

A New Energy Paradigm for the Future

Third Energy Master Plan

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01. OVERVIEW

2040 ENERGY TRANSITION WITH THE THIRD ENERGY MASTER PLAN

As the threat of climate change grows by the day, energy transition has become a key issue across the globe. With the launch of the New Climate Regime in 2021, the parties to the Paris Agreement will be required to voluntarily set their national targets and meet their commitments in accordance with the UN Framework Convention on Climate Change.

As countries push ahead with their energy policies to tackle climate change and secure a stable energy supply tailored to their domestic circumstances, the Republic of Korea is also set to make the transition towards clean and safe energy on the back of rising public concerns about safety. In June 2019, the Korean government confirmed the Third Energy Master Plan, which establishes a national energy blueprint up to the year 2040. The Third Energy Master Plan builds on the idea of a sustainable energy system stipulated in the First and Second Energy Master Plans, while also focusing on the innovative transition of the overall energy system from production and distribution to consumption.

The draft was developed with great care over an eight month period by experts from academia, industry and civic groups. Following this process, the Third Energy Master Plan was finalized after an extensive collection of opinions through an online bulletin board, information sharing sessions and debates held by topics and regions as well as careful deliberation by the National Energy Committee (NEC) and the Presidential Committee on Green Growth.

The goal of the Third Energy Master Plan is to achieve sustainable growth and enhance the quality of life through energy transition. In this light, the Energy Master Plan will surely serve as a solid framework as well as a mid- and long-term vision for Korea's energy transition.

To Achieve Sustainable Growth and Improve the Quality of Life through Energy Transition



Working group with 5 subcommittees and 75 experts (8 months)



76 subcommittee meetings



6 regional information sharing sessions, 11 debates on key agenda, expert meeting, online opinion gathering

To achieve sustainable growth and improve the quality of life through energy transition

Transition of energy supply, consumption and industry



Foundation for energy transition

Consumption Structure	Energy Mix	Distributed & Participatory Systems	Global Competitiveness	Foundation for Energy Transition
Demand management for industry, transportation and buildings Demand management market utilizing the 4th Industrial Revolution technologies Energy pricing systems	Renewable energy 30-35% of generation by 2040 Nuclear energy maintain core ecosystem Coal reduce fine dust & GHG emissions Oil less for transportation, more for industries Gas greater role in generation and transportation	Distributed power system expand the foundation for prosumer-based power generation Role and responsibilities of local governments reinforce regional energy plans Energy welfare system improve quality	Renewable energy industry improve efficiency and quality innovate business fundamentals Hydrogen industry establish a value chain (production/storage/transport/utilization) Efficiency-related industry develop high-efficiency equipment & energy solutions service industries NPP ecosystem decommissioning, spent fuels management	Energy market system electricity, gas, heat Energy technology & manpower development large-scale R&D and demonstration projects Energy big data platform



INNOVATION IN THE ENERGY CONSUMPTION STRUCTURE: AN OVERVIEW

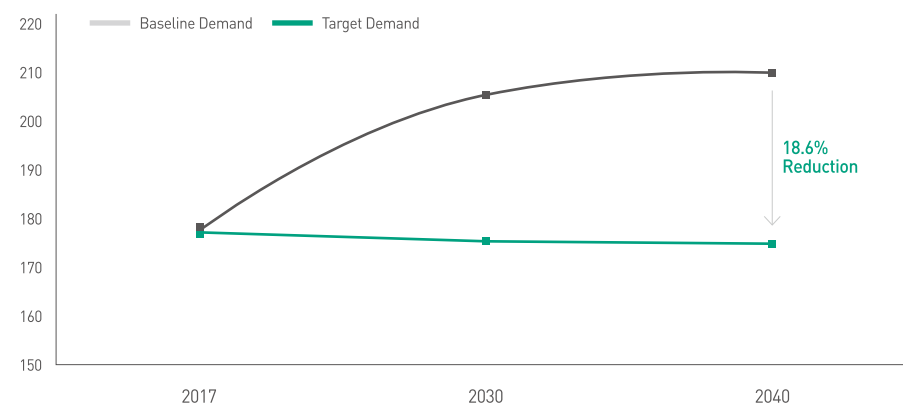
TO TRANSFORM THE ENERGY POLICY PARADIGM BY INNOVATING THE CONSUMPTION STRUCTURE

Energy efficiency is the most environmentally-friendly and economical energy source. As such, enhancing energy efficiency fundamentally reduces energy demand, thereby improving the environment and alleviating the burden of adding to base loads. The first and foremost task of the Third Energy Master Plan is to innovate the energy consumption structure by improving energy efficiency. The Korean government is set to reduce energy consumption by 18.6% below the BAU level by 2040 in order to decrease energy imports and contribute to a stable energy supply system. To this end, the government will improve demand management by sector, including industry, buildings and transportation, and facilitate the demand management market.

Energy efficiency will be improved in a comprehensive manner. Specifically, energy intensity targets will be managed by sector, including industry, buildings and transportation, while high-efficiency devices and products will be distributed and energy use will be optimized at the system and community levels. Businesses with high energy intensity will be encouraged to pursue voluntary agreements to reduce energy consumption as well as increase their use of high-efficiency devices. A Building Energy Management System (BEMS) will be widely introduced to reduce energy consumption in buildings. In the transportation sector, efforts will be made to improve fuel efficiency, distribute eco-friendly vehicles and innovate traffic systems.

Meanwhile, the demand management market will also be facilitated. To be specific, new business markets that combine Fourth Industrial Revolution technologies, such as the Internet of Things (IoT) linked with energy devices, as well as a small-scale public demand response market in which energy consumers can participate will be invigorated. With smart meters and electricity big data drawing attention as new business models in the demand management market, the Korean government will establish related standards and provide consumer-tailored services. Various market mechanisms will also be introduced in demand management. For instance, technologies that use electric vehicles as energy storage devices will be developed, companies specialized in energy saving will be promoted and energy management services businesses will be fostered.

Reduction Target for Final Energy Consumption



Reduction Target by BAU in 2040

39.2 million TOE



14.3
trillion won

Amount of energy imports : 14.3 trillion won
Unit cost of energy imports in 2017
0.364 million won/TOE
(Source: Korea Energy Agency)



x 26

26-fold greater than the energy
consumption of 961 million diesel cars
amounting to 1.5 million TOE
as of January 2018



x 3

3-fold greater than Denmark's
final energy consumption of
13.8 million TOE in 2016



03.



INNOVATION IN THE ENERGY CONSUMPTION STRUCTURE: PART 1

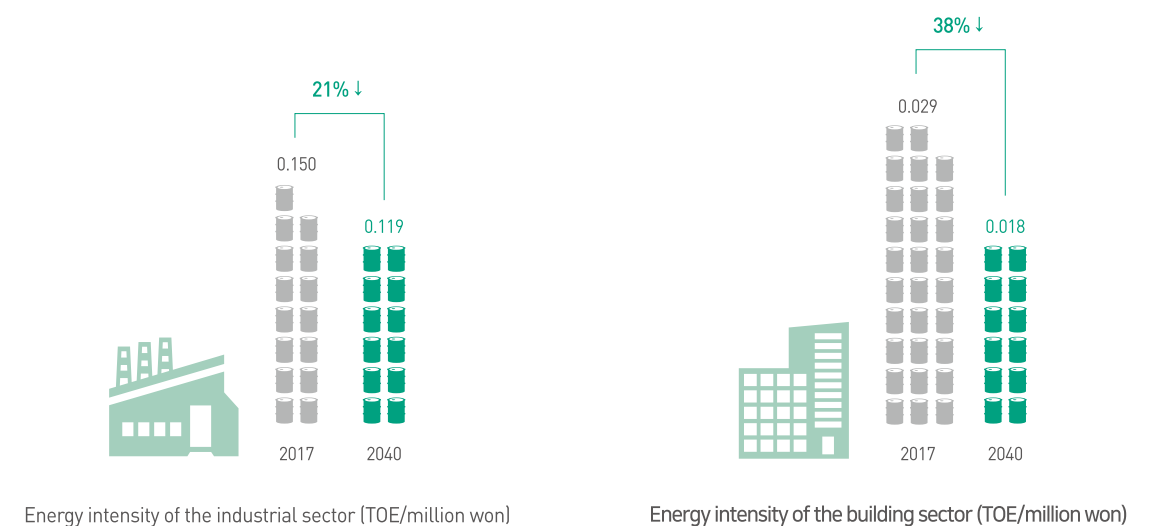
TO INNOVATE BUILDINGS AND INDUSTRIES WITH BETTER ENERGY EFFICIENCY AT THE SYSTEM AND COMMUNITY LEVELS

By utilizing BEMS, energy operations will be optimized based on the characteristics of individual buildings and an analysis of energy use collected from various equipment, such as lighting, heating and cooling systems, ventilation systems and electrical outlets. Moreover, buildings will become energy self-sufficient by mounting solar panels onto building exteriors, including windows and walls, as well as installing Energy Storage Systems (ESS) and fuel cells. Buildings constructed after the year 2030 will maximize their energy consumption efficiency and become zero energy buildings that self-sufficiently generate their energy needs.

A Factory Energy Management System (FEMS) will be installed in factories. FEMS will monitor real-time energy consumption and manufacturing status to identify the factors behind energy waste, and thereby minimize the amount of energy wasted by analyzing and using a wide range of information. Furthermore, the energy provided will be just enough to meet the demand for manufacturing processes and facility operations in order to eliminate factors that contribute to energy waste, such as oversupply and idling. By 2030, FEMS will be introduced to more than 1,500 SMEs that lack investment capabilities.

In addition to individual buildings and factories, energy efficiency at industrial complexes will likewise see vast improvements. Projects to improve energy efficiency at the community level will be undertaken, while microgrid industrial complexes based on distributed energy resources will be established. Local governments, specialized agencies and businesses will together contribute towards implementing energy efficiency plans that are tailored to their respective communities.

Building and Industry Energy Efficiency Targets



Energy Efficiency Improvement at the System and Community Levels



Develop and operate microgrid industrial complexes
20 complexes by 2030



Establish and operate regional energy efficiency communities
40 communities by 2030



Launch village-based energy rebuilding demonstrations with 3 apartment complexes
in 2020 → to be expanded in 2022



04.

INNOVATION IN THE ENERGY CONSUMPTION STRUCTURE: PART 2

TO IMPROVE ENERGY EFFICIENCY IN THE TRANSPORTATION SECTOR BY PROMOTING ECO-FRIENDLY TRANSPORTATION AND INTELLIGENT TRAFFIC SYSTEMS

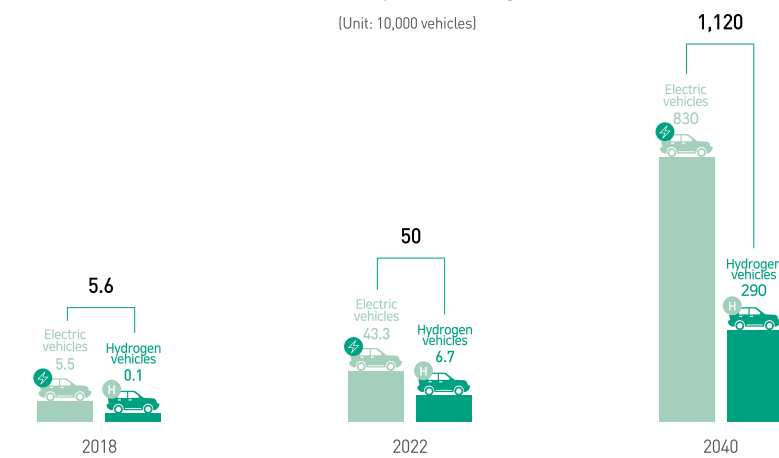
The transportation sector is a primary source of pollution due to its extensive use of fossil fuels, accounting for 23% of global greenhouse gas emissions in 2013. It is therefore of critical importance to improve efficiency in the transportation sector and implement a shift towards green transportation in promoting energy transition.

To this end, the fuel efficiency of vehicles in Korea will be significantly improved to that of European standards. The transportation system will also become more efficient by introducing an Intelligent Transportation System (ITS). Advanced communication and control technologies will be applied to the transportation system, including roads and traffic signals, to help effectively control traffic congestion and create a safer traffic environment. Moreover, as automated driving technologies that operate on a 5G network continue to advance and exchange information on roads and traffic flows, traffic congestion and accidents will be reduced while the energy consumed on roads will decrease significantly.

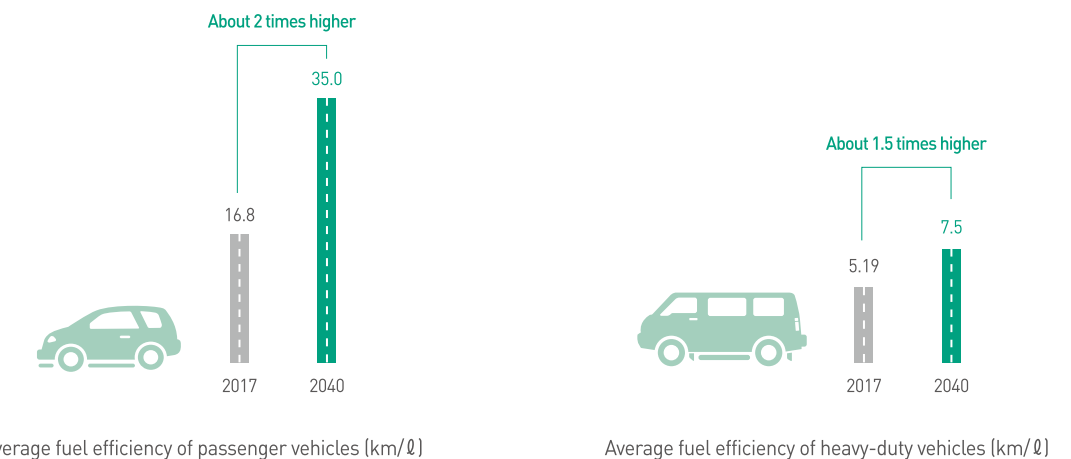
The number of green vehicles will also grow dramatically. Korea plans to distribute 8.3 million electric vehicles and 2.9 million hydrogen vehicles by 2040, which in total will account for the half of the vehicles registered in Korea. The advantage of hydrogen vehicles lies in their ability to travel farther on the same volume of fuel given the higher energy density of hydrogen compared to fossil fuels. In addition, hydrogen vessels, hydrogen trains as well as hydrogen drones will undergo technological development to be commercialized in the future.

Eco-friendly Vehicle Targets

(Unit: 10,000 vehicles)



Fuel Efficiency Improvement Targets



Average fuel efficiency of passenger vehicles (km/ℓ)

Average fuel efficiency of heavy-duty vehicles (km/ℓ)

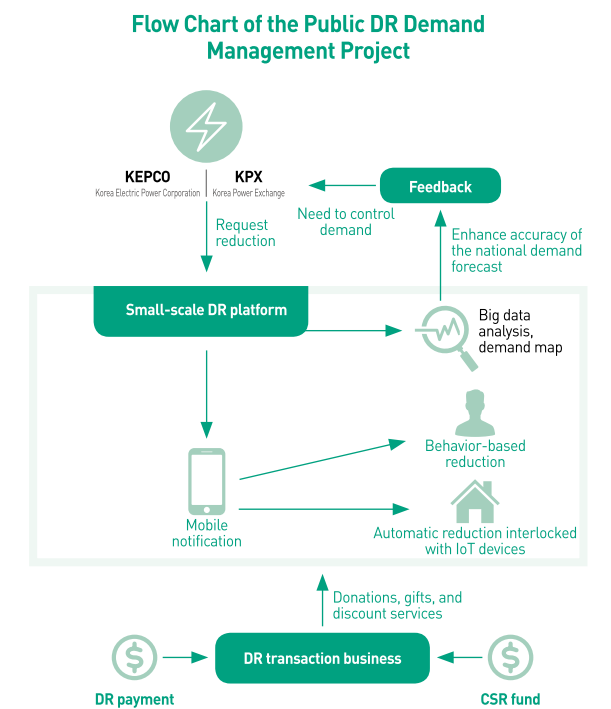
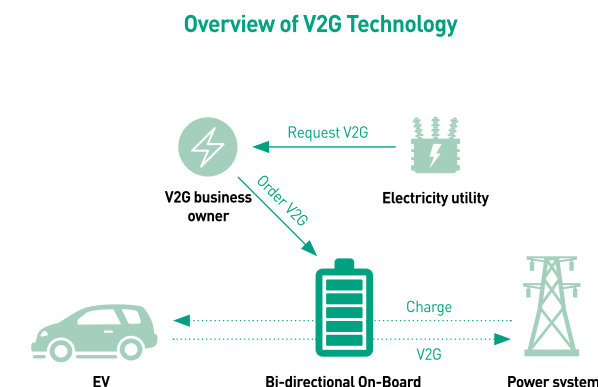


TO CREATE NEW BUSINESSES AND MARKETS

To manage energy consumption, smart energy infrastructure, such as ESS, smart meters and Internet of Things (IoT) will be widely distributed while markets for demand management services, which utilize Fourth Industrial Revolution technologies, will be promoted. Cases in point are the Public DR where citizens sell electricity saved by using smart home appliances and the Battery Second Use (B2U) where electricity produced from solar PVs are stored in an ESS and batteries used in EVs are reused as an ESS. Furthermore, a host of demand management models will be brought to the fore. For instance, a model to sell discharged electricity to the electricity market through vehicle-to-grid (V2G)* technology that uses EVs as an ESS will be developed.

Investments in energy efficiency will be significantly increased using the resources of major energy suppliers. An Energy Efficiency Resource Standard (EERS), a policy that mandates energy savings to achieve energy efficiency targets, will be legislated. Moreover, businesses specializing in demand management services, such as Energy Service Company (ESCO) and Energy Management Services (EMS) companies, will be developed.

* V2G: a technology that re-sends the remaining electricity in EV batteries into power grids by connecting the EV with the power grids



TRANSITION TOWARDS A SAFE AND GREEN ENERGY MIX

TO DEVELOP A SUSTAINABLE ENERGY MIX WITH MORE RENEWABLE ENERGY

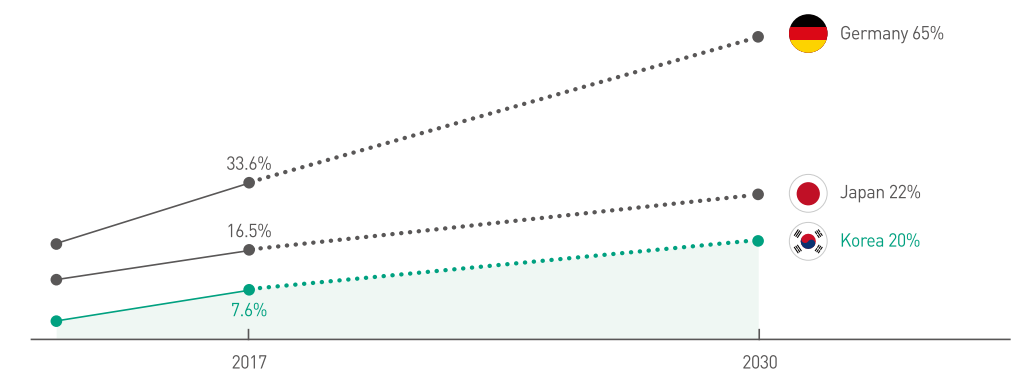
Korea will transform its energy mix by prioritizing the public's requests for a clean and safe environment.

The Korean government has set the goal of raising the share of renewable energy in power generation from 7.6% in 2017 to 30-35% by 2040. Nuclear power will be gradually phased out as no further extensions will be made to the lifespan of aged reactors and no new reactors will be constructed. At the same time, coal-fired power generation will be drastically reduced to within the range necessary to secure a stable supply and demand.

Natural gas, which emits the least amount of greenhouse gas and fine dust amongst fossil fuels in addition to its relatively low geographical risks compared to oil, will continue to play a greater role in the future.



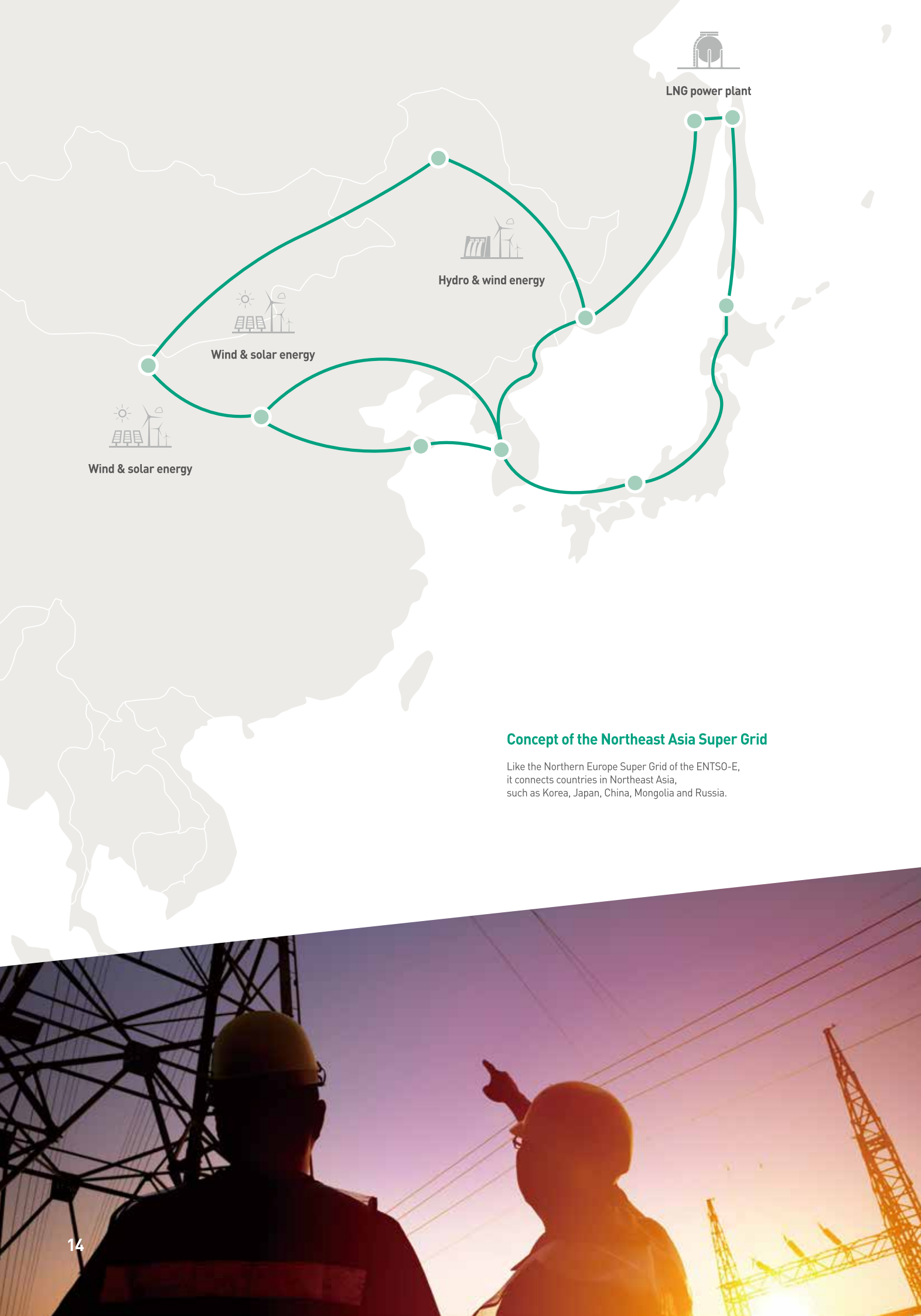
Renewable Energy Targets of Major Countries



Source: Energy Concept of Germany (2010), 5th Strategic Energy Plan of Japan (2018), Renewable Energy 3020 of Korea (2017)

Outlook for NPP Operation by Year





Concept of the Northeast Asia Super Grid

Like the Northern Europe Super Grid of the ENTSO-E, it connects countries in Northeast Asia, such as Korea, Japan, China, Mongolia and Russia.

07. IMPROVEMENT OF ENERGY SECURITY

TO STRENGTHEN ENERGY SECURITY THROUGH GLOBAL COOPERATION

Korea imports the vast majority of its energy resources including uranium, oil and LNG from overseas. In order to overcome its geographical limitations and secure a stable energy supply, the government is strengthening its cooperation with neighboring countries.

To begin with, Korea is forging ahead with the Northeast Asia Super Grid project to connect power grids with neighboring countries. By developing cross-border power grid systems, the efficiency of energy use between countries will be enhanced, and Korea will be able to benefit from a more stable supply and demand system.

Investments in overseas resource development will also be promoted with a focus on those that are most needed. Furthermore, the government will lay a foundation for public and private enterprises to jointly take part in overseas resource development projects by supporting the capability building of private resource development companies.

Continued efforts will be made to diversify import routes, particularly for crude oil and natural gas, in order to prepare for possible geopolitical risks. To decrease the country's heavy reliance on specific regions, the share of oil imports from non-Middle Eastern countries will increase while new gas suppliers will continuously be secured.





08. ENHANCED ENERGY SAFETY MANAGEMENT

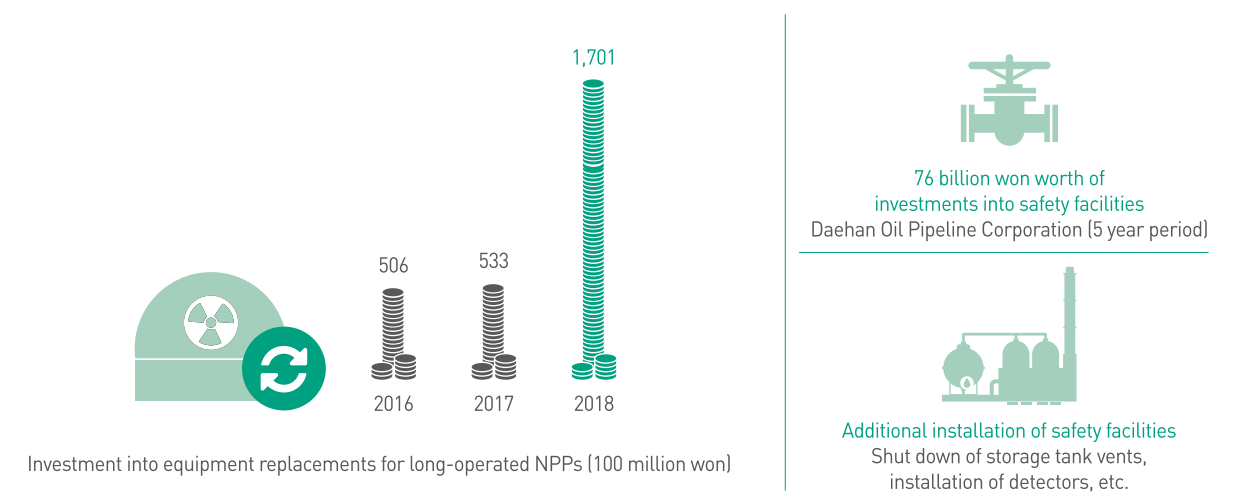
TO STRENGTHEN THE SAFETY FEATURES OF ENERGY FACILITIES BY PRIORITIZING PUBLIC SAFETY

After a series of earthquakes in the cities of Gyeongju and Pohang, public concerns regarding the safety of energy facilities have grown significantly. The Korean government will therefore develop a preemptive safety management system for its citizens to consume energy in a safer manner.

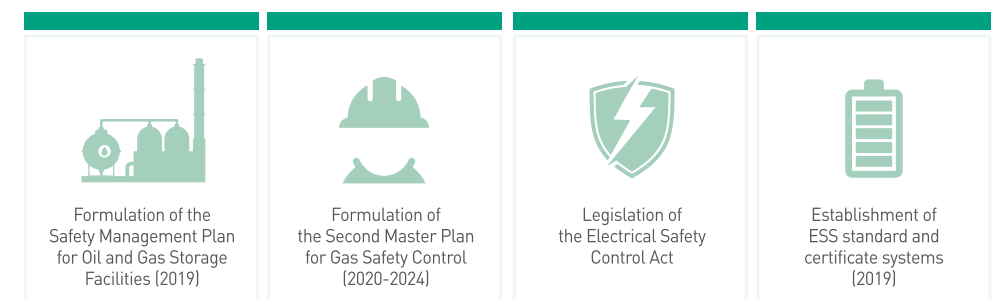
As for underground energy facilities, the government plans to make greater investments to diagnose, manage, and replace aged facilities in a timely manner to explore technology standards and enact safety management measures. It will also establish a remote monitoring and diagnostic system for underground facilities by fully utilizing autonomous drones and unmanned monitoring robots.

The safety management of power plants will be enhanced by conducting general safety check-ups, establishing participatory management systems and providing more staff. In addition, a Safety Management Committee will be launched to improve the transparency, efficiency, and compatibility of management systems and to add more staff for high-risk tasks. In particular, a quantitative safety evaluation will be introduced to a multiple number of nuclear reactors to enhance their scientific excellence, objectivity and credibility. Moreover, to improve the safety of nuclear fuel cycle facilities, the government will grant licenses for each phase in the exact same manner as nuclear power plants (NPPs) while harmonizing safety standards with those of the International Atomic Energy Agency.

Greater Investment into the Safety Management of Energy Facilities



Safety Management for Oil, Gas and Electricity



EXPANSION OF DISTRIBUTED AND PARTICIPATORY ENERGY SYSTEMS

TO ENHANCE REGIONAL ENERGY INDEPENDENCE THROUGH DISTRIBUTED GENERATION AND SMART GRIDS

Korea has long maintained a power system where a small number of large-scale power plants generate electricity and supply it nationwide. In the process, however, the government has encountered severe conflicts with local residents over the construction of large-scale power plants as well as transmission and distribution lines. To address this issue, the government will dramatically increase the share of distributed generation. Distributed generation refers to the power supply provided to consumers by installing small-scale power facilities, such as small-scale renewable energy and fuel cells, nearby where demand is created. As of 2017, the ratio of distributed generation in Korea stood at 12%, and the government plans to raise it to 30% by 2040.

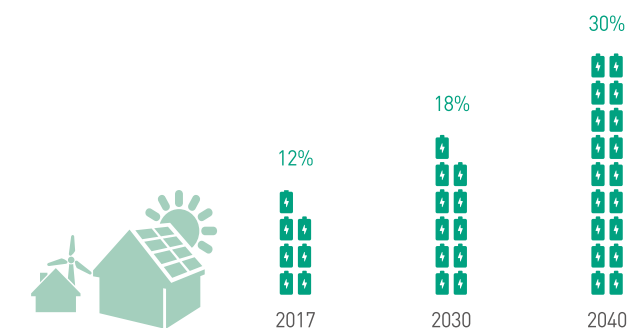
To do so, the government will encourage the installation of small-scale solar PVs, wind farms, fuel cells for power generation as well as combined heat and power plants. Furthermore, small-scale regional generation facilities will be connected to smart grids by using Information and Communication Technology (ICT). In this way, consumers will be able to produce and consume the electricity needed for their daily lives within their very region. As energy supply and demand becomes more flexible and the entire power system is integrally connected, Korea plans to encourage more consumers to become electricity prosumers* who independently produce and use power as well as sell excess electricity. Distributed generation will be diversified to include not only PVs and ESS but also various technologies, such as V2G connected to EV batteries. Moreover, the government will increase the number of Virtual Power Plants (VPP) that integrate various small-scale power sources and operate them as if they are one big plant.

Meanwhile, the power system will be revamped to enhance grid acceptance of renewable energy and increase the capacity of power distribution to ultimately ensure the stability of distributed generation networks. In addition, the government will promote projects that encourage the participation of local residents and share the profits to minimize conflicts within the region over renewable energy. By encouraging local residents and stakeholders to participate in the project from the planning stage and addressing relevant issues in a democratic manner, the government will widely deploy distributed generation.

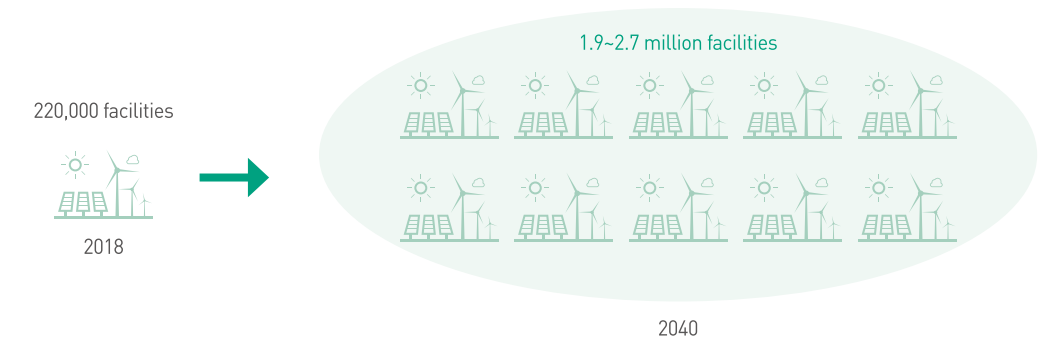
* Electricity prosumer: a person who consumes and produces power using small-scale generators and sells excess electricity



Distributed Generation Targets



Number of Renewable Energy Facilities by Year





10.



GLOBAL COMPETITIVENESS OF THE ENERGY INDUSTRY

TO DEVELOP THE ENERGY INDUSTRY AS A NEW GROWTH ENGINE AND EXCELLENT SOURCE OF QUALITY JOBS

Competition among countries in the global renewable energy market has grown fierce in recent years. In line with the so-called Plan to Strengthen the Competitiveness of the Renewable Energy Industry announced in April 2019, Korea aims to shift the focus of competition in the renewable energy market from price to quality and assist Korean firms to go global by innovating the domestic industrial ecosystem.

As a future growth engine and environmentally-friendly energy source, hydrogen will contribute much to boosting Korea's energy independence. It is also expected to provide new opportunities to innovate the energy industry and reduce greenhouse gas emissions. With hydrogen vehicles and fuel cell technologies as the two key pillars for realizing the hydrogen economy, the government plans to establish an ecosystem for the hydrogen industry.

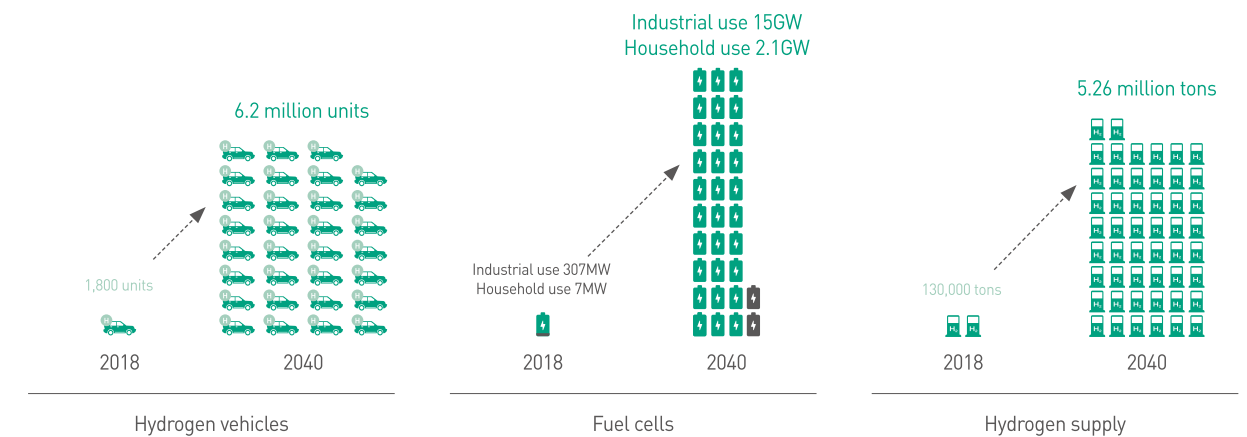
Hydrogen, a breakthrough energy source that does not emit CO₂, is a new growth engine that generates value added and jobs. As Korea takes the lead in spearheading the global hydrogen economy by utilizing its world-class hydrogen technologies, it is expected to create 420,000 jobs, generate up to 43 trillion won and reduce greenhouse gas emissions by up to 27.28 million tons by 2040.

Korea will also develop the energy efficiency industry as a new growth momentum. To do so, the government will promote domestic industries as well as support entry into the global market by developing technologies and streamlining institutions with high-efficiency devices and energy solution services.

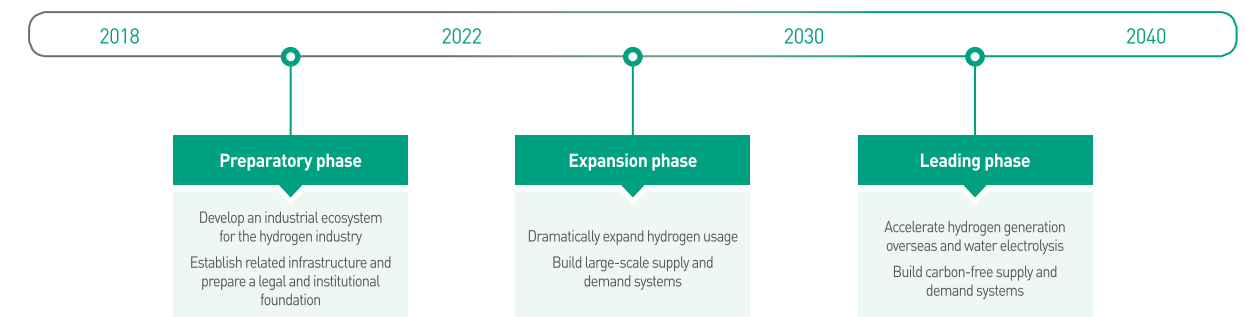
Korea will maintain and enhance the competitiveness of the conventional energy industries through innovation. As for nuclear power, the government will maintain the core ecosystem to ensure its stable operation over the long term and develop related industries, such as nuclear decommissioning and spent fuel management. Furthermore, other conventional energy industries, including oil and gas, will also seek higher value added by advancing processes and developing new business models.

Hydrogen Economy Roadmap

Leading the World in the Hydrogen Economy



Implementation Strategies



BETTER INFRASTRUCTURE AND MARKET SYSTEMS FOR ENERGY TRANSITION

TO ADVANCE THE ELECTRICITY, GAS AND HEAT MARKET SYSTEMS

For a successful energy transition to become reality, it is essential to ensure the free trade of energy sources, such as electricity, gas, and heat, as well as introduce competitive markets that can lead to the creation of new business models.

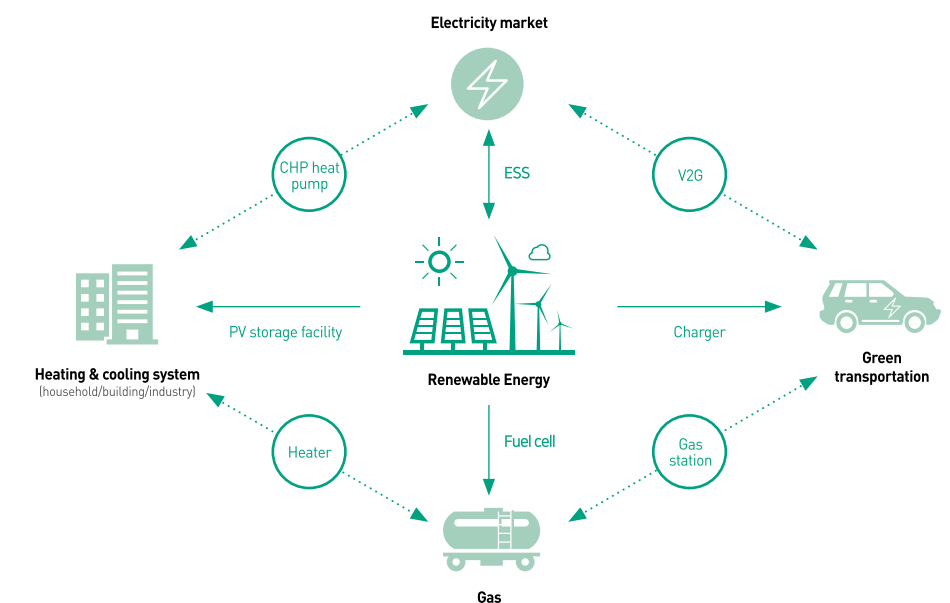
To enhance the efficiency of the electricity market, a level playing field will be established. Real-time markets and supplementary service operation systems will be introduced and aligned to further deploy renewable energy. Moreover, institutions will be revamped to promote the clean and safe energy distribution by enhancing environmental dispatches so as to apply costs for pollutant reductions and emissions trading systems in a timely manner. Such improvements in the electricity markets will contribute to greater adoption of new business models that utilize Fourth Industrial Revolution technologies and provide more options for consumers.

In the gas market, direct importers will be given greater responsibility for ensuring a stable supply and demand, while the efficiency and fairness of the market will be secured by improving the rate system for power generation of the Korea Gas Corporation. As for heat, supply markets, which are divided by region, will be connected to promote heat trading between different regions, thereby enhancing the use of high-efficiency heat sources.



Integrated Smart Energy System

The electricity, heat, gas and transportation sectors generate, transform, store, trade and consume in an optimized manner based on market prices





12. MORE INFRASTRUCTURE FOR ENERGY TRANSITION

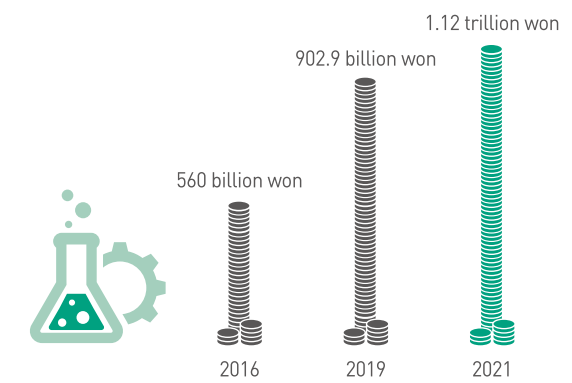
TO DEVELOP THE TECHNOLOGIES AND MANPOWER FOR ENERGY TRANSITION

The Korean government will invest more into the research and development (R&D) of key areas, such as efficiency improvement and energy safety. In addition, R&D participants will be diversified by strengthening cooperation between the government and public corporates, and encouraging private companies to participate in R&D projects that apply big data, Artificial Intelligence and the IoT.

As for manpower, Korea will train a skilled workforce that can facilitate the convergence between the energy industry and other industries, such as solar cells and the semiconductor industry or smart grids and the IT industry. The government will also develop world-class university laboratories and help strengthen global networks by dispatching the brightest minds to overseas universities and research institutes to conduct joint research.

In the meantime, statistical systems will be reinforced throughout the entire energy sector to support the seamless implementation of the energy transition policy and the development of new energy industries. Moreover, a big data platform, which covers electricity, city gas and other major energy sources, will be established and operated.

Clean Energy R&D Investment



Create an energy big data platform to provide energy information on supply, demand and technologies in an integrated manner



2019

Form and operate a consultative group of stakeholders including the government, energy suppliers, smart meter manufacturers, solution providers and telecommunication service providers



2022

Provide a web-based, one-stop service with customized multi-dimensional analysis and visual effects

