboryeong #2	926						
	9	(Osan CHP (IE))	-24						
	10	Youngnam CC	443						
	11	Dongtan CHP #1 (IE)	378						
	12	Dongtan CHP #2 (IE)	378						
	12	(Pyeongtaek CC #1)	-480						
	12	Hanhwa Energy Gunsan (IE)	49						
	12	Renewable Energy	204						
2018				107,609	110,735	86,114	87,155	25.0	27.1
	1	(Wolsong#1)	-679						
	6	Shinboryeong #1 (expanded)	93						
	6	Jeju CC	240						
	6	Renewable Energy	149						
	6	Asan National Industry Complex (Poseung district)(IE)	37						
	8	Pocheon CC (IE)	84						
	9	Shinboryeong #2 (expanded)	93						
	9	Shin Kori #4	1,400						
	12	Shin Hanwool #1	1,400						
	12	Renewable Energy	150						
2019				110,705	113,366	87,084	88,538	27.1	28.0
	1	(Youngdong #2)	-200						
	6	Renewable Energy	170						
	8	Seoul CC #1	400						
	8	Seoul CC #2	400						
	10	Shin Hanwool #2	1,400						
	11	Shinpyeongtaek CC #1	951						
	11	(Hanlim CC)	-105						
	11	Replaced Hanlim CC (LNG)	105						
	11	Sejong CHP #2 (IE)	515						
	12	(Samcheonpo #1)	-560						
	12	(Samcheonpo #2)	-560						
	12	(Jeju GT#3)	-55						
	12	Renewable Energy	170						
2020				115,776	116,917	88,779	90,342	30.4	29.4
	3	Shinseocheon #1	1,000						
	5	Yangsan CHP (IE)	114						
	6	Yeosu CC	1,000						
	6	New in Jeju	125						
	6	Renewable Energy	170						
	7	Yeosu Green Energy (IE)	124						
	12	Chungnam Provincial Government Relocation New City(IE)	97						
	12	Magok City Development District (IE)	285						
	12	Anyang CC (expanded) (IE)	465						
	12	Renewable Energy	171						
2021				117,634	119,901	90,382	92,104	30.2	30.2
	1	(Honam #1)	-250						
	1	(Honam #2)	-250						
	4	Goseong Hi #1	1,040						
	6	Renewable Energy	176						
	10	Goseong Hi #2	1,040						
	12	Samcheok Thermal #1	1,050						
	12	Renewable Energy	177						
2022				122,409	122,588	91,464	93,314	33.8	31.4
	1	(Ulsan #4)	-400						
	1	(Ulsan #5)	-400						
	1	(Ulsan #6)	-400						
	1	Shin Kori #5	1,400						
	5	(Boryeong #1)	-500						
	5	(Boryeong #2)	-500						
	6	Gangneung Anin #1	1,040						

Year	M	Power plant	Effective Capacity (MW)	Total effective Cap. (MW)		Peak (MW)		Reserve margin (%)	
				Summer	Year-end	Summer	Winter	Summer	Winter
	6	Gangneung Anin #2	1,040						
	6	Samcheok Thermal #2	1,050						
	6	Renewable Energy	178						
	12	Renewable Energy	179						
2023				123,518	121,899	92,553	94,525	33.5	29.0
	1	Shin Kori #6	1,400						
	4	(Kori #2)	-650						
	6	Renewable Energy	180						
	12	(Seoincheon CC #1)	-225						
	12	(Seoincheon CC #2)	-225						
	12	(Seoincheon CC #3)	-225						
	12	(Seoincheon CC #4)	-225						
	12	(Seoincheon CC #5)	-225						
	12	(Seoincheon CC #6)	-225						
	12	(Seoincheon CC #7)	-225						
	12	(Seoincheon CC #8)	-225						
	12	Renewable Energy	181						
2024				122,240	122,171	93,527	95,672	30.7	27.7
	3	(Samcheonpo #3)	-560						
	3	(Samcheonpo #4)	-560						
	3	Replaced Samcheonpo #3 (LNG)	560						
	3	Replaced Samcheonpo #4 (LNG)	560						
	6	Renewable Energy	341						
	9	(Kori #3)	-950						
	12	(Pyeongtaek #1)	-350						
	12	(Pyeongtaek #2)	-350						
	12	(Pyeongtaek #3)	-350						
	12	(Pyeongtaek #4)	-350						
	12	Dangjin Eco #1 (LNG)	970						
	12	Dangjin Eco #2 (LNG)	970						
	12	Renewable Energy	341						
2025				122,394	120,717	94,359	96,670	29.7	24.9
	6	Renewable Energy	223						
	8	(Kori #4)	-950						
	12	(Taean #1)	-500						
	12	(Taean #2)	-500						
	12	Replaced Taean #1 (LNG)	500						
	12	Replaced Taean #2 (LNG)	500						
	12	(Hanbit #1)	-950						
	12	Renewable Energy	223						
2026				120,940	119,513	95,104	97,568	27.2	22.5
	6	Renewable Energy	223						
	9	(Hanbit #2)	-950						
	11	(Wolsong #2)	-700						

Year	M	Power plant	Effective Capacity (MW)	Total effective Cap. (MW)		Peak (MW)		Reserve margin (%)	
				Summer	Year-end	Summer	Winter	Summer	Winter
	12	Renewable Energy	223						
2027				119,763	120,164	95,797	98,404	25.0	22.1
	6	Renewable Energy	250						
	12	(Wolsong #3)	-700						
	12	(Hanwool #1)	-950						
	12	New LNG #1	900						
	12	New LNG #2	900						
	12	Renewable Energy	250						
2028				120,418	121,072	96,399	99,131	24.9	22.1
	6	Renewable Energy	254						
	12	(Hanwool #2)	-950						
	12	New LNG#3	900						
	12	New LNG #4	450						
	12	Renewable Energy	254						
2029				120,626	121,680	96,986	99,839	24.4	21.9
	2	(Wolsong #4)	-700						
	6	Renewable Energy	254						
	12	Renewable Energy	254						
	12	New pumped-storage #1	800						
2030				121,962	122,845	97,533	100,498	25.0	22.2
	6	Renewable Energy	282						
	12	Renewable Energy	283						
	12	New pumped-storage #2	600						
2031				122,856	123,468	98,010	101,065	25.4	22.2
	6	Renewable Energy	11						
	12	New pumped-storage #3	600						
	12	Renewable Energy	12						

* For renewable energy and IE(CHP), capacity credits are applied

* Jeju GT #1,2 (110 MW) are used as sync. compensators are excluded

* The facilities in ( ) indicate power plants excluded on supply or facilities in supply uncertainty

* The capacity reserve for summer and winter refers to the peak capacity reserve respectively applied the effective capacity for each season

□ Seoul Metropolitan Area

Year	M	Generation Facility	Capacity (MW)	Flow Capacity (MW)	Total (MW)		Peak (MW)	Capacity Reserve (%)
					Summer	Year-end		
2016			27,749	12,700		40,449	32,773	23.4
2017				12,921	43,451	43,747	34,940	25.2
	1	Island (Seoul metropolitan area)	6					
	2	Paju-Moonsan CC #1	848					
	3	Pocheon Cheonyeon CC #1	874					
	3	Paju-Moonsan CC #2	848					
	4	(Seoul #5)	-250					
	4	Wirye CHP (IE)	413					
	6	Renewable Energy	43					
	9	(Osan CHP (IE))	-24					
	11	Dongtan CHP #1 (IE)	378					
	12	Dongtan CHP #2 (IE)	378					
	12	(Pyeongtaek CC #1)	-480					
	12	Renewable Energy	43					
2018				14,059	44,953	45,069	35,575	26.7
	6	Renewable Energy	31					
	6	Asan National Industry District (Poseung district) (IE)	37					
	8	Pocheon CHP (IE)	84					
	12	Renewable Energy	31					
2019				14,197	45,239	47,022	35,975	30.7
	6	Renewable Energy	32					
	8	Seoul CC #1	400					
	8	Seoul CC #2	400					
	11	Shinpyeongtaek CC #1	951					
	12	Renewable Energy	32					
2020				14,639	48,496	49,278	36,544	34.8
	6	Yeoju CC	1,000					
	6	Renewable Energy	32					
	12	Magok City Development District (IE)	285					
	12	Expanded Anyang CC (IE)	465					
	12	Renewable Energy	32					
2021				15,810	50,471	50,494	37,078	36.2
	6	Renewable Energy	22					
	12	Renewable Energy	22					
2022				17,442	52,148	52,170	37,403	39.5
	6	Renewable Energy	22					
	12	Renewable Energy	22					
2023				19,428	54,179	52,401	37,730	38.9
	6	Renewable Energy	22					
	12	(Seoincheon CC #1)	-225					
	12	(Seoincheon CC #2)	-225					
	12	(Seoincheon CC #3)	-225					
	12	(Seoincheon CC #4)	-225					
	12	(Seoincheon CC #5)	-225					
	12	(Seoincheon CC #6)	-225					
	12	(Seoincheon CC #7)	-225					
	12	(Seoincheon CC #8)	-225					
	12	Renewable Energy	22					
2024				20,214	53,207	51,827	38,013	36.3
	6	Renewable Energy	20					
	12	(Pyeongtaek #1)	-350					
	12	(Pyeongtaek #2)	-350					
	12	(Pyeongtaek #3)	-350					
	12	(Pyeongtaek #4)	-350					
	12	Renewable Energy	20					
2025				20,116	51,749	51,769	38,238	35.4
	6	Renewable Energy	20					
	12	Renewable Energy	20					
2026				20,017	51,690	51,710	38,427	34.6
	6	Renewable Energy	20					
	12	Renewable Energy	20					
2027				19,919	51,631	51,650	38,597	33.8
	6	Renewable Energy	19					
	12	Renewable Energy	19					
2028				19,820	51,570	51,589	38,731	33.2
	6	Renewable Energy	19					
	12	Renewable Energy	19					
2029				19,722	51,510	51,529	38,859	32.6
	6	Renewable Energy	19					
	12	Renewable Energy	19					
2030				19,543	51,370	51,389	38,969	31.9
	6	Renewable Energy	19					
	12	Renewable Energy	19					
2031				19,620	51,467	51,468	39,057	31.8
	6	Renewable Energy	1					
	12	Renewable Energy	1					

* For renewable energy and IE, capacity credits are applied
* The facilities in ( ) indicate power plants excluded on supply or facilities in supply uncertainty

☐ Jeju Island

Year	M	Generation Facility	Capacity (MW)	Flow Capacity (MW)	Total (MW)		Peak (MW)	Capacity Reserve (%)
					Summer	Year-end		
2016			610	400		1,010	849	19.0
2017				400	1,012	1,013	921	10.0
	6	Renewable Energy	1					
	12	Renewable Energy	1					
2018				400	1,258	1,263	970	30.2
	6	Jeju CC	240					
	6	Renewable Energy	5					
	12	Renewable Energy	5					
2019				400	1,270	1,223	1,003	21.9
	6	Renewable Energy	7					
	11	(Hanlim CC)	-105					
	11	Replaced Hanlim CC (LNG)	105					
	12	(Jeju GT #3)	-55					
	12	Renewable Energy	7					
2020				600	1,555	1,562	1,051	48.6
	6	New in Jeju	125					
	6	Renewable Energy	7					
	12	Renewable Energy	7					
2021				600	1,570	1,577	1,086	45.2
	6	Renewable Energy	7					
	12	Renewable Energy	7					
2022				600	1,584	1,590	1,111	43.2
	6	Renewable Energy	7					
	12	Renewable Energy	7					
2023				600	1,596	1,602	1,138	40.8
	6	Renewable Energy	6					
	12	Renewable Energy	6					
2024				600	1,607	1,612	1,161	38.8
	6	Renewable Energy	5					
	12	Renewable Energy	5					
2025				600	1,617	1,622	1,182	37.3
	6	Renewable Energy	5					
	12	Renewable Energy	5					
2026				600	1,627	1,632	1,204	35.5
	6	Renewable Energy	5					
	12	Renewable Energy	5					
2027				600	1,636	1,641	1,227	33.7
	6	Renewable Energy	5					
	12	Renewable Energy	5					

Year	M	Generation Facility	Capacity (MW)	Flow Capacity (MW)	Total (MW)		Peak (MW)	Capacity Reserve (%)
					Summer	Year-end		
2028				600	1,646	1,650	1,252	31.8
	6	Renewable Energy	5					
	12	Renewable Energy	5					
2029				600	1,655	1,660	1,282	29.5
	6	Renewable Energy	5					
	12	Renewable Energy	5					
2030				600	1,665	1,670	1,321	26.4
	6	Renewable Energy	5					
	12	Renewable Energy	5					
2031				600	1,675	1,680	1,348	24.6
	6	Renewable Energy	5					
	12	Renewable Energy	5					

* For renewable energy and IES, peak contributions are applied
* Jeju GT #1,2 are used as sync. compensators; excluded in installed capacity (no peak contribution available)
* The facilities in ( ) indicate power plants excluded on supply or facilities in supply uncertainty

9 Licensed PV & Wind Power Facilities (40 MW+)

Energy	Power Plant Name	Company	Area	Capacity (MW)
PV	Youngam	Youngam PV	Jeonnam	98
	Haenam Solaseado	Solaseado PV	Jeonnam	98
	Jeju Clean Energy	Jeju Energy Development	Jeju	95
	Seosan	Hyundai Eco Energy	Chungnam	65
	Bonghwa-Hwacheon	Bonghwa-Hwacheon PV	Gyeongbook	60
	Bonghwa-Docheon	Woori Power No. 15	Gyeongbook	55
	Euiseong Jeomgok	Jeomgok PV	Gyeongbook	50
Wind power	Goseong	GA Power	Gangwon	333
	Jeonnam Shinan Offshore	POSCO Energy	Jeonnam	300
	Samcheok	Energy Meca	Gangwon	285
	Pyeongchang Baekseoksan	Taehwan Wind Power Pyeongchang	Gangwon	168.3
	Taebaek Geumdae Eco	O2 Power	Gangwon	165
	Pyeongchang Hoenggye Dongjin	Dongjin Wind Power Generation	Gangwon	147
	Samcheok Cheonbong	Samcheok Wind Power Generation	Gangwon	138.6
	Yanggu Barameui	Global Wind Energy	Gangwon	126
	Goseong Alps	Goseong Alps Wind Power Generation	Gangwon	100
	Uljin	Booseon	Gyeongbook	99.2
	Younggwang Dooyoori	Jaewon Energy	Jeonnam	99.1
	Pyeongchang Bangrim	Daehwa Wind Power Generation	Gangwon	99
	Samcheok Odu	EWP	Gangwon	99
	Jeongseon Imgye	EWP	Gangwon	99
	Saemangeum	Saemangeum Offshore Wind Power	Jeonbook	98.8
	Cheongsong Eco Wind	Cheongsong Eco Wind	Gyeongbook	97.2
	Pohang Eco Land	Pohang Eco Land	Gyeongbook	96.6
	Jeonnam Offshore	SK E&S	Jeonnam	96
	Youngdeok J	Ilchool Energy	Gyeongbook	93.15
	Youngdeok Jeil	Youngdeok No. 1 Wind Power Generation	Gyeongbook	92.4
	Gampo Find Green	Find Green	Gyeongbook	92.4
	Yangyang Soori	Eco Green Wind Power	Gangwon	90
	Pohang Beehak	Beehak Wind Campus	Gyeongbook	90
	Yanggu Unification Observatory	Global Wind Energy	Gangwon	90
	AWP Youngyang Wind	AWUP	Gyeongbook	89.1
	Pyeongchang Bongpyeong	Clean Green Power	Gangwon	87
	Cheongsong Myeonbongsan	Cheongsong Myeonbongsan Wind Power	Gyeongbook	86.4
	Pyeongchang Dosari	Taehwan Wind Power	Gangwon	85.8
	Hongcheon Yeuljeon	Hongcheon Yeuljeon Wind Power Generation	Gangwon	84
	Goseong Hahil	GS EPS	Gyeongnam	82.5

Energy	Power Plant Name	Company	Area	Capacity (MW)
Wind power	Youngyang Youngdeung	SK D&D	Gyeongbook	80
	Younggwang	Younggwang Wind Power Generation	Jeonnam	79.6
	Youngwol Eco Wind	Youngwol Eco Wind	Gangwon	79.2
	Youngyang Yanggoo	Youngyang Eco Power	Gyeongbook	75.9
	Jangseong Buseon	Booseon Wind Power	Jeonnam	72.6
	Pohang Jukjang	SK D&D	Gyeongbook	72
	Euiseong Hwanghaksan	SK D&D	Gyeongbook	72
	Pyeongchang Heungjeong	Taehwan Wind Power Generation	Gangwon	69.3
	Gunwi Poongbaek	SK D&D	Gyeongbook	66
	Pohang Homigot	Hyosung	Gyeongbook	66
	Pyeongchang Yoocheon	Taehwan Wind Power	Gangwon	66
	Youngwol Eco Energy	Youngwol Eco Energy	Gangwon	64.8
	Pohang Smile	EWP	Gyeongbook	63
	Sooncheon Barangsan	Barangsan Wind Power	Jeollah	60.4
	Bigeum	Bigeum Wind Power Generation	Jeonnam	60
	Korea Offshore	Korea Offshore Wind Power	Jeonbook	60
	Gangneung Anin	KOSPO	Gangwon	60
	Jeongseon Sabuk	Woongjin Wind Power Generation	Gangwon	60
	Yangyang Energy Plan	GS EPS	Gangwon	60
	Youngdeok Dongdae	Osung ENT	Gyeongbook	60
	Taebaek Deokhangsan	Jinseong Power	Gangwon	60
	Pohang Daesong	The Wind Power	Gyeongbook	60
	Bonghwa Omisan	Unison	Gyeongbook	60
	Samcheok Odu 2	Samcheok Odu Ⅱ Wind Power Generation project	Gangwon	57.6
	Youngyang Posan	GS E&R	Gyeongbook	56.1
	Uljin Hyunjongsan	Uljin Wind Power	Gyeongbook	53.4
	Goheung Dogyeong	Dogyeong Wind Power Generation	Jeonnam	51
	Samcheok Cheolma	BS Energy	Gangwon	50.4
	Samcheok Gapoong	KOSPO	Gangwon	50.4
	Danyang	Cheongsong Energy	Chungbook	45.6
	Bonghwa	Wooram Energy	Gyeongbook	45
	Gimje Samhyun	Samhyun Wind Power	Jeonbook	45
	Cheonsa	Shinan Green Energy	Jeonnam	42
	Pohang Donghae Green	Donghae Green Wind Power	Gyeongbook	42
	Cheongsong Bunam	Wooram Power Generation	Gyeongbook	42
	Gokseong Green	Daemyong Energy	Jeonnam	42
	Samcheok Eori II	Myongjin Wind Power Generation	Gangwon	42
	Samcheok Dogye	BS Energy	Gangwon	42

10 Opinions from Public Hearing and the Trade, Industry and Energy Committee

A. Public Hearing Opinions

- ○ Residents requested public hearing about reduction in the use of nuclear power plants and compensation for residents' damage while civic groups requested speedy escape from the use of nuclear energy
- ○ The participants delivered the concerns of consumers and industries on the rising electric rates and expressed their opinion that demand side management needs to be strengthened with the rise in DR and rates, lowering the target demand
- ○ Pros and cons about the promotion of renewable energy exist among the residents; some say that incentives need to be provided to the private sector by policy while wind power and other energy development is degrading the environment
- ○ Pros and cons also exist in terms of the use of coal. Some proposed more government support for LNG.

B. Opinions from the Trade, Industry and Energy Committee

- ○ The current demand forecast model needs to be modified or a new model is needed to reflect the impact of the 4th Industrial Revolution
- ○ Some people are very positive about the increasing use of green energy with the reduction of aging generators based on nuclear energy and coal and the rising LNG generation. Some insist that the reduction plan be reviewed again because of the roles of baseload generators.
  - – Those in favor of nuclear energy request the grounds for cancellation of construction of six new nuclear power plants and insist that a strategic export area for nuclear power plant be designated in Korea
- ○ There is room for improvement in the feasibility of renewable generation; there should be a concrete roadmap and investment plans laid out for the promotion of distributed energy resources
  - – Bio energy and wastes need to be reviewed as renewable energy sources
- ○ Many people request more aggressive demand side management actions including a broader application of smart factories in the industrial complexes and improvements/wider use of DR programs
- ○ Solutions have to be laid out to enhance energy efficiency and strengthen DSM by overhauling the electric rates system including the industrial utility system