Energy Policy Review

Korea 2025

INTERNATIONAL ENERGY AGENCY

The IEA examines the full spectrum of energy issues including oil, gas and coal supply and demand, renewable energy technologies, electricity markets, energy efficiency, access to energy, demand side management and much more. Through its work, the IEA advocates policies that will enhance the reliability, affordability and sustainability of energy in its 32 Member countries, 13 Association countries and beyond.

IEA Member countries:

Australia
Austria
Belgium
Canada
Czech Republic
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Ireland
Italy
Japan
Korea
Latvia
Lithuania
Luxembourg
Mexico
Netherlands
New Zealand
Norway
Poland
Portugal
Slovak Republic
Spain
Sweden
Switzerland
Republic of Türkiye
United Kingdom
United States

The European Commission also participates in the work of the IEA

IEA Association countries:

Argentina
Brazil
China
Egypt
India
Indonesia
Kenya
Morocco
Senegal
Singapore
South Africa
Thailand
Ukraine

Source: IEA.
International Energy Agency
Website: www.iea.org

Table of contents

Executive summary

The energy crises resulting from the global Covid-19 pandemic and the Russian Federation's invasion of Ukraine propelled carbon neutrality and energy security to the forefront of Korea's energy policy. Despite robust growth in gross domestic product (GDP), Korea has managed to stabilise and reduce its greenhouse gas (GHG) emissions in recent years following a peak around 2018. Nonetheless, it faces challenges in fully decoupling emissions from economic growth. Notable among these challenges is the continued reliance on coal and the need for further expanding renewable energy technologies.

Addressing Korea's challenges will require sustained policy efforts, domestic and international co-operation, and technological innovation. In 2021, the Framework Act on Carbon Neutrality and Green Growth for Coping with Climate Crisis (Carbon Neutrality Act) enshrined the country's 2050 net zero target into law alongside interim 2030 GHG reduction targets and sector-specific measures. A Presidential Commission on Carbon Neutrality and Green Growth acts as a climate policy council, advises the government on targets and policies, and reviews progress on mitigation and adaptation each year. In 2022, the government placed an emphasis on energy security and announced the introduction of nuclear power and other low-carbon energy sources. In 2025, a new organisation, the Ministry of Climate, Energy and Environment, was established underscoring the government's commitment to a renewable energy-centred transition and comprehensive decarbonisation across all sectors.

Korea sets out many of its climate and energy policy objectives in strategic plans, which are updated on a cyclical basis. As much of Korea's climate and energy policy is set out in these non-binding plans, it may be vulnerable to political

changes. Mindful of this, and in acknowledgement of the multi-agency nature of Korea's energy goals and the cross-cutting nature of many policies, the government should look at ways to strengthen internal co-ordination. The establishment of the Ministry of Climate, Energy and Environment (MCEE) in October 2025 is expected to strengthen the overall coherence of climate and energy policies. The MCEE assumed most energy functions from the former Ministry of Trade, Industry and Energy (MOTIE). MCEE is today responsible for climate, electricity, grid, and energy transition policies. MOTIE, now renamed the Ministry of Trade, Industry and Resources (MOTIR), continues to oversee resource industries such as oil, gas, coal, minerals, and nuclear exports.

Electrification of buildings, transportation and industry combined with a growing demand for air conditioning and data centres is resulting in a shift toward an electrified economy. Substantial investments in new, diverse sources of electricity supply alongside reliable and resilient network infrastructure will be needed. A well-functioning wholesale market for power can provide efficient signals to invest. Given the structure of the electricity market, which is dominated by the state-owned Korea Electric Power Corporation (KEPCO), reforming the present market arrangements could deliver a more effective outcome.

Since October 2025, responsibility oversight of the electricity market regulator (KOREC) rests with the Ministry of Climate, Energy and Environment. Consumers and the electricity sector would be better served by an independent market regulator, with responsibility for modernising the wholesale electricity market and redressing imbalances in the electricity retail market. It should oversee the transition from the existing tariff retail regime to a transparent and market-based pricing regime while protecting low-income households and vulnerable consumers from energy poverty. The regulator should deliver the effective unbundling of KEPCO's different functions while ensuring the long-term financial sustainability of its retail electricity business. The regulator's authority should also extend to natural gas and the emerging market for hydrogen.

Despite the expansion of renewables generation in the past decade, the share of renewables in Korea's electricity supply remains the lowest among IEA countries. Korea faces distinct challenges in its efforts to expand renewable energy sources. Factors include the limited amount of available land, the large share of forested areas and high population density. Public opposition to energy infrastructure also leads to delays, resulting in higher costs, which are having a material impact on the location of energy projects. To make public engagement meaningful, Korea

should develop a strategy for public engagement to establish standards of communication with communities. To support the effective delivery of new electricity infrastructure, Korea should also look to embed spatial planning into the energy planning process.

The Korea Emissions Trading System (K-ETS) covers almost 80% of domestic GHG emissions and 800 of the country's largest emitters and aims to support the country in achieving its 2050 net zero goal. Despite its scale and broad coverage, the K-ETS price remains relatively low and the market lacks liquidity. Liquidity and price discovery could grow by increasing the share of allowances allocated by regular auctions and fully opening these auctions to all market participants. Introducing a market stability mechanism with a mandate to auction additional allowances held in reserve within the overall cap in periods of low liquidity would further boost liquidity when necessary.

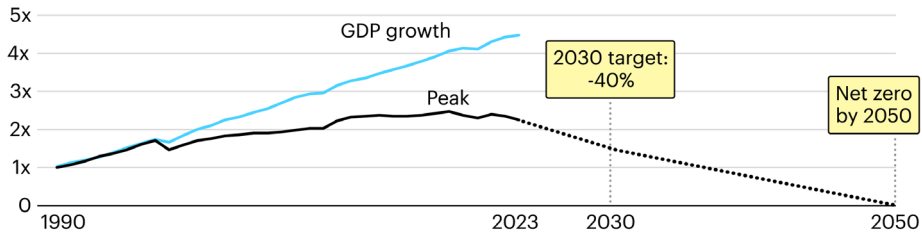
Nuclear energy is one of the pillars of Korea's long-term energy and climate strategy, with a target for nuclear to provide a minimum of 30% of the energy mix in 2030. Today, 26 reactors of 26 gigawatts (GW) of installed capacity provide about a third of electricity. To support its goals, Korea has built a highly skilled workforce in the nuclear energy sector, enabling the country to strengthen its position as a global player. It exports its technology widely. Research and development (R&D) efforts in the nuclear sector focus on building the country's nuclear technology base to support exports. Small modular reactors (SMRs) are a major focus of its efforts. Korea should leverage its existing knowledge, technical expertise and manufacturing capacity to support the development a national industrial complex for the construction and demonstration of SMRs. With a focus on demonstrating both SMR manufacturing and operation for an end-use industrial case application, the country could look to showcase efficient SMR manufacturing.

Low-emissions hydrogen is widely seen as a potential solution for decarbonising hard-to-abate industrial sectors where alternatives are limited. Korea was one of the first countries to launch a hydrogen roadmap (in 2019), which focuses mainly on the transport, buildings and power sectors. Nonetheless, the adoption of low-emissions hydrogen is some way off and Korea must overcome several challenges if it is to fully realise its potential. Korea should clarify the policy instruments needed to increase use of hydrogen in hard-to-abate sectors such as industry and heavy-duty transport. It should also create clear and transparent rules on building, owning and operating hydrogen pipelines and import terminals. Investors and project developers need clear and stable regulatory frameworks; without timely

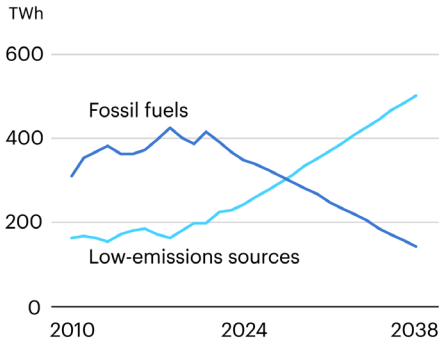
buildout of infrastructure, the link between hydrogen supply and demand is broken, leading to uncertainty and stunted market growth.

Korea's power system is isolated, lacking interconnections with neighbouring countries; therefore maintaining the reliability and stability of the system is a challenge. The planned expansion of nuclear power and variable renewable energy (VRE) sources alongside the planned phase-out of coal-fired power will have major implications for the operation of the electricity system as the stable and reliable supply of electricity is becoming more important for major industries such as semiconductors and data centres. In the power sector, energy storage, particularly battery storage, contributes to electricity security by stabilising the grid, meeting peak load demands and facilitating the integration of increasing amounts of VRE. A Development Strategy for the Energy Storage Industry was announced in October 2023, and in July 2025, Korea launched its first Energy Storage System Central Contract Market. Korea aims to boost the global competitiveness of lithium battery-based energy storage systems (ESS) and develop non-lithium, long-duration energy storage technologies. Using large-scale batteries, Korea aims to stabilise the grid during periods of high demand while smoothing out fluctuations in VRE supply. While using battery storage can add capacity to the system, investment in the technology is limited, as battery storage is unable to participate in the wholesale electricity market, offer ancillary services or contribute to grid congestion management. Korea should establish a clear roadmap for the expansion of the centralised contract market to the mainland based on lessons learnt from recent trial projects on Jeju Island.

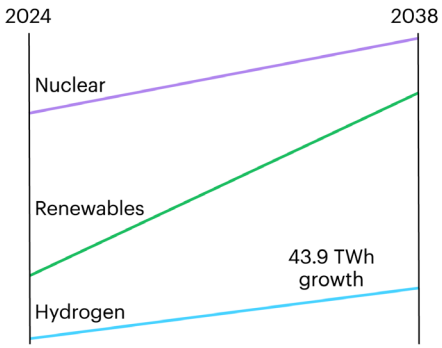
Having **decoupled emissions** from **economic growth**, Korea is igniting the next stage: **substantive reductions**



Plans for a major power sector transformation would **double low-emissions sources**



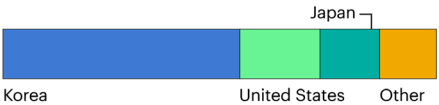
Hydrogen is set to play **a growing role** in supporting Korea's isolated power grid



55%

of **battery manufacturing capacity** outside of China is owned by Korean companies (2024)

Capacity share by country affiliation



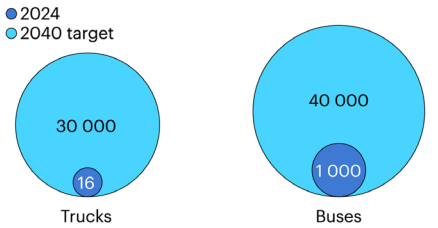
3rd

worldwide in number of nuclear power plants that **started construction** (2005-2025)

Over 600

nuclear energy patents filed since 2000, ranking fifth worldwide

Fuel cell electric trucks and buses **can help decarbonise** heavy-duty transport



Sources for this infographic can be found in the Annexes.

Policy recommendations for Korea

Energy policy landscape

1. Strengthen the role of the Presidential Commission on Green Growth and Carbon Neutrality to support the implementation and co-ordination of the sectoral basic plans.
2. Strengthen progress toward a carbon-free economy with use of nuclear power, expanding renewable energy, and promoting new technologies for a net-zero pathway and decarbonisation.
3. Prepare a National Strategy to improve public acceptance of energy projects by ensuring early, regular and meaningful stakeholder engagement in plan and project development.
4. Strengthen and incorporate strategic spatial planning processes to support better energy planning and management.
5. Increase the number of credits auctioned in K-ETS, establish a market stability mechanism and ensure electricity price pass through.
6. Establish a well-resourced independent regulatory body responsible for oversight of the electricity, natural gas and hydrogen markets.
7. Create a national industrial complex for demonstration of small modular reactors.

Hydrogen in Korea's energy transition — Focus area

8. Prioritise the efficient production, conversion, transport and use of hydrogen in applications with high emissions reduction potential.
9. Implement a regulatory framework for the hydrogen economy including rules for the development and operation of hydrogen infrastructure.

Energy storage technologies — Focus area

10. Accelerate the rollout of a centralised contract market for energy storage services to ramp up the deployment of battery storage.

Energy policy landscape

The Republic of Korea's (hereafter "Korea") is committed to its clean energy transition and has created a comprehensive framework of legal, economic and policy commitments aimed at limiting GHG emissions, encouraging the adoption of carbon-free energy sources and promoting the development of clean technologies. Located on the southern part of the Korean Peninsula, the mountainous terrain concentrates the population of almost 52 million to the lowlands, with over 80% of the population living in urban centres. Korea has limited natural energy resources and as an "energy island" with no interconnections, is a major importer of energy, mainly in the form of oil, natural gas, coal and uranium. These factors shape Korea's energy policy and make energy security a priority.

Korea's economy is one of the most energy-intensive in the OECD, with the third-highest energy use per unit of GDP.[1] It is a manufacturing economy that relies on its energy-intensive sectors such as petrochemicals, steel, automotives, shipbuilding and textiles. It was the world's 13th-largest economy by GDP (USD, 2015 prices and purchasing power parities) in 2023. The economy is primarily driven by its robust manufacturing industry, which is focused on advanced technology and producing automobiles and technical appliances for export. Its limited natural resources mean it relies on imports for the raw materials and energy needed to support its strong manufacturing base. Domestic industry benefits from regulated electricity tariffs, which are among the lowest in the OECD.

Korea's energy policy has undergone substantial reform in recent years. In 2022, Korea implemented a policy to expand renewable energy while maintaining an

[1] Unless otherwise indicated, all material presented in text, figures, and tables is derived from IEA data and analysis.

appropriate level of nuclear power utilisation as a supplementary energy source. Korea also implemented an emissions trading system, the K-ETS, the world's third-largest ETS. The K-ETS covers several sectors, including power generation, industrial processes, buildings, waste and transportation. In September 2023, the government announced its Carbon-Free Energy (CFE) Initiative at the United Nations General Assembly. Korea aimed to reduce dependence on fossil fuels and satisfy 70% of its electricity generation from zero-carbon sources such as nuclear, renewables and hydrogen by 2038; develop smart grid technologies; invest in energy storage solutions and technology advances to achieve carbon-neutral industrial processes.

Climate and energy strategy

Since 2020, rising geopolitical tensions in the region followed by the Russian Federation's (hereafter, "Russia") full-scale invasion of Ukraine propelled carbon neutrality and energy security to the forefront of domestic energy policy. In response, the government signalled plans to utilise a diverse range of carbon-free energy sources such as nuclear power; renewable energy; pumped storage hydroelectricity; hydrogen fuel cells; and carbon capture, utilisation and storage. The government also raised its 2030 emissions reduction target from a 26.3% cut to a 40% cut compared to 2018, capping emissions at around 440 million tonnes (Mt) in 2030 (compared to around 730 Mt in 2018).

The revised target, submitted in 2021, was confirmed in the 2023 National Strategy for Carbon Neutrality and Green Growth. The Strategy set mid- to long-term emissions reductions targets along with sector-specific measures. These sector-specific measures include proposals to phase out coal-fired power while expanding nuclear power and renewable energy in a rational and feasible manner supported by investments in grids and ESS. It places a significant emphasis on hydrogen, including the development of hydrogen production, growing demand, building infrastructure and strengthening the hydrogen industry ecosystem.

The Presidential Commission on Carbon Neutrality and Green Growth acts as a climate policy council, advises on targets and policies, and reviews progress on mitigation and adaptation every year. The 2023 Basic Plan presents non-binding emissions reduction targets and annual trajectories by sector up until 2030. The greatest reduction is planned in electricity generation, which is set to reduce emissions by approximately 46% compared to 2018, corresponding to 124 million tonnes carbon dioxide equivalent (Mt CO_2-eq) and 43% of the total planned emission

reductions. Industry, the second-largest emitting sector, is set to reduce emissions by 11%, which is still 10% of the total planned emissions reductions. Transport emissions are planned to fall by 38%, or 13% of the total efforts. International mitigation co-operation under Article 6 of the Paris Agreement is also planned to contribute 13% of the total.

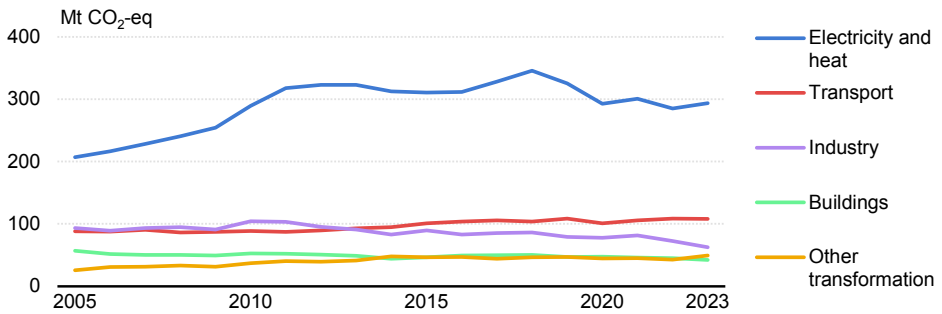
Korea's Energy Carbon Neutrality Technology Development Strategy aims to support the energy transition and technology diffusion while contributing to a robust industry base and the creation of sustainable employment. The Strategy places a strong emphasis on achieving the country's carbon-neutrality goals by means of electrification, energy efficiency improvements and expanding the market for hydrogen. Korea adopted the Fifth Energy Technology Development Plan pursuant to the Energy Act in December 2024. These plans cover a ten-year period. Updates to the plan are approved by a Presidential Advisory Council on Science and Technology every five years.

Climate trends and targets

Economy-wide GHG emissions increased significantly until 2012 but have since stabilised, largely thanks to reductions in the power sector. GHG emissions started to fall in 2018, a trend which accelerated during the Covid-19 pandemic. In the Enhanced Update of its first Nationally Determined Contribution (NDC), Korea committed to a legally binding target of up to a 40% reduction by 2030 compared to 2018. Since net GHG emissions in 2018 reached almost 700 Mt CO_2-eq, Korea will need to reduce GHG emissions by almost 300 Mt CO_2-eq by 2030 if it is to meet its 40% target.

Energy accounted for 87% of Korea's GHG emissions in 2018. The largest emitting subsector in the energy sector is electricity and heat generation, which was responsible for around half of energy-related GHG emissions in 2022. Coal power accounts for a large share of electricity generation and is the main driver of emissions from the sector. The second-largest emitting sector is transport, followed by industry and buildings. Emissions from electricity and heat peaked in 2018 before slowly declining. Transport emissions increased by 23% from 2005 to 2022, while emissions from the buildings and industry sectors decreased over the same period.

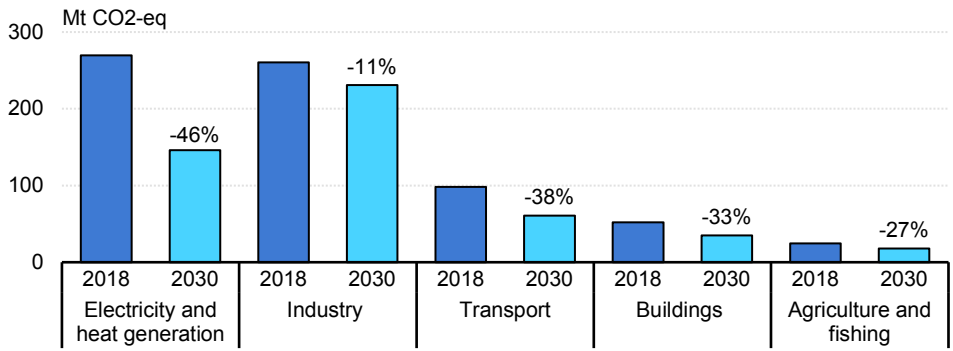
Energy-related greenhouse gas emissions by sector in Korea, 2005-2023



Source: IEA (2025), Greenhouse Gas Emissions from Energy.

In 2023, the first National Basic Plan for Carbon Neutrality and Green Growth defined sectoral emissions targets to help achieve Korea's NDC targets. The country established targets to cut GHG emissions by at least a third by 2030 in the transport and buildings sectors from 2018 levels. The industry sector will reduce emissions by 11% compared to 2018 and is set to be the largest emitter in 2030. The power sector will reduce emissions by 46% to ensure that the economy-wide target of 40% is met.

Economy-wide greenhouse gas emissions (2018) and targets (2030) by sector in Korea



Source: IEA analysis based on Korea, Ministry of Environment (2023), First National Basic Plan for Carbon Neutrality and Green Growth (accessed January 2025).

Climate policy framework

Korea passed its Carbon Neutrality Act, which enshrined its 2050 net zero target and its interim 2030 GHG reduction target. The Act legally binds Korea to a 40% reduction in GHG emissions compared to 2018. The Act also established the Presidential Commission on Carbon Neutrality and Green Growth in 2021 and the Climate Crisis Response Fund. Korea is set to publish a new NDC for 2035 with its expected submission to the United Nations Framework Convention on Climate Change Secretariat in 2025.

The Presidential Commission on Carbon Neutrality and Green Growth monitors Korea's climate policy and is intended to lead the country's climate strategy and engage non-governmental stakeholders in net zero policy making. The Commission is responsible for reviewing national net zero plans, monitoring implementation and providing policy recommendations. It is comprised of private and public stakeholders, including representatives from several sectors, civil society and youth.

Energy targets

The Korean energy policy framework contains a robust mix of voluntary and mandatory energy efficiency policies. Governed by the Energy Use Rationalization Act, Korea has strategically pursued energy efficiency measures at the national level since 1979. With the Act, Korea is committed to publishing five-year basic plans and 20-year master plans on energy efficiency. These plans lay out mid- and long-term efficiency policies and provide projections for efficiency savings in the following years. The broader energy efficiency framework includes voluntary targets, mandatory regulations, efficiency standards, data collection, financial support and operational assistance.

Korea is committed to phasing out coal-fired power by 2050. The Basic Plan for Electricity Supply and Demand (BPLE) includes plans for coal use. It is issued every two years. The 11th Basic Plan projects a reduction in the share of coal in power generation to 10% in 2038. The Basic Plan for Carbon Neutrality and Green Growth notes the goal of retiring 20 of 58 operating coal-fired power plants by 2030. Through these efforts, Korea projects to achieve 70% carbon-free electricity generation in 2038, up from 39% in 2023, with a projected interim share of 53% by 2030.

The CFE initiative calls for international support for Korean decarbonisation targets. The CFE, which was proposed at the United Nations General Assembly in September

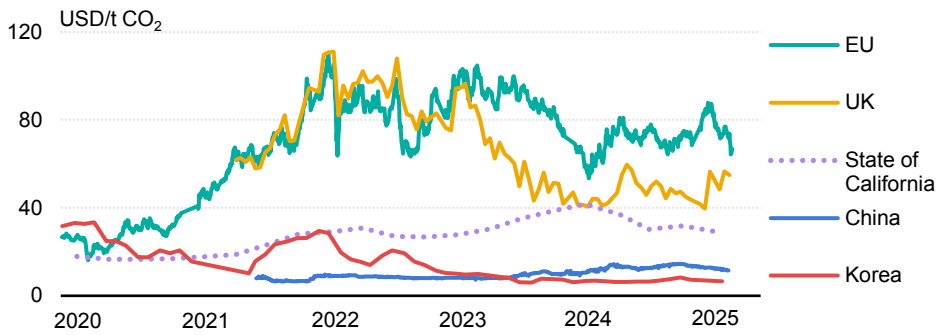
2023, is an open platform to promote the adoption and deployment of carbon-free energy and achieve industrial decarbonisation. In addition, it proposes measures to foster innovation in clean energy technologies, support the shift to renewable energy and improve energy efficiency across all sectors. Several countries, including France, Japan, Saudi Arabia, the United Arab Emirates and the United Kingdom, pledged to support Korea in its efforts. Korea aims to establish internationally accepted implementation standards for CFE by means of public-private partnerships and by driving global demand for lower emissions products.

Taxation and carbon pricing

The K-ETS is an important part of the country's strategy to achieve its emissions targets. Launched in 2015 as the region's first nationwide, mandatory ETS, it aims to help the country achieve its objective to become carbon-neutral by 2050. It is the world's third-largest emissions trading system behind the People's Republic of China's (hereafter, "China") ETS and the European Union's (EU) ETS. More than 70% of domestic GHG emissions are covered, and more than 700 of the country's largest emitters in the power, industrial, buildings, waste, transport, domestic aviation and maritime sectors are included. Currently in its third phase (2021-25), 90% of the allowances are freely allocated, a decrease from 97% in the second phase. Korea is currently developing its fourth-phase ETS master plan which will cover the period 2026-30.

Despite its broad coverage and success, the price under the K-ETS is relatively low at 18 USD/Mt CO_2-eq in 2024 compared to 87 USD/Mt CO_2-eq in the EU ETS. The market also lacks liquidity, with limited participation, lower trading volumes and fewer financial instruments. Revenues raised through the K-ETS support climate and energy-related initiatives. These include funds to support GHG mitigation, R&D, adaptation efforts, energy modernisation and households. The allocations for the fourth trading period (2026-30) of the K-ETS will be determined soon. This process will determine the overall cap, which could be aligned with the 2030 target and take the country much of the way to meet its 2030 emissions reduction target. Alternatively, a less ambitious cap could undermine Korea's ability to meet its target. To maximise the efficiency of the ETS and minimise cost, price discovery should be supported with more auctioning and other reforms, and the marginal carbon price needs to pass through fully to all covered entities, including electricity supply.

Carbon price in selected Emissions Trading Systems, 2020-2025



Notes: 2025 data is available until April 2025. EU = European Union; UK = United Kingdom.
Source: IEA analysis based on International Carbon Action Partnership (2025), Allowance Price Explorer (accessed July 2025).

Korea imposes several excise taxes on energy products but does not have an explicit carbon tax. Instead, individual excise taxes are applied, including taxes on liquefied natural gas (LNG) of 10 200 Korean won/tonne (KRW/t; 7.8 USD/t)[2] and coal ranging from 35 500 to 41 600 KRW/t (27.2 to 31.9 USD/t) based on the calorific value of the coal. Tax cuts on LNG and coal for electricity production have been extended several times to help ease the financial strain on power utilities resulting from rising costs. The average fuel excise price was 27 600 KRW/t CO_2-eq (21.13 USD/t) in 2023. Efforts to introduce a carbon tax have faced difficulties, with several proposals failing to gain sufficient parliamentary support in 2013 and 2021. Public sentiment around carbon pricing in Korea remains a significant factor influencing lawmakers.

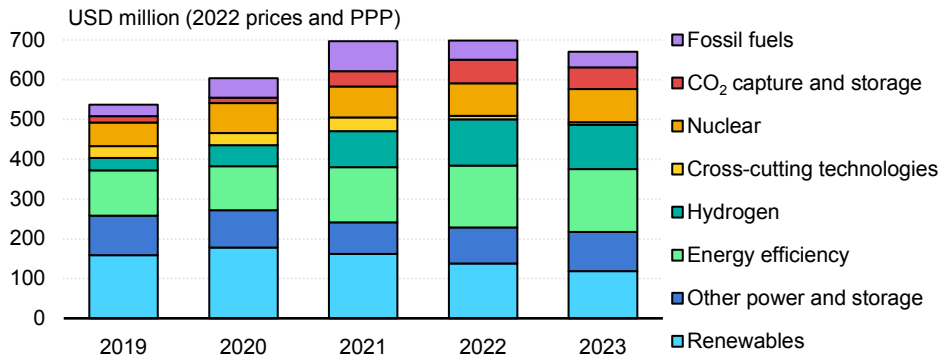
Energy research and development

Technology development in industry and energy will play an important role in achieving carbon neutrality. Guided by the 2021 Carbon Neutral Industry and Energy R&D Strategy, R&D investments are focused on 17 sectors, primarily in industry and energy. The Strategy seeks to accelerate technology development. It is supported by the 2050 Carbon Neutral Energy Technology Roadmap, which specifies 197 energy technologies for investment. The goal is to commercialise these technologies, helping

[2] 1 USD = 1 306 KRW based on OECD average rate in 2023

the electricity and industry sectors to decrease their emissions. Under these initiatives, Korea has increased R&D investment in carbon-neutral technology in recent years. From 2019 to 2023, R&D spending increased by 33%, with a substantial increase in the level of investment in energy efficiency; hydrogen; and carbon capture, utilisation and storage, which saw spending nearly triple.

Total energy-related research, development and demonstration budget in Korea, 2019-2023



Note: PPP = purchasing power parities.
Source: IEA (2025), Energy Technology RD&D Budgets database.

Korea's approach focuses on a series of key technologies and is supported by measures to increase efficiency and reduce energy demand. The key technologies include:

- Solar photovoltaics (PV): development of multi-junction PV cell technology with the goal to exceed silicon PV cell marginal efficiency; low-cost process technology and manufacturing process innovation.
- Wind power: development and demonstration of large-scale offshore wind power; development of floating wind turbines; optimisation of operations and minimisation of environmental impact.
- Nuclear power: development of SMRs with a focus on safety, feasibility and flexibility; production of nuclear hydrogen; systematic management of radioactive waste.

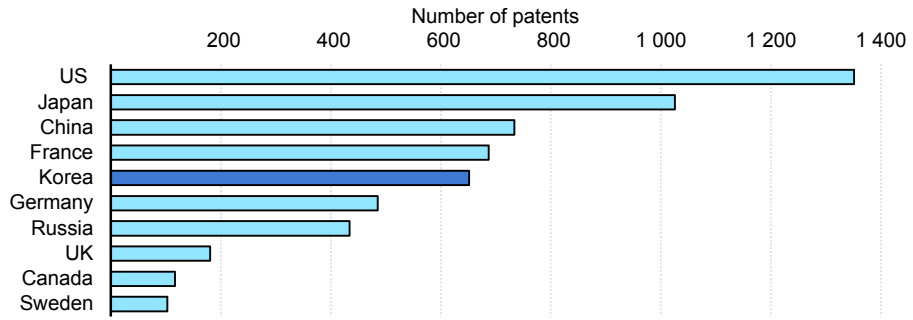
- Hydrogen: commercialisation of high-capacity combined ammonia and hydrogen power generation; secure water electrolysis core technology for low-carbon hydrogen production.
- Carbon capture, utilisation and storage: development for optimal capture technology for each power generation and industrial process; development of low-cost capture technology, storage technology and utilisation technologies.
- Smart grids and battery storage: implementation of power grid with full VRE integration; long-duration energy storage systems to overcome volatility; development of next-generation battery technologies and system integration.

In terms of energy efficiency, the focus is on reducing energy loads in the building sector and improving the efficiency of heating and cooling devices; optimising the use of energy management systems in buildings; and making electric vehicle (EV) charging more convenient. Research efforts also focus on managing energy demand; using energy data to strengthen real-time demand response; using data to promote new energy services; and securing supply and demand flexibility in the distribution system.

Nuclear developments in Korea

Today, 26 reactors with a total of 26 GW of installed capacity provide about one-third of Korea's electricity. The country is a significant player in the industry and exports its technology widely. According to the 11th Basic Plan for Long-term Electricity Supply and Demand, Korea nuclear power could provide at least 30% of electricity in 2030.

Cumulative number of nuclear patents in leading countries, 2000-2023



Notes: Patents are expressed as fractional counts of patents. UK = United Kingdom; US = United States.

Source: IEA (2024), Energy Technology Patents Data Explorer.

R&D efforts in the sector focus on building the country's nuclear technology base to support nuclear exports. In the United Arab Emirates, for example, the Barakah Nuclear Power Plant is being developed by Nawah Energy, a collaboration between the Emirates Nuclear Energy Corporation and KEPCO.

The Korea Atomic Energy Research Institute (KAERI) is the main body responsible for R&D. Its activities include reactor design and nuclear fuel, nuclear safety, radioactive waste management, radiation and radioisotopes application, and basic technology research. Its basic technology research programme includes the development of liquid metal reactors, direct use of spent pressurised water reactor fuel in Candu reactors (DUPIC), application of lasers and research reactor use.

KAERI received a Standard Design Approval for the System-integrated Modular Advanced ReacTor (SMART) SMR from the Nuclear Safety and Security Commission in 2012. SMART uses the same fuel as the current industry standard for similar design water-cooled reactor technologies. Given this, no barriers are expected in the fuel supply chain for this SMR. The 11th BPLE foresees one operational SMR by the mid-2030s. In April 2023, KAERI and the government of Alberta, Canada, signed a memorandum of understanding to develop SMRs, including SMART, for emissions reduction in Alberta.

Skills and competences for the energy transition

The government predicts that Korea could face a shortage of energy professionals as labour demand for trained energy professions increases, especially in the power system, nuclear and renewables sectors. The Ministry of Education is developing strategies and hosting events, such as the Human Capital Development Strategy Meeting, to increase support for science and engineering talent, particularly in the green industries and energy sectors.

Korea has a mid- to long-term strategy for energy workforce development to prepare the workforce for the energy transition. The strategy sets objectives to meet labour demand, develop regional energy industries and create internationally competitive talent. To position the labour force to meet demand, Korea plans to train 20 000 professionals by 2030 for the energy sector. Alongside this effort, the strategy plans to increase the number of graduate school programmes with a focus on energy. To

support the development of regional energy industries, Korea is creating regional labour supply and demand maps. To ensure the development of globally competitive talent, the strategy includes increasing co-operative programmes with international institutions and facilitating short-term employment overseas.

While there is no comprehensive national labour plan tailored to the coal workforce, regional efforts have emerged to support workforce transitions in response to plant closures. In Chungnam Province, for example, where four coal-fired generation units were closed, the regional government developed a plan to support workers, including job retention agreements and local development projects. Specifically, the Province addressed the premature closure of the Boryeong Units 1 and 2, successfully redistributing a large majority of their workers to other active coal or LNG plants.

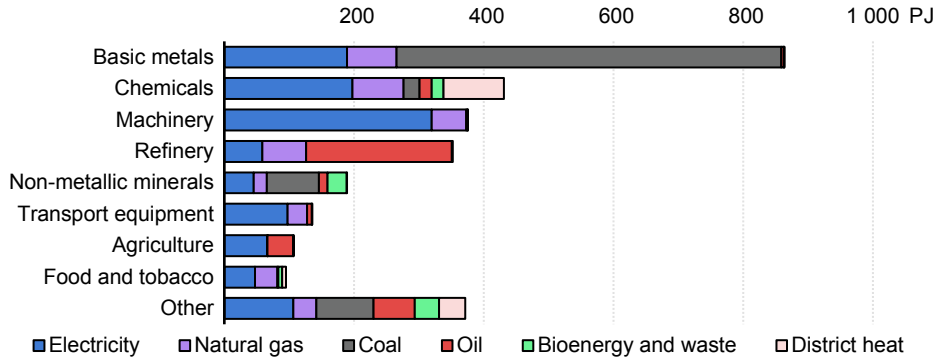
End-use sectors

Industry accounted for the largest share of energy consumption and energy-related emissions in 2023, followed by buildings and transport. When reallocating emissions from electricity generation to each sector, industry was again the largest emitter in 2022, followed by buildings and transport.

Industry

The influence of industry on the country's economy, energy consumption and emissions profile is very significant. Korea has one of the largest shares of industry in GDP (37% in 2022) and total final energy consumption (39%) in the world. With its large manufacturing base, Korea is an export-focused economy, fostered by sectors such as steel, car manufacturing and shipbuilding, electronics, textiles, and petrochemicals. It excels in the production of clean-tech goods such as heat pumps, EV components and batteries. In 2023, the largest industry subsectors by energy consumption were basic metals (31%), chemicals products (14%), machinery (13%) and refineries (12%). The industry sector benefits from relatively low electricity tariffs compared to other IEA countries (134 USD/MWh in 2023, compared to the IEA average of 219 USD/MWh).

Energy use in industry by subsector and fuel in Korea, 2023



Notes: PJ = petajoule. Non-energy used is not included.
Source: IEA (2025), Energy End-uses and Efficiency Indicators.

Korea's economic growth relies on manufacturing sectors, which accounted for 30% of GDP in the second quarter of 2024. Industry's energy intensity, though considerably higher than the IEA average, has declined over the last 20 years. However, some subsectors have either declined at a slower pace or have increased.

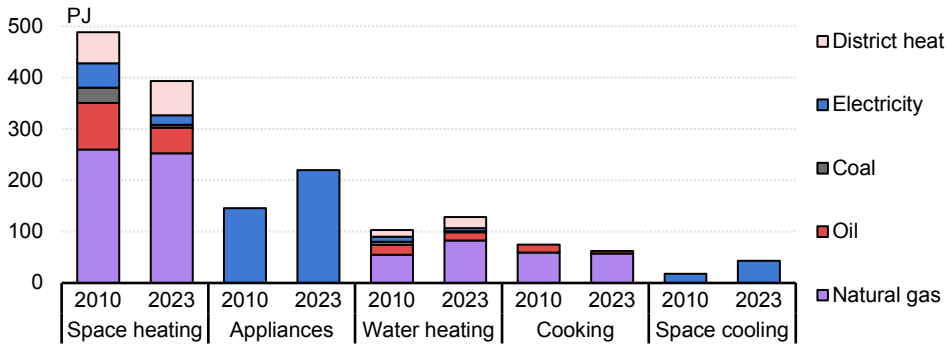
Korea's energy efficiency improvement efforts have focused on firms in energy-intensive sectors. Under the Korea Energy Efficiency Partnership 30, the top 30 energy-consuming companies (accounting for 60% of industry energy use) signed voluntary agreements to achieve a 1% annual energy efficiency improvement from 2023 to 2027. In addition, the Energy Use Rationalisation Act allows Korea to monitor energy intensity in industry, requiring energy-intensive firms to report their annual energy consumption and comply with audits.

The Energy Efficiency Resources Standards is a mandatory energy-saving target initiative for energy suppliers. It began as a pilot project in 2018 with KEPCO and expanded to include the Korean District Heating Corp and the Korea Gas Corporation (KOGAS) in 2019, before full implementation in 2020. It places mandatory energy-saving targets of 1% for electricity by 2031, but the gas and heat sector's energy-saving targets have not yet been determined (in 2024, the saving targets were 0.2% for electricity, 0.02% for gas and 0.15% for heat).

Buildings

Korea is an urbanised society with more than 80% of the population living in urban areas. The stock of buildings is large, with 19.5 million residential units, of which 12.6 million are apartments and 1.4 million non-residential buildings. Around 400 000 new residential units are added each year. Around 45% of the building stock was built in the past 20 years. Ownership is relatively heterogeneous with around 56% of housing owner-occupied.

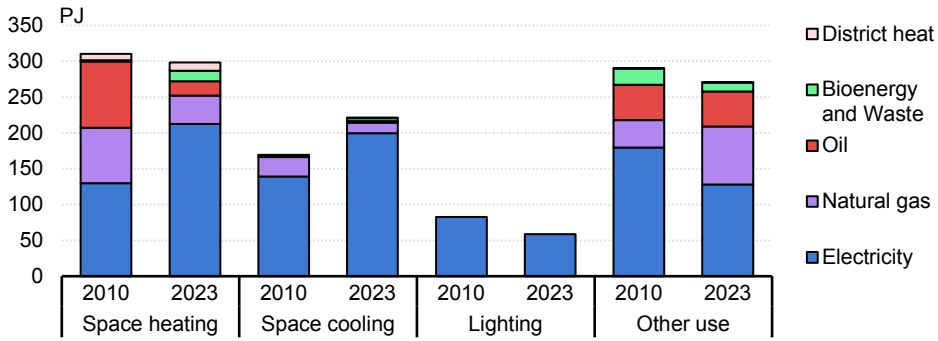
Residential buildings energy consumption by end-use and source in Korea, 2010 and 2023



Note: Biofuels are only used marginally and therefore excluded from the analysis.
Source: IEA (2025), Energy End-uses and Efficiency Indicators.

Buildings accounted for 33% of energy-related CO_2 emissions in 2022, including indirect emissions from electricity and heat used in the sector. Almost a third of the total energy demand is used to heat buildings and supply hot water. Electricity was the largest energy source in buildings in 2023 (51%) followed by natural gas (31%), oil (9%), heat (6%) and bioenergy (1%). Residential buildings accounted for 75% of the energy consumption in buildings in 2022. In residential buildings, space heating accounted for 47% of energy use in 2022, primarily relying on fossil fuels such as natural gas.

Public buildings energy consumption by end-use and source in Korea, 2010 and 2023



Source: IEA (2025), Energy End-uses and Efficiency Indicators.

Korea promoted the development of zero-energy buildings (ZEB) through the implementation of certifications under the Green Buildings Construction Support Act. Buildings are rated based on their overall primary energy demand, the existence of an energy management system and the independence rate with the use of renewable energy. Public sector buildings with a floor area of 500 m² or more are required to obtain a ZEB certification since 2020. The private sector will be subject to stricter design standards for buildings with a floor area of 1 000 m² and more starting in 2025. In 2020, Korea introduced a Roadmap for Mandatory Net Zero Energy Buildings, planning for a phased implementation of new standards, starting initially with publicly owned buildings. Since then, the government worked to increase the adoption of ZEBs across the residential, commercial and public sectors by means of ongoing reinforcement and early implementation of the ZEB roadmap.

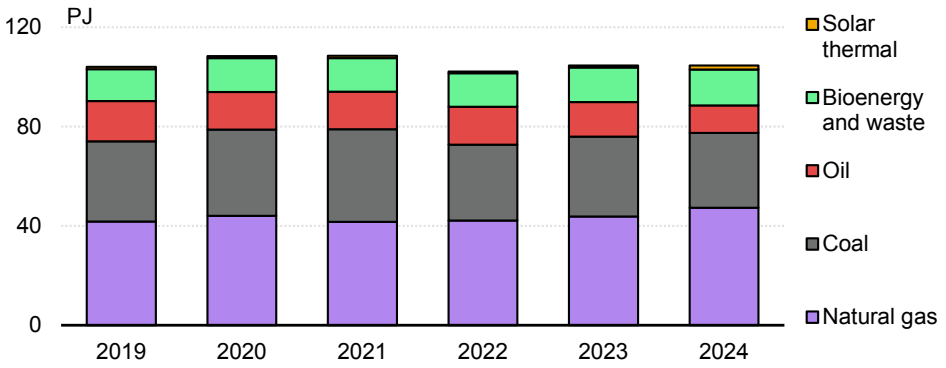
Korea also introduced a comprehensive programme for the existing building stock with the introduction of a GHG target management system and special measures for the public sector. The objective of GHG target management system in buildings is to target buildings that exceed a predetermined emissions level. Since March 2023, the emissions threshold for corporate entities is 50 000 t CO_2-eq or 15 000 t CO_2-eq per facility.

Regulations on the Rationalization of Energy Use by Public Institutions encourage the efficient use of energy, reduce GHG emissions, and promote the use of new and renewable energy in buildings owned by public institutions. The law provides for buildings energy management systems, energy diagnosis systems, and the use of high-efficiency equipment in new buildings or the expansion of existing ones. Buildings energy management systems are required in all new buildings or the expansion of existing ones of 10 000 m² or more. Installation must be certified by the Korea Energy Agency. Public institutions greater than 3 000 m² are subject to a mandatory energy diagnosis as energy-intensive buildings. Publicly owned buildings are required to replace existing indoor and outdoor lighting systems with LEDs, operate high-efficiency (Grade 1) appliances and equipment, maintain indoor temperature standards, and establish seasonal energy-saving measures.

District heating and cooling

Currently, around one-fifth of households, mainly in urban areas, have access to district heating. The district heating industry in Korea commenced as a government-led initiative in the 1980s, targeting major cities such as Seoul and Busan, with implementation through publicly owned companies. In the 2000s, the market opened to the private sector, attracting interest from service providers such as GS Power. By the end of 2022, there were a total of 34 operators in the sector, providing heat to 3.7 million households. District heat is largely generated from fossil fuels (natural gas, coal and oil) and to a lesser extent from bioenergy. Several policies support the development of district heating. The Integrated Energy Supply Act mandates developers to consult and execute feasibility studies for publicly funded housing projects of more than 10 000 units or a development area of over 600 000 m². The Act mandates that housing construction projects meeting certain criteria be designated as areas requiring the use of integrated energy systems, which include district heating and cooling. By the end of 2022, almost 180 housing projects were designated under this Act, providing a stable business model for district heating providers by granting them exclusive supply rights within these designated areas. Designation guarantees a stable business model for district heating providers by granting monopoly supply rights within the designated area. To create summer heat demand for district heating, mandatory use of district cooling is applied under certain conditions. District heating prices are regulated: the Heat Rate Cap System determines the upper limit of district heating rates at 110% of the market reference price.

District heating fuel sources for buildings in Korea, 2019-2024



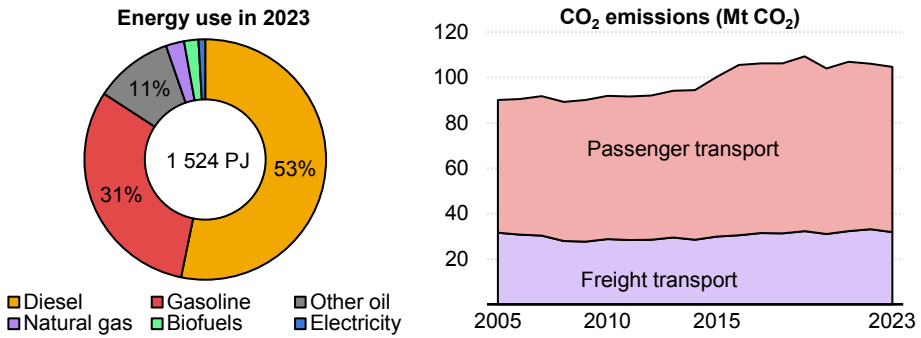
Source: IEA (2025), World Energy Balances.

Transport

The transport sector is almost entirely dependent on fossil fuels. It is the third-largest emitting sector (22% of energy-related GHG emissions in 2022), while accounting for 29% of total final energy consumption in 2023. Road transport accounted for 94% of emissions from the transport sector in 2022.

Korea's first National Basic Plan for Carbon Neutrality and Green Growth mandates a 38% reduction in transport-related emissions by 2030, compared to 2018 levels. To achieve this, the Plan sets an ambitious target of having 4.5 million electric and hydrogen vehicles on the road by 2030, supported by mandatory public sector purchases. To meet its 2050 net zero target, Korea will need to reduce GHG emissions by over 91% by 2050. Since road transport accounts for the largest share of emissions, it must achieve a 92% reduction compared to 2018 levels. Measures for achieving this target would require a 15% reduction in passenger traffic and the electrification of 85% of road vehicles.

Transport sector energy use by fuel (2023) and emissions in Korea (2005-2023)



Sources: IEA (2025), World Energy Balances; IEA (2025), End-uses and Efficiency Indicators.

Starting in 2011, the government implemented the Act on the Promotion of Development and Distribution of Environment-friendly Vehicles. Its purpose is to continuously advance the adoption and development of fully electric, hybrid and hydrogen-powered vehicles, with specific targets set and updated periodically. To reduce emissions from the sector, the Fourth Master Plan for Eco-Friendly Cars (2021-2025) focuses on several key strategies: introducing a green vehicle purchase target for large-scale fleet operators, expanding the EV fleet, and increasing the installation of EV chargers in residential areas and workplaces.

In 2024, Korea introduced a fuel efficiency and emissions grading system for vehicles to guide consumers to the most efficient option. Manufacturers of both passenger and freight vehicles and trucks are required to comply with the targets, which includes increasing fuel efficiency (kilometres per litre [km/L]) and decreasing emissions (g CO_2/km) until 2030.

Energy economy labelling for road vehicles in Korea, kilometres per litre

	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Internal combustion engine	> 16 km/L	15.9-13.8 km/L	13.7-11.6 km/L	11.5-9.4 km/L	< 9.3 km/L
Electric vehicle	> 5.8 km/kWh	5.7-5.0 km/kWh	4.9-4.2 km/kWh	4.1-3.4 km/kWh	< 3.3 km/kWh

Note: Light vehicles under ≤ 1,000 cc or ≤ 15 kW, with a maximum size of 3.6 × 1.5 × 2 m as defined the Automobile Management Act, plug-in hybrids, and hydrogen electric vehicles are excluded from the labelling obligation. However, to be classified as eco-friendly cars, they still have to meet efficiency standards defined in Act on the Promotion of Environmentally Friendly Automobiles.
Sources: Korea, Ministry of Trade, Industry, and Energy (2023), Regulation on the Energy Consumption Efficiency and Rating of Automobiles (accessed July 2025).

Prices for diesel are lower than the OECD average, whereas gasoline prices are higher. The fuel taxes levied on diesel are the transportation, energy and environment tax (around 50% of the tax component); the education tax (whose revenue is earmarked for education); and the motor fuel tax (whose revenue is earmarked for fuel subsidies). Premium gasoline is subject to the same taxes, as well as sales charges. The Transportation, Energy and Environment Tax Law was established by presidential decree and revenue is earmarked for energy and transportation infrastructure. During the 2022 energy crisis, the government reduced fuel taxes to alleviate inflation and implemented tax cuts on automotive fuels to support its citizens. With its centralised manufacturing industrial structure, transportation costs also have a knock-on effect on the economy. Korea repeatedly extended its fuel tax reductions with the latest extension to October 2025.

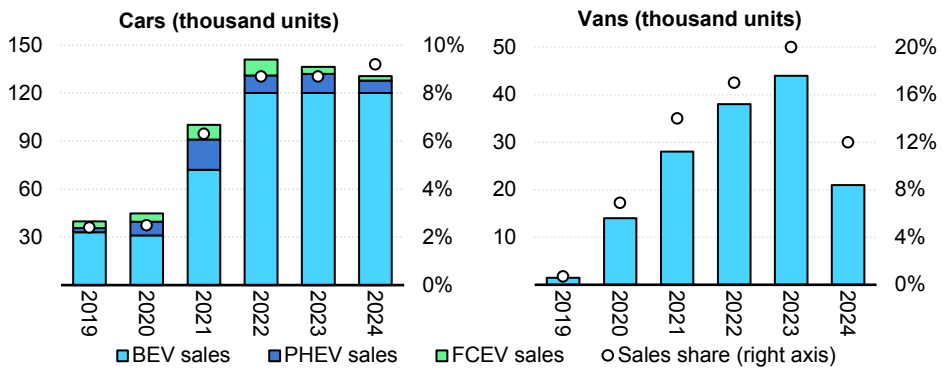
Korea's approach to electric vehicle deployment

Korea lags many IEA countries in terms of the uptake of EVs. Nonetheless, it continues to achieve growth through sustained investment. Korea is also dedicated to developing the hydrogen vehicle market and has to date demonstrated strong growth in this market.

In 2024, the share of EVs in Korea's total passenger fleet was only 2.8% and the share of EVs in vehicle sales was 9.2% (8.7% in 2023). The same year, the global share of EVs in the fleet was 4.5% and in sales 22%. Korea is the only country where the sales share of electric light commercial vehicles (12%) is higher than that of electric passenger cars. The light commercial vehicles, produced and sold locally, satisfy the features of Korean light-freight market, typically covering short distances. As Korea is one of the world's most densely populated countries and most people live in multi-unit dwellings, charging infrastructure is limited, and EV owners rely more heavily on publicly-owned charging points. Korea has one of the highest ratios of public charging capacity to EVs in the world.

The country is a dominant player in the global market for hydrogen-fuelled vehicles. In 2023, Korea alone accounted for 40% of all fuel cell electric vehicles (FCEVs) in the world, with a relatively large passenger car fleet (36 000 units), and around 180 hydrogen refuelling stations. In May 2024, the government increased support to hydrogen refuelling station operators in response to rising hydrogen prices. In addition to expanding the fleet of hydrogen passenger vehicles, Korea's hydrogen roadmap seeks to extend the application of hydrogen technology to other transportation sectors. The roadmap targets the deployment of 80 000 hydrogen taxis, 40 000 hydrogen buses and 30 000 hydrogen freight trucks by 2040. Furthermore, the country places a strong emphasis on the important role of R&D advances.

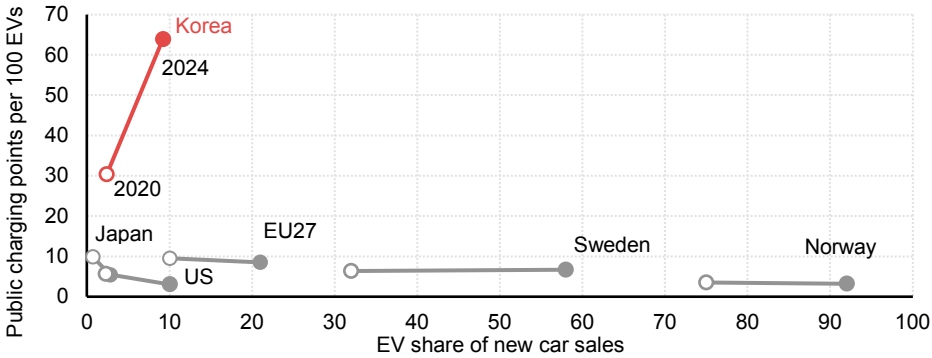
Electric and fuel cell car and van sales in Korea, 2019-2024



Note: BEV = battery electric vehicles; PHEV = plug-in hybrid electric vehicle; FCEV = fuel cell electric vehicle.

Source: IEA (2025), Global EV Data Explorer.

Number of public electric vehicle chargers vs. the share of electric vehicles in new car sales in selected countries, 2020 and 2024



Note: Electric vehicles (EVs) include battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs).
Source: IEA (2025), Global EV Data Explorer.

Policies supporting cleaner vehicles

Despite the strong focus on hydrogen-fuelled vehicles, Korea also promotes the use of EVs. The Ministry of Environment provides a variety of subsidies for battery electric vehicles and FCEV purchases based on the vehicle's size and overall performance. The subsidy programme is reviewed annually to align with evolving environmental policies and increasing demand for EV incentives. Subsidies and tax exemptions accelerated EV adoption by narrowing the cost gap with internal combustion engine vehicles. In 2023, the Ministry of Environment announced a plan to reform the EV subsidies programme. The support schemes contributed to the purchase of more than 167 000 EVs in 2023. As the number of EVs continues to grow, the support schemes aim to address not only the financial aspects of purchasing EVs but also provide post-purchase advantages to EV owners, assist in safety and risk-mitigation measures, and support R&D. Subsidies and tax reductions are provided at the purchasing stage. During ownership, the government assists with infrastructure development, such as building and developing charging stations.

The Ministry of Environment's expenditure on low-emission vehicles has been on the rise since 2019. In 2023, it allocated KRW 2.6 trillion (USD 2 billion) for purchase subsidies and KRW 0.5 trillion (USD 380 million) for charging infrastructure

development, which together represented 25% of the Ministry's total budget of KRW 13.5 trillion (USD 10.3 billion). In 2024, the government revealed plans to reduce the unit price for EV subsidies for 2025, redirecting funds to improve inadequate charging infrastructure. Funding decreased to KRW 2.4 trillion (USD 1.8 billion) in 2024. Under the 2024 Electric Vehicle Subsidy Revision, Korea committed KRW 1.7 trillion (USD 1.3 billion) in subsidies, with 55% allocated to light-duty passenger vehicles, 8% to heavy-duty buses, 37% to light- and medium-duty commercial vehicles, and the remainder to two-wheeled vehicles. The amount of subsidy for each vehicle class is based on various factors, including battery efficiency, recyclability, operational and maintenance support, and overall vehicle cost. Moreover, industrial policy played an important role in offering liquidity support and loan guarantees to domestic manufacturers such as Hyundai and KIA. Korea aims to install 521 500 slow chargers and 69 000 fast chargers by 2025, along with 450 hydrogen refuelling stations, with a long-term goal of reaching 1 200 hydrogen stations by 2040.

International shipping activities fuel the Korean economy

Korea ranks second in energy consumption for international shipping among IEA countries, behind the United States. Energy consumption in international shipping increased at a pace similar to GDP over the last decade, accounting for around 450 PJ in 2023. Trade is a key driver of Korea's economy. Exports of automobiles, semiconductors and petrochemicals continue to shape Korea's economy. Conversely, Korea meets nearly all its energy needs through imports. LNG and crude oil are transported by tanker to Korea. This combination of an export-oriented economy and a high dependency on imported energy commodities results in significant international shipping activity. Vessels and tankers to transport cargo or commodities are generally fuelled by heavy fuel oil. Scaling-up low-emission fuels will play an important role in decarbonising international shipping. Korea plays an active role in designing low-emission bunkering ships and ammonia-powered vessels to transport liquefied petroleum gas (LPG) and ammonia.

Electricity

Korea projects strong growth in electricity demand and electrification over the coming decades. Electrification of buildings, transportation and industry combined with a growing demand for air conditioners and data centres is ushering a shift toward an economy with electricity as its foundation. Investments in new sources of electricity

supply and in resilient network infrastructure backed by a market that rewards investment in capacity and flexibility will be needed.

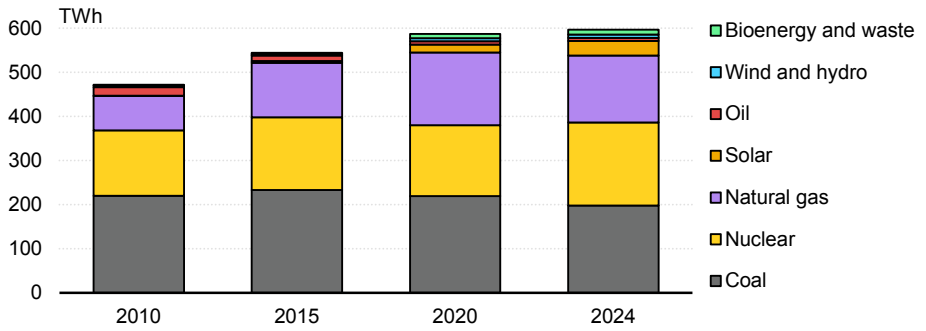
State-owned KEPCO is the dominant player in all segments of the electricity sector. It owns 100% of six nuclear and thermal generation companies, accounting for about 60% of electricity capacity. Since 2001, privately-owned generating companies can enter the market. KEPCO is the owner of the Korean electricity transmission and distribution systems, the only operator of the distribution system, and the sole electricity retailer in the country.

KOREC, the electricity market regulator, was established in 2001 under MOTIE to oversee the single-buyer market, review electricity consumer rights and settle disputes. The Electricity Market Surveillance Committee monitors the market under KOREC's supervision. Although KOREC has enforcement functions, its role is mainly advisory, while the Korea Fair Trade Commission is responsible for monitoring monopoly behaviour and unfair business practices.

Electricity and heat generation is carbon-intensive

Coal and natural gas account for 58% of electricity generation in Korea. Generation from coal was around 200 terawatt hours (TWh) in 2024 while generation from gas nearly doubled since 2010 to reach around 150 TWh in 2024. Nuclear generated 189 TWh in 2024, or 31% of the electricity mix. The share of renewables in electricity generation increased from 4.7% in 2019 to 8.6% in 2024, driven by solar PV output, which almost tripled.

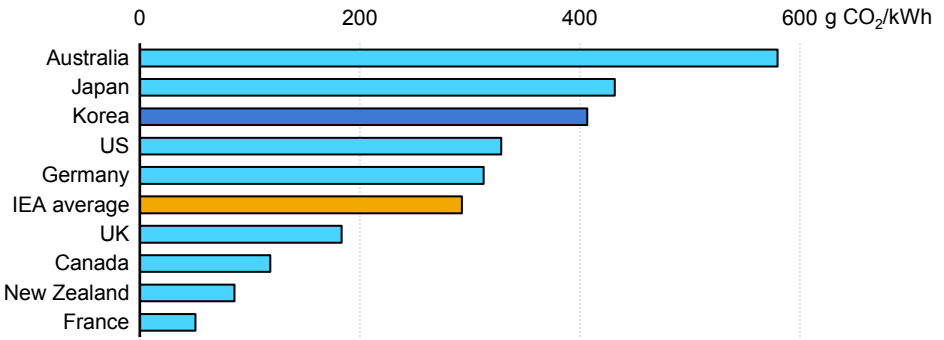
Electricity generation in Korea, 2010-2024



Source: IEA (2025), World Energy Balances.

Korea's high share of fossil fuels and low share of renewables makes electricity generation carbon-intensive, despite the large nuclear fleet. Korea's renewable energy expansion efforts accelerated in recent years and the installed capacity of renewables in 2024 was more than four times greater than in 2015, demonstrating strong growth. Despite the fact that the share of renewables in the power generation mix remains below the IEA average, this growth trend indicates strong potential for future carbon reductions and the energy transition. Nonetheless, in line with the 11th BPLE, carbon-free energy sources such as renewable energy, hydrogen and nuclear power are projected to reach 70% of total power generation by 2038.

Carbon intensity of electricity and heat generation in selected countries and IEA average, 2023



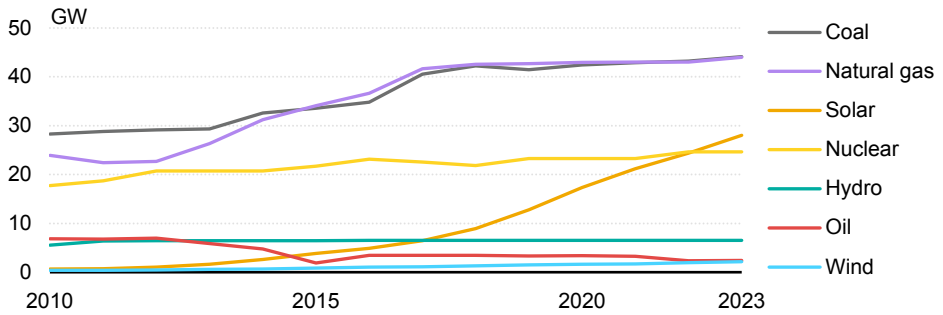
Note: US = United States; UK = United Kingdom.
Source: IEA (2024), Emissions Factors.

Electricity consumption reached around 550 TWh in 2024 This represents an increase of 12% over the decade driven by the growing consumption in industry. Industry is also the main consumer of electricity, with close to half of total consumption, followed by public and residential buildings.

Renewables grew significantly, albeit from a low base

Korea's electricity generation fleet increased by 70% in the past decade, reaching 154 GW in 2023, and is among the largest in the IEA. With around 23 GW of new capacity, solar PV accounts for most of the capacity growth. Coal and natural gas added a significant amount of capacity, almost 15 GW and 18 GW respectively. Peak load was 97 GW in 2024.

Electricity capacity in Korea, 2010-2023



Source: IEA (2025), Electricity Information.

Electricity generation from renewables increased significantly from almost 11 TWh in 2015 to 52 TWh in 2024. The increase is led by growing solar PV (accounting for 33 TWh in 2024). Nonetheless, the share of renewables in electricity in Korea was the lowest among IEA countries, at 8.6% (5.5% solar, 1.8% bioenergy, 0.6% wind and 0.7% hydro) compared to the IEA average of 33% (and 24% in Japan). The low share is partly explained by the scarcity of available land. In 2023, Korea's installed solar PV capacity per non-forested land area was very high (around 780 kW/km^2), slightly lower than Japan (around 800 kW/m^2), but much higher than many other countries (less than 100 kW/m^2 in Brazil, China, India, the United Kingdom and the United States). The 11th BPLE seeks to increase renewables to 29%, or 206 TWh, of power generation in 2038.

Renewable energy certificates drive the solar expansion

A renewable portfolio standard replaced a feed-in tariff system in 2012. The renewable portfolio standard mandates producers with installed capacity greater than 500 megawatts (MW) to produce electricity from a minimum share of new and renewable energy sources or buy renewable energy certificates from other producers. The mandatory share started at 2% in 2012 and increased to 13.5% in 2024. It is set to further increase to 25% in 2030. However, the target values have changed over time; the share for 2024 increased to 17% in 2022 only to be pushed back to 13.5% one year later. The 25% share was initially for 2026 but was pushed back to 2030. Renewable energy certificates are weighted depending on various economic,

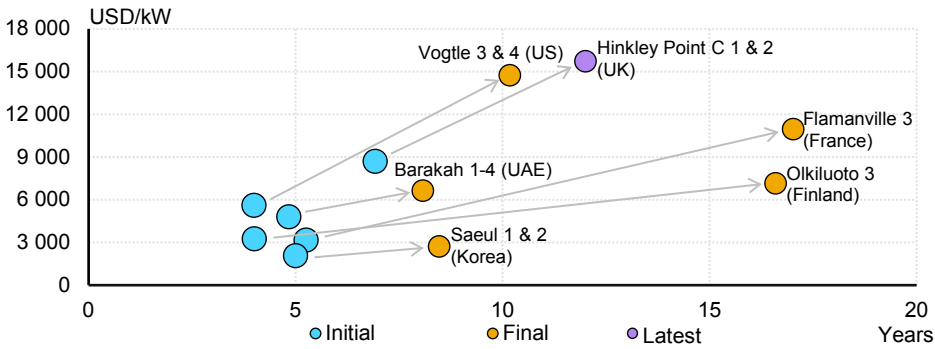
environmental, technological and policy factors (e.g. generation cost, GHG emissions reduction, potential system effects, public acceptance, etc.).

In 2022, total installed wind capacity in Korea was 2.4 GW, all onshore. The 11th BPLE targets total wind capacity of 18.3 GW by 2030 and 40.7 GW by 2038. To support these targets, in August 2024 the Korean government announced a roadmap of auctions for the supply of offshore wind power. According to the roadmap, auctions from the second half of 2024 to 2026 would procure 7-8 GW of offshore wind capacity. In 2024, a tender allocated 1.9 GW of offshore wind capacity, an increase from 1.4 GW procured in 2023.

Nuclear is one of the pillars of the electricity system

The nuclear reactor fleet comprised of 26 units in 2024, following the commissioning of a 1.4 GW Shin Hanul 2 reactor. Future capacity additions include 2.8 GW of large nuclear reactors (two 1.4 GW units) by 2038 and a 0.7 GW SMR operational by 2035. The 11th BPLE targets an increase in the share of nuclear in electricity generation to 35.2% of power generation by 2038.

Initial and latest capital cost estimates and construction time for selected recent nuclear projects



Source: IEA (2025), The Path to a New Era for Nuclear Energy.

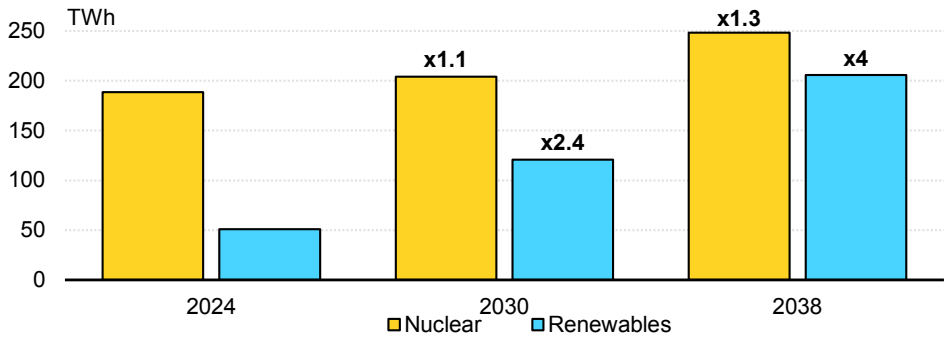
Nuclear power plant construction times vary widely across countries and regions. Even in Korea, where most nuclear reactors took four to six years to build, the last

three reactors took ten years each to complete. In advanced economies, most recent projects have been plagued by substantial delays and cost overruns. Nonetheless, Korea's recent nuclear projects have been completed with relatively moderate delays and limited cost overruns. Saeul 1 and 2 reactors, for example, became operational after a two- and five-year delay, respectively. Construction costs increased by about 30% compared with initial estimates, with cost per capacity reaching 2 700 USD/kW. Similarly, the Korean-built Barakah nuclear power plant in the United Arab Emirates was completed with delays comparable to those experienced by Saeul 1 and 2, while incurring limited cost overruns. Korea is also one of the few global manufacturers and exporters of nuclear reactors.

Korea's long-term strategy for the power sector

KEPCO is responsible for developing the Long-term Transmission and Substation Plan (TSP) every two years for a 15-year period. This is done in accordance with the Electric Utility Act (Articles 25 and 27) and the guidelines specified in the BPLE. Planning encompasses the expansion standards for transmission and distribution systems and aligning the generation mix set out in the BPLE with the power system and ensuring a stable supply of electricity demand. Planning is approved by the KEPCO board and overseen by KOREC. The 11th TSP covers the period 2024-38.

Nuclear and renewables generation (2024) and targets (2030 and 2038) in Korea



Sources: IEA (2025), World Energy Balances; Korea, Ministry of Trade, Industry, and Energy (2025), 11th Basic Plan for Long-term Supply & Demand (accessed May 2025).

Peak electricity demand is forecast to grow to 129.3 GW in 2038, driven by economic and population growth, industry electrification, and the impact of climate change (such as average temperature increases). Electricity demand from the semiconductor industry and data centres is expected to more than double from 2023 to 2030. Based on this demand, the 11th BPLE computes the required supply using a capacity reserve margin (20% until 2028, 21% from 2029 to 2032, and 22% from 2033 to 2038) and sets a target capacity of 158 GW in 2038.

The projected electricity generation mix for 2038 reflects the plans to increase the share of low-emission sources (nuclear, renewables and hydrogen will account for 70% of electricity generation, from 40% in 2023) while maintaining the focus on the security of supply. In 2030, renewables are expected to account for around 19% and hydrogen/ammonia for 2.4%. Two coal power plants (Samcheok 1 and 2) are the last ones in the BPLE construction pipeline. Coal assets are expected to either close or be converted to hydrogen combined-cycle gas turbines in the longer term. Coal use is expected to be phased out by 2050.

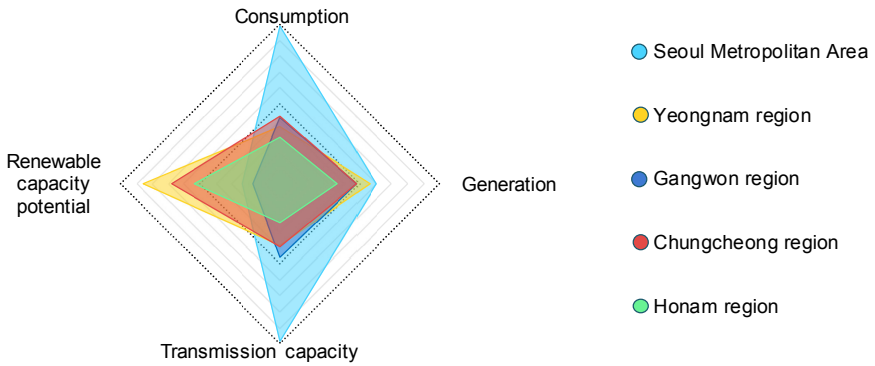
Large-scale transmission lines connect demand and generation centres

Electricity transmission transports electricity from electricity production sites to demand centres. Most demand is currently concentrated in the north-west Gyeonggi region, where Seoul is located. At the same time, generation is located along the west and south coasts, requiring electricity to be transported across the country. The greatest potential for renewables development is concentrated in the southern part of the country, enhancing possible grid constraints. In response to the excessive concentration of electricity demand in the Seoul Metropolitan Area, the Korean government enacted the Special Act on the Promotion of Distributed Energy. Based on this legislation, the government is designing a range of policies to promote localised energy production and consumption at the regional level. The BPLE provides an outlook for long-term electricity demand, which is matched with expected renewable energy generation to identify needed expansion of the transmission grid. The TSP maps the expected transmission expansions. KEPCO released the tenth TSP in 2023.

Delays to transmission projects are not unusual. The Dongducheon-Yangju line in the Seoul Metropolitan Area, for example, was initially expected to be ready by 2019 in the sixth TSP, but delivery was postponed to 2022 with the ninth plan and to December 2024 in the tenth plan. Opposition from local communities is among the

main causes for project delays. To address persistent delays in transmission grid development, the Korean government enacted a Special Act for National Power Grid Expansion. This legislation is expected to play a key role in facilitating the timely development of power infrastructure by resolving permitting delays and mediating local conflicts related to grid expansion.

Electricity patterns across selected categories in different regions in Korea



Note: Consumption, generation and transmission capacity are based on 2023 values.

Sources: IEA analysis based on Aurora Energy Research (2024), Opportunities and Challenges in the Korean Energy Market (accessed February 2025); Electric Power Statistics Information System (2024), Substation facilities by region (accessed February 2025).

Electricity market design

Korea is an isolated electricity system without any cross-border electricity interconnections. It is thus fully self-sufficient in terms of electricity generation. This impacts its electricity market design, as it has no need to interface with other electricity markets. The independent system operator is Korea Power Exchange, operating under MCEE; it is independent from the electricity utility KEPCO, which is partially state-owned.

The wholesale market was established in 2001 as part of the government's early efforts to reform the electricity market. Today, around 7 000 generators, the transmission and distribution companies, retailers, and eight district electricity

businesses participate in the market. Market participants trade around a cost-based pool on a single day-ahead market. Innovations such as a real-time markets and ancillary services markets are planned. The market operates under a cost-based system, where the system marginal price reflects the operators' operating costs. Generators submit their variable costs monthly and the hourly price is determined on the day-ahead, according to the marginal unit needed to satisfy the system demand. The system marginal price is frequently set by LNG-fired plants (more than 90% of times in 2024).

This type of market design is not sending the correct price signals to support the energy transition. Instead, it tends to distribute higher profits to technologies with lower fuel costs and higher emissions, for example coal-fired generation. With the 11th BPLE, the wholesale electricity market will undergo a reorganisation and transition to a price-bidding model, with a two-way bidding system, where both supply and demand sides submit bids. Other new features include the creation of a dedicated low-carbon electricity central contract market or forward market, and the introduction of real-time and ancillary service markets.

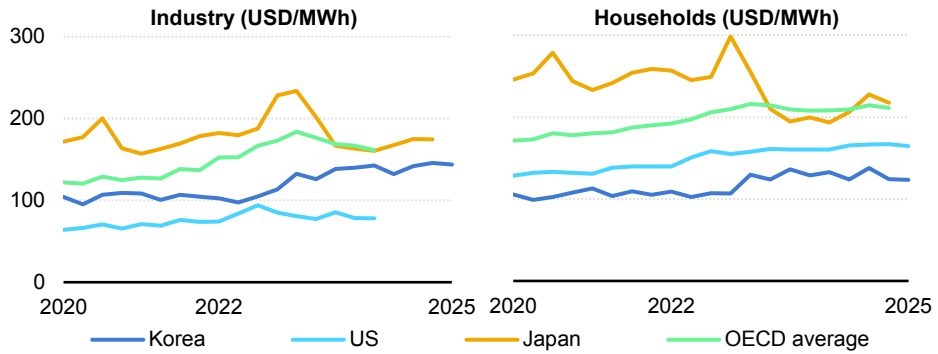
The K-ETS carbon price is only partially passed on in the cost of electricity. While the ETS cost is partly included in the cost of generation through the "environmental dispatch" component, it is currently mostly compensated by Korea Power Exchange by means of the retail tariffs. The inclusion of a sufficiently high carbon cost into generators' variable cost can shift the merit order for dispatch, resulting in a reduction of emissions, as lower emission technologies are dispatched more.

Several market reforms are expected in the coming years. The government plans to introduce changes to the electricity market to help manage VRE sources and ensure electricity security of supply. The government's New Energy Policy of 2022 supports reform of the electricity market based on the principles of competition and fairness, and the establishment of cost-based electricity tariffs. The government plans to shift from the current renewable portfolio standard to more direct auctions, introduce a real-time energy market, a renewable bidding system and zonal pricing. Many of these reforms are being tested on Jeju Island, with notable effects such as significantly lower day-ahead prices attributable to renewables bidding directly into the market.

Retail prices and affordability

Electricity tariffs differ based on the customer category. There are seven categories of use: residential, general commercial, educational, industrial, agricultural, street lighting and midnight power. Korea has a time-of-use pricing system, where tariffs vary based on the hour and the season, incentivising off-peak electricity consumption. Voltage and rate classification also influence tariffs.

Retail electricity prices by quarter in Korea, 2020-2025



Notes: Not all countries' data are available until Q1 2025. US = United States.
Source: IEA (2025), Energy Prices.

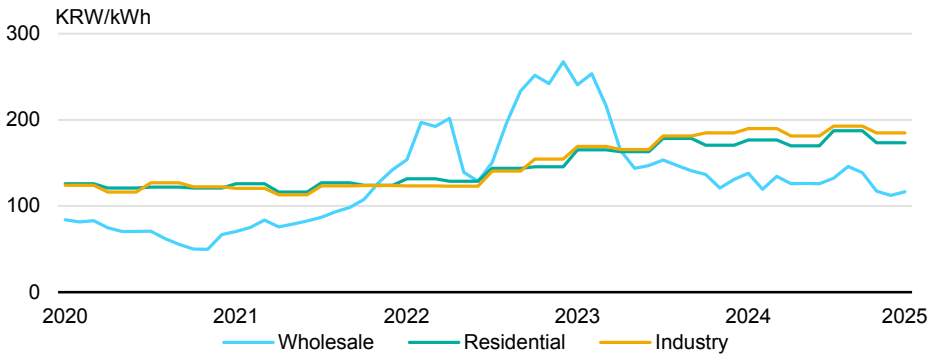
Electricity prices are highly susceptible to global energy shocks. Korea's reliance on imported fossil fuels for electricity generation – notably natural gas, which sets the marginal price in the wholesale market most of the time – contributed to surging prices in the aftermath of the 2022 energy crisis. During the same period, demand spiked further as North Asia experienced an exceptionally cold winter, with temperatures in Seoul reaching their lowest in 35 years, further exacerbating the price increases. Political discourse focused on high prices and affordability, reflecting global trends.

Despite these recent increases, electricity prices in Korea, both for households and industry, are lower than the IEA average. This disparity is largely attributable to government intervention in the electricity market. In 2023, the electricity price for households was 130 USD/MWh, lower than the OECD average of 220 USD/MWh

and much lower than OECD Europe at 322 USD/MWh. Prices for industry were also among the lowest in the OECD, at 122 USD/MWh in 2023, lower than the OECD average of 164 USD/MWh.

The existing market structure design could cause distortions and inefficiencies. KEPCO maintains an extensive presence along the electricity supply chain. Furthermore, the regulated pricing mechanism enables the government to keep electricity prices low, limiting market-driven price signals. In the aftermath of the energy crisis, and to combat inflation and shield consumers from the full effect of rising fossil fuel costs, the government decided to maintain low consumer prices.

Wholesale and retail electricity prices in Korea, 2020-2025



Note: Data is available until the end of December 2024.

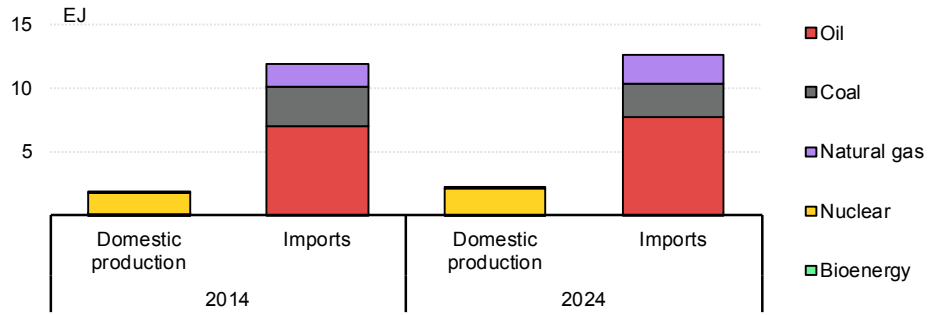
Sources: IEA analysis based on IEA (2025), Energy Prices; EPSIS (2025), Hourly System Marginal Price (accessed May 2025).

While consumers benefit from stable and low electricity prices, KEPCO faces strong financial headwinds. Volatile energy markets caused wholesale energy price fluctuations resulting in higher wholesale prices. KEPCO faced large costs in meeting the demand for energy but was unable to recover much of these energy costs from end users. As a result, it absorbed significant costs, resulting in large financial deficits. In response, KEPCO issued more government-backed bonds, saw its credit rating downgraded and is selling off parts of its business. KEPCO's debt amounted to KRW 202.5 trillion in 2023 (USD 155.1 billion).

Fuels

Geography and the structure of energy supply make Korea particularly vulnerable to external energy security threats. Most of its energy supply is provided by fossil fuels, the vast majority of which are imported. Korea's reliance on fossil fuels decreased slightly over the past decade. In 2012, fossil fuels accounted for 83% of total energy supply (TES). In 2023, this share remained high (78%). Oil remains the predominant fossil fuel, representing 35% of TES, largely resulting from its extensive use in the transport sector and in the country's large oil refineries. Coal, accounting for 24% of TES, is primarily used in electricity generation and by energy-intensive industries. Natural gas makes up 19% of TES, and is used in electricity generation, industry and building sectors.

Domestic fuel production and imports in Korea, 2014 and 2024



Note: EJ = exajoule.
Source: IEA (2025), World Energy Balances.

Oil

With a refining capacity of 3.5 million barrels per day, Korea is the fifth-largest refiner by capacity globally. Petroleum products such as gasoline, diesel and jet fuel are exported, owing to production exceeding domestic demand, while naphtha and LPG are imported. The Daehan Oil Pipeline Corporation is Korea's sole petroleum pipeline company and the key infrastructure operator. It manages an oil product pipeline network of 1 116 km, linking refineries to major demand centres and airports. Ownership of the Daehan Oil Pipeline Corporation is shared among the four major

refineries (85%), the government (9.8%), Korean Air (3.1%) and Hanwha Total Energies Petrochemical (2.3%). Although the pipelines are primarily used by these companies, access by third parties other than shareholders is permitted in principle.

Korea imports all crude oil supplies. In terms of energy use, transport is the largest oil consumer, but oil used as a feedstock in the chemical and petrochemical industry exceeds transport's oil demand. International bunkers accounted for 15% of total demand in 2023. There has been no domestic oil production since 2023 and in the absence of cross-border pipelines, the country is reliant on tanker shipments. Crude oil imports mainly come from the Middle East, with Saudi Arabia being the main source (33% in 2023), but Korea is making strong efforts to diversify import sources. Since 2018, the United States increased in importance as an importing partner.

Natural gas

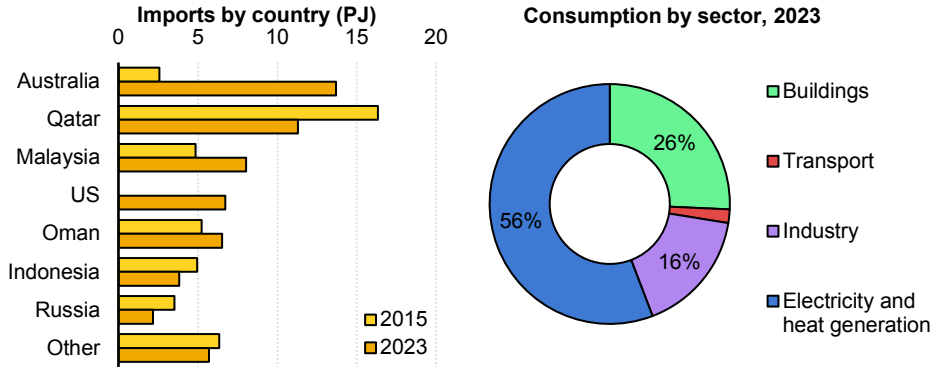
KOGAS, a state-owned wholesale business entity, imports LNG with government approval. KOGAS, the world's second-largest single buyer of LNG, imports gas exclusively as LNG given the lack of gas pipeline connections with other countries. Other direct importers report to the government once they purchase LNG for power generation and industrial use. In principle, privately-owned operators are allowed to purchase gas for private use, and not to resell in the market.

KOGAS sells natural gas to city gas companies and power generation companies as a wholesale business while the city gas companies sell to their own regional customers. KOGAS builds and operates the gas transmission network. Distribution pipelines may be constructed, owned and operated by local city gas companies. A direct importer who is not a city gas business operator may construct its own pipelines for self-consumption or jointly use KOGAS' pipelines within the facility capacity. Storage facilities owned by KOGAS or a direct importer can be used jointly with commercial agreement between the facility owner and the user. In recent years, the volume of directly imported LNG and privately-owned LNG infrastructure investments (storage and regasification units) increased. In 2023, more than 20 privately-owned companies accounted for around one-fifth of LNG imports.

In addition to electricity and heat generation, natural gas is also used in buildings (25%) and industry (16%). Consumption and imports of natural gas have increased in recent years, with total imports growing by 39% from 2015 to 2022. In 2024, natural gas imports increased by 5% compared to the previous year. Korea has no domestic

natural gas production. It relies on imports mostly from Qatar, Australia, Malaysia and the United States. The government and KOGAS control Korea's natural gas emergency reserves.

LNG imports by country (2015 and 2023) and consumption by sector in Korea (2023)



Note: US = United States.
Source: IEA (2025), Natural Gas Information.

Coal

Korea relies on coal for around one-third of its electricity generation – a share that has decreased from 48% at its peak in 2009. Almost all coal is imported from Australia (31% of imports), Russia (22%) and Indonesia (22%). Domestic mining accounted for only 0.4% of total supply in 2023. There is a national plan to phase out coal use in the long-term: increased use of nuclear power and renewable energy will see the capacity of coal-fired power plants falling from around 39 GW in 2023 to 22 GW by 2038, resulting in the closure of 40 of the current 59 coal-fired power plants. Consequently, coal's share of total power generation capacity will decline from 27.1% to 8.4% over the same period. The Third National Master Plan for Energy prohibits the construction of new coal power plants. The 11th BPLE includes the goal of converting coal-fired power plants to lower emission plants, such as those using coal and ammonia co-firing, and hydrogen combustion.

A successful transition away from unabated coal use requires Korea to design and implement a robust set of policies that enable it to unlock opportunities presented by the clean energy transition while avoiding unintended adversities such as severe

unemployment and negative economic impacts. Many lessons can be learnt from other countries' progress in the transition away from coal.

A people-centred transition away from unabated coal use should ensure fair treatment for workers and their communities, opportunities for re-employment, and fair compensation schemes. Korea should seek engagement with coal communities and impacted stakeholders and create governance schemes involving those directly affected by coal closures, as well as from other strands civil society. Social safety net expansions, retraining and job relocation programmes for coal power plant workers and their communities will be essential to ensure that no one is left behind. Establishing clear long-term energy transition strategies would foster investment in technologies, such as electric mobility and renewable energy, resulting in sustainable job creation opportunities. Policies should also avoid regressive distributional impacts.

Korea is already making progress in planning for a coal-free future. Labour unions, mining companies' management and government came to an agreement on the gradual early closure of coal mines by means of the Involving Stakeholders in Coal Mining for Transition to Carbon-Neutral Regime. Revision of the Enforcement Decree and Public Notice Enactment laid the groundwork for compensation for early retirement of coal miners at the Hwasun Mining Company of Coal Corporation in 2023, the Jangseong Mining Company of Coal Corporation in 2024 and the Dogye Mining Company of Coal Corporation in 2025.

Projects that involve stakeholders to promote economic activity and prevent mining damage in areas with abandoned mines increase the community's acceptance of early coal mine closure policies. The government is working with communities to identify economic promotion projects designed to reduce the impact of mine closures and ensure local self-sustainability. This includes developing and implementing comprehensive plans for preventing mining damage and restoring the environment in mining areas.

The implications of a coal phase-out extend beyond the societal costs. A sustainable energy transition requires a secure and affordable energy system. Coal-fired power plants also contribute to system adequacy and flexibility and provide inertia to the grid. These services can also be provided by low-emissions assets and storage technologies, which combined with other measures already planned in Korea such as energy efficiency, can support a transition to a more sustainable power grid without significant increases in costs for consumers. Enhancements in electricity market

design, for example flexibility payments, can help to provide incentives for other dispatchable assets such as batteries to contribute to the system.

Recommendations

1 Strengthen the role of the Presidential Commission on Green Growth and Carbon Neutrality to support the implementation and co-ordination of the sectoral basic plans

In acknowledgement of the multi-agency nature of the energy programme and the cross-cutting nature of policies, the IEA recommends that the government enhance the role of the Presidential Commission on Carbon Neutrality and Green Growth in partnership with the Ministry of Climate, Energy and Environment (MCEE) and entrust it with a guiding role in strengthening the National Framework Plan for Carbon Neutrality and Green Growth. In particular, the Commission's primary function would be to encourage gradual progress and provide strategic recommendations for policy delivery. Its role as a collaborative forum to align and establish guidelines across levels of government in pursuit of the targets outlined in the National Strategy and Framework Plan for Carbon Neutrality and Green Growth should be further strengthened. It could help MCEE ensure that the market frameworks are in place to deliver the optimal technology mix and the associated investments, taking a system-wide perspective that accounts for increased variable generation and other clean energy technologies such as nuclear power and pumped storage. The government may like to explore the experiences and lessons from other IEA countries such as Ireland, Switzerland and the United Kingdom when developing legislation on climate action and sectoral climate plans and how advisory councils support and advise their governments.

2 Strengthen progress toward a carbon-free economy with use of nuclear power, expanding renewable energy, and promoting new technologies for a net zero pathway and decarbonisation

Korea's plans to expand its nuclear capacity should be coupled with an ambitious renewables programme. Realisation of the renewables programme involves significant expansion of installed capacity from 2022 to 2030 to reach Korea's longer-term goals. Looking beyond plans for solar PV and offshore and onshore wind, there should be careful consideration of the potential of renewable energy sources and technologies such as hydrogen, large-scale battery ESS, and electric and fuel cell vehicles to progress to a low-carbon economy. Korea faces distinct challenges in its efforts to expand new and renewable energy sources. The limited amount of available land, the large share of forested land and the high population density impose stress on planning for renewables. Deployment and integration of renewable electricity is further complicated by the lack of interconnections with neighbouring countries. Many other IEA countries have greatly expanded their renewable energy capacity in recent years and have published roadmaps for further expansion.

3 Prepare a National Strategy to improve public acceptance of energy projects by ensuring early, regular and meaningful stakeholder engagement in plan and project development

Public opposition to energy infrastructure can lead to delays, increased costs and have a negative material impact on the location of energy power projects. To make engagement meaningful and embed it into all policy areas, Korea should develop and adopt a national strategy for public engagement that establishes standards of communication with local communities. Communication should begin at the earliest possible opportunity, for example when plans are first being developed, and maintained on a continuous basis, including the permitting and construction phases. These standards will create understanding at the local level as to how they will be consulted with and at which stage of plan and project development.

Furthermore, the messaging around these infrastructure projects should be simplified and linked to broader goals of climate change and economic opportunity. As much as

possible, communications and engagement should be led at the local level by public administrators and local politicians. At the national level, messaging across government should be coherent and simple as to the purpose of these plans and projects. The Strategy should include commitments to review community benefits, including compensation, proximity pricing, employment opportunities and local service obligations. The Strategy will also seek to instil a sense of national pride, helping to ensure the project's success and long-term sustainability.

4 Strengthen and incorporate strategic spatial planning processes to support better energy planning and management

The core function of spatial planning is to better balance social, economic and physical development. In Korea it could be used to identify optimal locations for new energy infrastructure and different categories of land and sea use. Mapping energy demand will allow better forecasting the location and spatial demands of future energy requirements. Korea should seek to embed spatial planning into the energy planning process, which will enable it to align the needs of electricity demand, generation and transmission infrastructure. Plans for new hydrogen and LNG infrastructure should also be taken into account when developing an integrated approach to new infrastructure. A national spatial plan would serve as a catalyst for a national conversation about the optimal location of energy demand from new industries and necessary infrastructure.

5 Increase the number of credits auctioned in the K-ETS, establish a market stability mechanism and ensure electricity price pass through

The K-ETS covers about three-quarters of GHG emissions and is the main tool to achieve Korea's climate pledges. The K-ETS experiences low liquidity, prices are low and have decreased in recent years. The fourth phase of the K-ETS will run from 2026 to 2030 and the cap for this period will be determined soon. Liquidity and price discovery could grow by increasing the share of allowances allocated by regular auctions and fully opening these auctions to all market participants, banks, brokerages and other intermediaries. Introducing a market stability mechanism with a mandate to auction additional allowances held in reserve (within the overall cap) in periods of low liquidity, as is the case for other market stability mechanisms, would

further boost liquidity when necessary. The market design should ensure the carbon price feeds through to the electricity price and acts as an incentive to invest in zero and low-emissions technologies. The allocation of allowances should also be linked directly to Korea's 2030 climate targets.

6 Establish a well-resourced independent regulatory body responsible for oversight of the electricity, natural gas and hydrogen markets

The present regulatory model for Korea placed KOREC in the structure of the newly-established Ministry of Climate, Energy and Environment in October 2025, a major shareholder of KEPCO. Consumers and the energy sector will be better served by adopting a new regulatory model. Among other tasks, the independent regulator should be responsible for redressing imbalances in the electricity retail market and ensuring the transition from the existing tariff retail regime to a transparent and market-based one. The regulator should also ensure that low-income households and vulnerable consumers are protected from exposure to energy poverty. The regulator should focus on developing measures to effectively unbundle KEPCO's different functions while ensuring the long-term financial sustainability of its retail electricity business.

7 Create a national industrial complex for demonstration of small modular reactors

Korea is an assertive and successful nuclear energy producer which is rightly a source of national pride and international envy. The country has strong ambitions to establish itself as a leader in the development and construction of small modular reactors. One means to support this goal would be to leverage existing knowledge, technical expertise and manufacturing capacity to create a national industrial complex for the construction and demonstration of SMRs. This industrial complex should focus on demonstrating both SMR manufacturing and efficient SMR operation for an end-use industrial case application. By leveraging its industrial capabilities, Korea can focus on showcasing efficient SMR manufacturing while pioneering the world's first integrated industrial case of, for example, nuclear hydrogen production and use. This would position Korea at the forefront of an emerging industrial sector and consolidate its own emerging hydrogen economy, driving significant economic growth.

Focus areas

Hydrogen in Korea's energy transition

A focus on demand creation

The global energy sector is experiencing a deep transformation as efforts to strengthen energy security and fight climate change drive countries towards cleaner, more sustainable energy sources. One of these sources is hydrogen, a versatile energy carrier, which can help tackle various critical energy challenges. Today, hydrogen is mainly used in the refining and chemical sectors and produced using fossil fuels such as coal and natural gas, thus responsible for significant annual CO_2 emissions. In the near future, low-emissions hydrogen produced with renewable or nuclear energy, or fossil fuels using carbon capture, can help decarbonise a range of sectors, including heavy industry and long-haul transport, where it is harder to reduce emissions. Hydrogen, being one of the few options for storing energy over weeks or months, can also support the integration of VRE in the electricity system.

Given this context, interest in low-emissions hydrogen in Korea is rising owing to several important factors. First, it is widely understood that hydrogen can offer a solution for decarbonising hard-to-abate industrial sectors where alternatives are limited. Second, the recent global energy crisis highlighted the potential energy security benefits of low-emissions hydrogen. Korea was one of the first countries to launch a hydrogen economy roadmap (in 2019), which focuses mainly on the transport, buildings and power sectors.

In the recent past, the lack of strong policy incentives for low-carbon hydrogen production and use contributed to uncertainty surrounding its expansion globally. The high domestic production costs of low-emissions hydrogen resulted in limited supply, making government policy support essential for expanding the market. Clearer and

more comprehensive policies for both low-emissions hydrogen production and its use in different sectors, notably industry, would further attract long-term investments. The creation of a supportive policy environment that underpins the profitability and economic viability of the hydrogen sector is a priority for government and crucial for attracting additional financing and fostering industry growth. In this regard, the introduction of the Basic Plan for Hydrogen Economy Implementation addresses the promotion of hydrogen use in hard-to-abate sectors such as power generation, iron and steel, petrochemicals, and cement.

The first Carbon Neutrality Basic Plan (April 2023) and the 2050 Carbon Neutrality Scenario (October 2021) identify hydrogen as a key emissions reduction technology in several sectors, including power generation, transportation and industry. In line with this vision, the Korean government subsequently announced policies such as the 2022 Strategy for Building a Clean Hydrogen Ecosystem, demonstrating its commitment to demand creation. Among these policies, the most prominent is the Clean Hydrogen Portfolio Standard (CHPS), which incentivises the replacement of fossil fuels with clean hydrogen in the power generation sector.[3] This measure is designed to drive large-scale hydrogen demand as a means of reducing GHG emissions. Korea began implementing this system in 2024. Nevertheless, since domestic hydrogen supply is primarily produced from methane or natural gas, the government acknowledges the need to transition to a low-emissions hydrogen-based ecosystem to drive emissions reductions. Efforts are underway to secure diverse domestic low-emissions hydrogen production capabilities and to establish an economically viable overseas low-emissions hydrogen supply chain.

Korea plans to implement further policy measures to promote investment when best available technologies are ready for scaled-up investment in each sector. Furthermore, the Restriction of Special Taxation Act was amended in April 2023 to designate the hydrogen sector as a national strategic technology. Tax credits can, for example, be offset against electrolysis costs, manufacturing of components, hydrogen-cell turbines and steelmaking technologies. The tax credit is also available for ammonia-fired power generation technology design and manufacturing as well as industrial-scale boilers and burners. Subsidies are also available for the purchase of fuel cell vehicles, the installation of hydrogen refuelling stations, the purchase of hydrogen as a fuel and to meet losses resulting from operating a fuelling station.

[3] See Explanatory note in the Annexes regarding the use of the term “clean” hydrogen in this report.

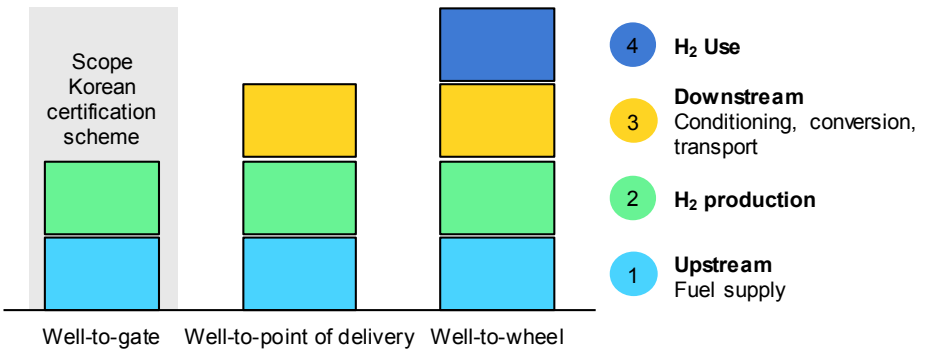
Legal frameworks to support hydrogen production and use

Korea developed a legal framework for hydrogen certification. The Hydrogen Act was amended in June 2022, with an Enforcement Decree enacted in November 2023. Enforcement Rules and Clean Hydrogen Notifications followed in December 2023 and March 2024. Operational Regulations for the Certification Operating Agency, the Korea Energy Economics Institute, were finalised in May 2024. The government established certification standards and emissions calculation principles. The Korea Testing Certification Institute and the Korea Testing & Research Institute were appointed the Certification Test and Evaluation Institution to verify compliance with the scheme and focus on on-site inspections. The Certification Operating Agency offers a preliminary review consulting service to enhance predictability for the final certification process and mitigate potential risks associated with related systems, such as the low-carbon hydrogen bidding market.

Korean hydrogen definitions and market

The Hydrogen Act introduced a definition of low-emissions hydrogen. The certification is based on the well-to-gate boundary. Korea's certification scheme was established in accordance with international standards (including ISO/TS 19870) and other schemes related to emissions calculation methodology.

Hydrogen value chain and system boundaries for emission accounting schemes



Sources: IEA analysis based on IEA (2023), Towards hydrogen definitions based on their emissions intensity; KEEI (2024), Korea's clean hydrogen certification scheme (accessed May 2025).

The government also introduced a low-emissions hydrogen certification system that certifies hydrogen as clean (low-carbon) if the carbon intensity during production or the import process is below a certain level, enabling administrative and financial support. In the Hydrogen Act, hydrogen is graded along a scale of one to four and is classified as low-carbon if its carbon intensity is 4 kg CO_2-eq or less per kilogramme of hydrogen.

Hydrogen certification grades in Korea

Classification	Tier 1	Tier 2	Tier 3	Tier 4
Emission range (kg CO_2-eq/kg H_2)	0~0.1	0.1~1	1~2	2~4

Source: Korea government submission to the IEA.

The system also defines eligible hydrogen production pathways that ensure credible GHG emissions reductions. Low-emissions hydrogen production from renewables, for example, allows indirect grid connections for on-site use, but these connections are limited to the same grid within a one-month time frame to ensure temporal correlation. Hydrogen manufactured from natural gas reforming coupled with carbon capture and storage, on the other hand, requires a carbon capture rate of at least 90%, and the captured CO_2 must be permanently stored.

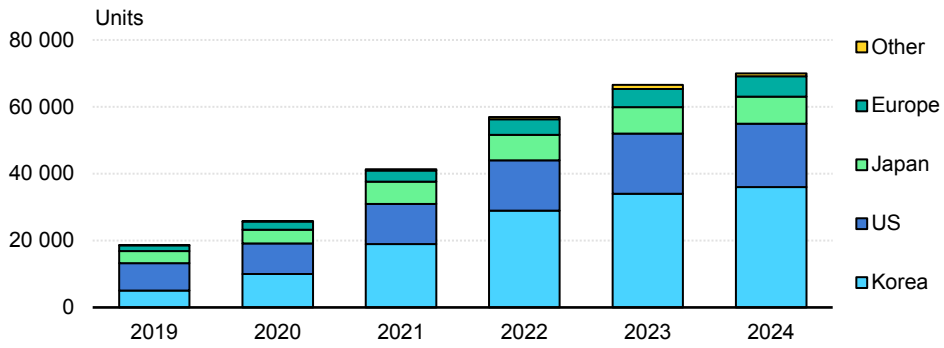
An international standardised emissions accounting system helps improve transparency, but a clear definition of clean hydrogen and the use of renewable energy is required. At present, a monthly temporal correlation applies only to the facilities that will come into operation by 2030. Direct and indirect connection methods (power purchase agreements, renewable energy certificates) with renewable energy facilities are permitted. The government's definition of clean hydrogen, in principle, encompasses emissions from transportation or those linked to the conversion of ammonia or liquefied hydrogen back to gaseous hydrogen, but it temporarily adopts well-to-gate approach like many other certification schemes because the global market situation is not ready (e.g. lack of available clean-fuel powered ships).

The market for hydrogen

Hydrogen offers an important decarbonisation route for different sectors. It is currently used in Korea largely in refineries and produced solely from fossil fuels. In 2020, hydrogen production was 220 kilotonnes. The government aims to increase it to 1.9 Mt by 2030 while at the same time importing 1.9 Mt of hydrogen. In the future, decarbonised energy system, low-emissions hydrogen can play a role across different sectors, from replacing the existing use of high-emissions hydrogen to heavy-duty, aviation and marine transport to industrial processes and electricity generation.

FCEVs powered by hydrogen produce no harmful tailpipe emissions and emit only water vapour and warm air. Korea is the world's leading consumer of hydrogen in the transport sector. With substantial purchaser subsides for all categories of vehicles in place, more than 37 000 passenger FCEVs were on the road in 2024. The country accounts for more than 50% of the global stock of passenger FCEVs and almost 40% of total FCEVs of all types. Korea is a leading market for FCEV buses, with almost 1 700 buses on the road in 2024 and a target of 21 200 by 2030. In early 2024, Hyundai expanded its capacity from 500 to 3 000 units per year to keep pace with deployment. The country also announced plans for hydrogen-fuelled short-sea vessels (see the Transport Section).

Fuel cell passenger car stock by region, 2019-2024



Note: US = United States.
Source: IEA (2025), Global EV Data Explorer.

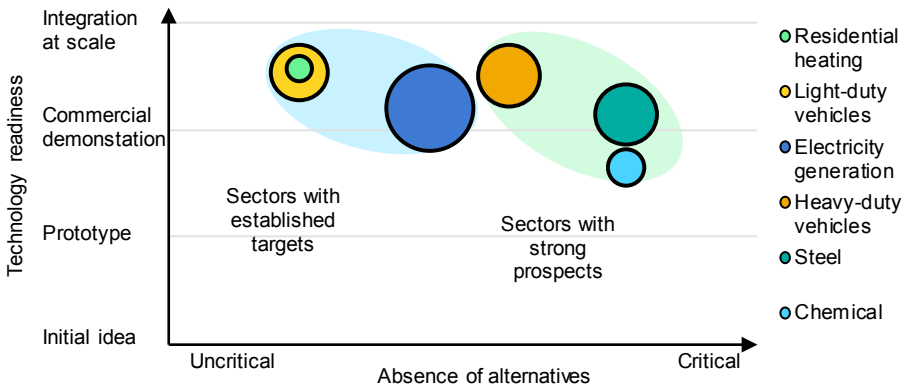
There are no heavy-duty FCEVs in the freight transport sector, which represents a potential area of growth for Korea. Substantial subsidies are available for the deployment of hydrogen refuelling stations (HRS) for all classes of vehicles. The government also supports HRS operators with a subsidy to cover up to 80% of their annual operating losses. With more than 300 refuelling stations, or a vehicle-to-HRS ratio of around 200, already available for passenger FCEVs and buses, Korea is in a strong position to develop hydrogen-powered heavy-duty vehicles.

Korea sees a role for hydrogen in decarbonising dispatchable electricity generation. It organised auctions for electricity generated from hydrogen (without constraints in emissions intensity), with two tenders for a combined volume of 1 430 gigawatt hours (GWh). In a world first, in November 2023, Hanwha Impact achieved a 100% hydrogen fuel supply in an 80 MW gas turbine, after achieving a 60% co-firing share in April.

The government is also exploring fuel cell use in buildings. Fuel cells mostly run on natural gas, however, which is pre-reformed into hydrogen in the fuel cell before being used to produce heat and power. Fuel cells running on pure hydrogen (supplied by a refinery) were installed in 2024 in a building complex, providing 840 MWh of electricity in June 2024 along with some heat.

Korea is exploring the use of new hydrogen technologies in heavy industry. Multiple projects around the world aim to use hydrogen-based direct reduction ironmaking, requiring high-grade iron ore pellets, which have limited availability. Korea, however, is also exploring other technologies and POSCO (formerly the Pohang Iron and Steel Company) is developing its proprietary HyREX process, which uses fine iron ore in a fluidised bed reactor to produce direct reduced iron, integrated with an electric smelting furnace capable of processing direct reduced iron from low-grade iron ore. POSCO completed a pilot-scale electric smelting furnace facility in 2024 and successfully verified fluidised hydrogen reduction technology through experimental operations. Meanwhile, the Korean government has designated hydrogen-based steelmaking as a national strategic technology and is actively promoting the development of a Korean hydrogen-based direct reduction process. As part of this effort, the government designated the hydrogen-based direct reduction demonstration technology development project as a preliminary feasibility study target project in November 2024.

Demand-side sectors for hydrogen use in Korea



Notes: Bubble size displays estimated emissions reduction potential from low-emissions hydrogen use in Korea. Emissions reduction potential for sectors with established targets are based on policy targets; other sectors are based on IEA analysis and the Net Zero Emissions Guide.

Sources: IEA analysis based on IEA (2025), Energy End-uses and Efficiency Indicators; Clean Air Task Force (2023), Hydrogen for Decarbonisation (accessed May 2025); Korea, Ministry of Trade, Industry, and Energy (2021), Hydrogen Economy Roadmap of Korea (accessed May 2025); IEA (2025), ETP Clean Energy Technology Guide; IEA (2023), Net Zero Emissions Guide.

Many technologies for hydrogen applications are relatively mature (especially the ones Korea targets), with most of them beyond the commercial demonstration level. Other technologies in sectors with strong prospects are at a similar technology readiness level. For some applications, a range of other low-emission alternatives exist.

Hydrogen and the electricity market

The Hydrogen Act provided for the establishment of a bidding market for hydrogen-powered electricity generation to facilitate the implementation of a hydrogen economy and meet the government's target of 2.4% of power generation from hydrogen by 2030 and 6.2% by 2038. The Act also provides for the Korea Power Exchange, designated by the Korean government as the market management agency, to operate the hydrogen power bidding market and ensure that participating operators meet the legally prescribed standards, including those related to facility quality and human resources.

Korea first held tenders in 2023 for electricity generated from hydrogen with a combined volume of 1 430 GWh, without any constraints on the emissions intensities of the hydrogen. In 2024, 1 314 GWh was awarded under the same market. In parallel, up to 6 500 GWh of electricity generated from low-carbon hydrogen was auctioned over a 15-year contract period starting from commercial operation. For coal and ammonia co-firing in existing power plants, CHPS put additional measures in place to curb emissions. For instance, plants with a remaining lifespan of less than 15 years are not allowed to extend their decommissioning schedule by winning new contracts. Article 25.6 of the Hydrogen Act established a dedicated bidding market for power generators using low-carbon hydrogen as a fuel. Participation is limited to hydrogen-consuming generators that meet Korea's national clean hydrogen certification standards (carbon intensity of 4 kg CO_2-eq or less per kg of hydrogen).

The bidding price was based on the levelised cost of electricity (LCOE) and capped at the LCOE plus an indexed fuel cost. The successful bidder must fulfil a set of criteria beyond price, including a satisfactory credit rating, plant flexibility, expected lifetime, etc. Bids will be assessed based on price and quantitative and qualitive evaluation, which includes, but is not limited to, credit rating, hydrogen quality and security of supply, emissions factors, job creation, domestic participation and value chain contribution.

The successful plant is also expected to be centrally dispatched and will earn the system marginal price on the electricity spot market. Settlement for hydrogen power generation is based on a bid price, and a contract for difference mechanism is applied for the difference between the contract price and the system marginal price. In the case of reformed hydrogen, the settlement price can be indexed to reflect fuel price changes. Operators can also be penalised for delays in plant operations and low availability. While almost 5 800 GWh were registered, one bidder was successfully awarded the contract with a bid below the ceiling price. While there is no global market for clean hydrogen or its derivatives, price discovery played a prominent role in the CHPS bidding process. Aware of its implication for the domestic electricity price, the government ran the first year of CHPS very cautiously to help understand the dynamics of the new market. Based on the results of the first year, CHPS rules will be revised for more effective bidding competition and for more complete price/cost information in future years.

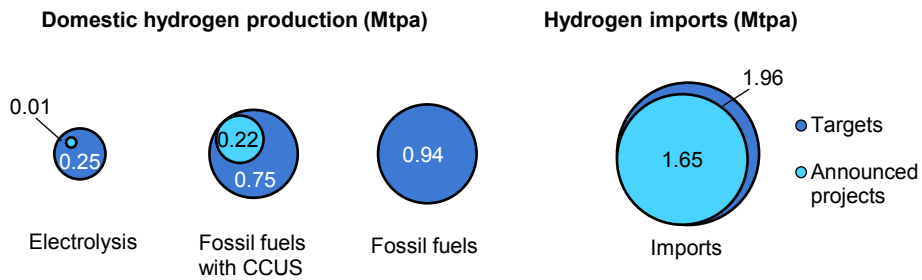
Supply and infrastructure

Governments need to improve efforts to accelerate the development of hydrogen infrastructure to avoid further delays that risk slowing down the scale-up of

low-emissions hydrogen production and demand. Without timely infrastructure deployment, the link between supply and demand cannot be established, hindering market growth, and creating uncertainty for producers and consumers. Korea is planning several critical elements, including creating a liquid hydrogen ecosystem, building production infrastructure in other countries and establishing receiving terminals at home.

SK Innovation E&S commissioned its first liquified hydrogen plant in Incheon in May 2024. The plant is expected to produce around 30 000 tonnes of liquid hydrogen a year. The plant serves demand in the Seoul Metropolitan Area and is the world's largest hydrogen liquefaction plant. The plant, which cost around USD 510 million to construct, consists of three production facilities, each with a capacity of producing 30 tonnes of liquefied hydrogen daily, as well as six 20-tonne storage facilities.

Hydrogen production and imports in Korea (announced projects by 2030 and 2030 targets)



Notes: Data to estimate announced projects for hydrogen production from fossil fuels is not available. 'Targets' refer to the intended composition of hydrogen supply as formulated in Korea's Basic Plan for the Hydrogen Economy. CCUS = carbon capture, utilisation and storage. Mtpa = million tonnes per annum.

Sources: IEA analysis based on Korea, Ministry of Trade, Industry, and Energy (2021), Basic Plan for the Hydrogen Economy; IEA (2024), Hydrogen Production and Infrastructure Projects Database (accessed August 2025).

The Basic Plan for Implementation of Hydrogen Economy includes a target of 1.96 Mt of H_2 imported by 2030. In 2021, the Korean government signed a partnership with Australia including close co-operation for the supply of hydrogen and ammonia. Saudi Arabia exported 25 kilotonnes of ammonia to Korea in 2022. Korea plans to

establish ammonia receiving and storage facilities of 4 Mt/year by 2030 focused on coastal areas close to power sector demand.

In February 2023, KOGAS selected DNV to assess the feasibility of blending hydrogen into the country's 5 000 km transmission network, as it aims to achieve 20% blending by 2026. In April 2024, Samsung C&T announced Korea's first ammonia import terminal to be operational by 2027. Korea plans several overseas production projects to secure low-emissions hydrogen. The immediate focus will be on countries that offer an advantageous hydrogen production environment. To date, Korean companies signed memorandums of understanding with companies to develop clean hydrogen projects in Australia, Malaysia, Oman, Saudi Arabia and the United States.

Korean ship manufacturers also announced multiple designs for liquified hydrogen tankers, with the first LPG/ammonia gas tankers to be delivered by 2026. An increase in the number of tankers may be constrained by the relative technical complexity of liquefied gas tankers, with only a few shipbuilding yards in Korea, Japan and China capable of constructing them. This limited shipbuilding capacity could potentially create bottlenecks in the short term, and there have been reports of a lack of capacity in Korean shipyards. Nonetheless, the first orders for ammonia-fuelled ships were placed at the Hyundai Mipo Dockyard, starting with a pair of midsize LPG/ammonia gas tankers ordered by EXMAR in October 2023, that will be propelled by dual-fuel engines and are expected to be delivered by 2026. In December 2024, Korea launched a national demonstration project to develop its first liquefied hydrogen carrier, with the goal of completing a 2 000 m³ vessel by 2027

Recommendations

8 Prioritise the efficient production, conversion, transport and use of hydrogen in applications with high emissions reduction potential

Korea is working to deliver its Basic Plan for Hydrogen Economy Implantation and subsequent policy directions from the Hydrogen Economy Committee, which determines a pathway for developing its hydrogen ecosystem. The government implemented a certification system to ensure that incentivised hydrogen is clean. Korea focuses on demand-side policies to kick off the market for clean hydrogen, specifically by incentivising the use of hydrogen in electricity generation and mobility.

Although this may be a good strategy to attract the first import volumes of clean hydrogen, Korea may have to identify other decarbonisation options for its hydrogen economy, with an emphasis on cost-effectiveness.

Korea should clarify the policy instruments needed to increase the use of hydrogen in hard-to-abate sectors such as industry and heavy-duty transport, which were envisioned in the Basic Plan for Hydrogen Economy Implementation and subsequent policies. Furthermore, it should aim to reduce the number of conversion steps when importing hydrogen from abroad, for example by using the hydrogen (carrier) in the form it arrives in Korea. To achieve this, policy instruments based on the entire "well-to-wheel" value chain should be strengthened.

9 Implement a regulatory framework for the hydrogen economy including rules for the development and operation of hydrogen infrastructure

Korea should create clear and transparent rules on building, owning and operating hydrogen pipelines and import terminals. Investors and project developers need clear and stable regulatory frameworks to back their investments. Without timely buildout of infrastructure, the link between hydrogen supply and demand is broken, leading to uncertainty and stunted market growth. Regulatory measures that focus on planning, repurposing existing natural gas pipelines and storage facilities to lower costs, streamlining permitting frameworks, and building cross-border co-operation on hydrogen networks can facilitate robust market development.

As part of these broader efforts, Korea introduced a legislative proposal in January 2025: the Hydrogen Business Bill. It aims to establish a sound regulatory foundation for the hydrogen industry by setting rules for permitting, supply-demand management, obligations of market participants and user protection. It is expected to lay a firm legal ground for shaping a well-functioning hydrogen market and supporting the development of a robust industrial ecosystem, which would reinforce investor confidence in Korea's emerging hydrogen economy.

Korea developed a certification scheme with emission categories for hydrogen for use in its Clean Hydrogen Power Bidding Market. As a major future importer of clean hydrogen and its derivatives, Korea is active in international fora (e.g. the International Partnership for Hydrogen and Fuel Cells in the Economy) discussing

clean hydrogen certification schemes and their mutual recognition. Korea's clean hydrogen certification scheme is based on various international standards, including ISO/TS 19870, while taking its national circumstances into consideration. As demonstrated in the first year of the electricity bidding market of the Clean Hydrogen Portfolio Standard, suppliers that are interested in the Korean market are willing to align their production processes to the Korean scheme. These suppliers that need to consider the certification rules of their buyers may prefer that domestic market certification schemes do not conflict with those of their buyers. Accordingly, it is important to advance discussions on harmonising clean hydrogen certification standards internationally, while taking into account each country's specific national and market circumstances to ensure credibility and interoperability across markets.

Energy storage technologies

As an isolated power system without interconnection with neighbouring countries, maintaining the reliability and stability of the power system is a critical challenge for Korea. Policies such as the expansion of nuclear power and VRE sources alongside the planned phase-out of coal-fired power will have major implications for the operation of the electricity system as the stable and reliable supply of electricity is becoming more important for major industries such as semiconductors and data centres. In the power sector, energy storage, and in particular battery storage, contributes to electricity security of supply by stabilising the grid, meeting peak load demands and facilitating the integration of increasing amounts of VRE. In the past, pumped storage hydropower played an important role in many power systems by ensuring electricity security and stabilising the balance between supply and demand. More recently, battery technology has developed as a viable alternative for energy storage.

Over the past decade, global installed battery storage capacity has increased exponentially, from about 1 GW in 2013 to over 85 GW in 2023. More than 40 GW were added in 2023 alone, or more than twice as much as in 2022. Together, China, the European Union and the United States accounted for nearly 90% of the capacity added in 2023. Nonetheless, utility-scale battery storage capacity additions in Korea increased substantially in 2023, rising to more than 300 MW. Conversely, behind-the-meter capacity additions in Korea peaked in 2018, but the market crashed following the withdrawal of subsidies and has yet to regain its 2018 level. Korea's 11th BPLE sets a target to build an additional 23 GW of energy storage by 2038, including 1.25 GW of pumped-hydro storage.

The government announced its Development Strategy for the Energy Storage Industry in October 2023. The Strategy aims to boost the global competitiveness of lithium battery-based ESS and develop non-lithium, long-duration energy storage technologies such as sodium sulphur batteries, compressed air storage, Carnot batteries and variable-speed pumped storage hydropower. With global competition for long-duration energy storage technology intensifying, leveraging domestic infrastructure for early commercialisation could help dominate the expanding market. Korea is exploring the use of ESS to support frequency regulation and peak shaving.

Using large-scale batteries, Korea aims to stabilise the grid during periods of high demand while smoothing out fluctuations in VRE supply. Korea also plans to leverage smart grid technologies to optimise the management and operation of ESS. KEPCO will invest in communication networks, advanced sensors and data analytics to help inform energy storage and distribution. It is also exploring the use of ESS to manage grid congestion, which is a growing problem for the system operator. The strategic deployment of well-placed batteries can help alleviate anticipated congestion, maximise the use of existing infrastructure and minimise investments in costly upgrades.

To date, the deployment of energy storage facilities is largely attributable to incentives such as discounts on late-night charging fees and favoured weighting of renewable energy certificates for renewable energy-linked storage facilities. The Korea Power Exchange opened a pilot long-term contract market for low-carbon power generation in 2024 to support the expansion of ESS deployment. In 2023, a 65 MW/260 MWh long-duration battery energy storage system tender process was completed in Jeju. Projects eligible for bids will be of four hours or more duration and the successful bidders will be guaranteed a price for 15 years, part of a policy shift to deploy market-based ESS. The aim of the process was to effectively integrate the output of VRE generation on the island. Thirteen power providers from 11 companies with a total capacity of 206 MW participated in the tender. In the eastern region, 35 MW were awarded to Korea East-West Power, while in the western region, LS ELECTRIC and Korea Southern Power were awarded 10 MW and 23 MW, respectively. Subsequently, the government announced a roadmap to auction 3.66 GW of capacity through to 2030 focused on South and North Jeolla Provinces in the southwest, where much of the country's VRE is located.

Despite some progress, ESS deployment remains limited owing to the lack of fully established market mechanisms. The government plans to designate a special (deregulated) district following the adoption of the Special Act on Distributed Energy

Promotion in 2025 and power trading between individuals will be permitted in this area. In addition, power market reforms, such as a renewable energy bidding market, ancillary services markets, and virtual power plant and aggregation, may encourage the spread of ESS facilities. Korea is also promoting R&D in ESS technology. Collaboration between government institutions, industry and academia are driving innovations in battery chemistry, system design and control algorithms. These advancements are aimed at improving the performance, durability and cost-effectiveness of ESS, making them more viable for widespread deployment.

Regulatory barriers to battery storage

Battery storage development faces significant regulatory challenges in many countries. Regulatory frameworks are inadequate frameworks, often leading to uncertainty over long-term revenues and concerns regarding double taxation. Storage systems, owing to their dual nature as both generation and demand, may be taxed during both charging and discharging cycles, creating a systemic disadvantage. Restrictions on market participation and service provision can further limit battery owners' ability to contribute fully to energy systems.

In Korea, battery storage use can add capacity to the system, but it is unable to participate in wholesale markets, offer ancillary services or contribute to grid congestion management. In the European Union, for example, batteries are often ineligible for short-term markets and capacity mechanisms, thereby discouraging uptake. In China, a lack of market-based outlets for storage coupled with renewable energy can lead to low use rates, affecting profitability. Slow deployment of smart meters in many countries also hampers the development of virtual power plants and the aggregation of distributed energy resources. Other barriers include delays in building grid connections and high costs for grid upgrades. Regulatory processes for approvals can be complex and time-consuming. In many markets, arrangements designed for conventional technologies fail to incentivise optimal investment in battery storage.

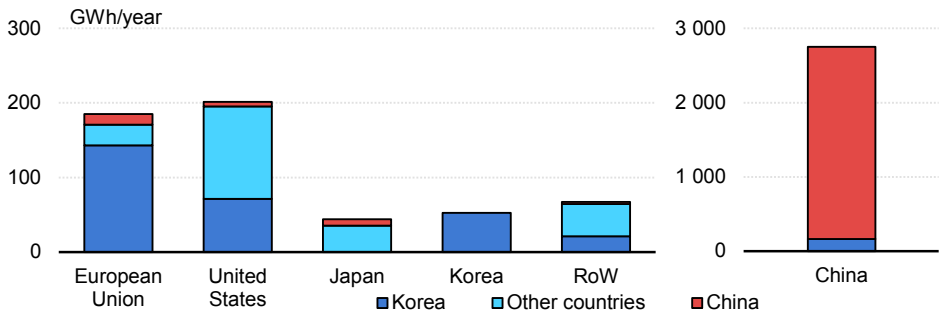
To unlock the full potential of battery storage, Korean policy makers and regulators need to ensure that the regulatory regime recognises the full value of the services that long-duration energy storage technologies offer, enable market access and establish price signals that accurately reflect its various contributions. To capture the full benefits of behind-the-meter batteries, regulatory systems need to better align consumer and system benefits through cost-reflective variable electricity tariffs. Where feasible, they should also allow the aggregation of behind-the-meter batteries

into virtual power plants that can offer services akin to utility-scale projects. Korea is successfully making progress in better aligning consumer and system benefits through cost-reflective variable electricity tariffs but has much to do in terms of aggregation services and the introduction of virtual power plants for consumers and ensuring that they are remunerated in proportion to the system value of the services. KEPCO also needs to maintain its progress on developing a smart grid and digitalisation, which will allow higher visibility of real-time system needs. This will help ensure that the system can extract the maximum benefit from the system flexibilities that behind-the-meter batteries can provide.

Supply chains

Global battery supply chains are very complex, starting with the extraction of mineral ores, which are refined to form high-purity battery-grade chemicals. Advanced materials synthesis subsequently produces cathode and anode materials. Supply chains for components are also complex. China plays a significant role in the production at various stages of the downstream battery supply chain. Over half of global raw material processing for lithium, cobalt and natural graphite takes place in China. With 90% of global graphite mining, China leads the entire graphite anode supply chain from start to finish.

Lithium-ion battery manufacturing capacity by region and headquarters location, 2024



Note: RoW = rest of world.
Source: IEA (2025), Global EV Outlook 2025.

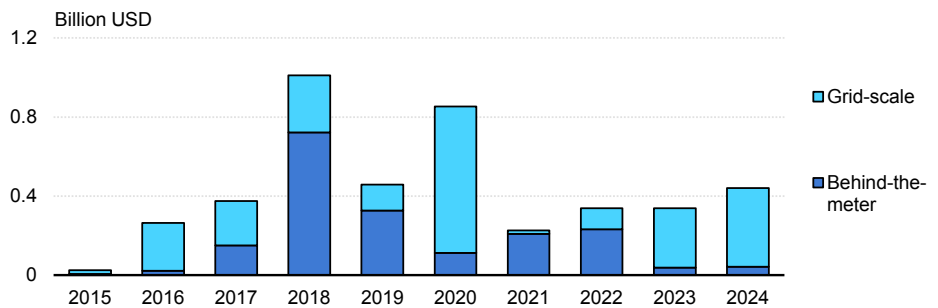
Nonetheless, Korea plays a prominent role in the global battery supply chain. It holds nearly 10% of global manufacturing capacity for cathode active materials, key

components in lithium-ion batteries. Korean battery manufacturing companies are leaders in overseas markets investments, followed by Japan and China, holding over 350 GWh of capacity abroad. LG Energy Solution owns a plant in Poland which accounts for half of Europe's total manufacturing capacity. The government continues to invest in the battery industry and in critical minerals processing, both domestically and abroad. In 2023, it invested KRW 38 trillion (USD 29 billion) to strengthen supply chains and expand production capacities. Korea has a considerable share of the battery supply chain downstream from raw material processing, particularly in cathode material production, and accounts for nearly 10% of global cathode active material manufacturing capacity.

Flexibility in the electric power system

Realising the full potential of expanding solar PV and wind will require the implementation of proactive integration strategies. The growing variability of the Korean power system will require increasing the flexibility of the entire power system by leveraging dispatchable generation, grid enhancements and increasing storage and demand response. Successful integration maximises the amount of energy that can be sourced securely and affordably, minimises costly system stability measures, reduces dependency on fossil fuels, and lowers GHG emissions.

Investment in battery storage by system placement, Korea, 2015-2024



The IEA developed a VRE integration framework to understand the challenges grid operators face as they expand their networks to accommodate increasing volumes of VRE. The IEA analysis outlines six phases of impacts on the power system resulting

from increasing loads of solar PV and wind. Each phase presents new challenges requiring targeted measures to enable the secure and cost-effective uptake of VRE. Korea could be said to be transitioning from phase 1 to phase 2, which are considered low phases of VRE integration. This means Korea is experiencing relatively low impacts, with most challenges addressable through straightforward modifications to existing assets or operational improvements.

A combination of technical enhancements, institutional reforms, market design updates and policy making will be necessary in Korea if the system is to accommodate the projected volumes of solar PV and wind. All these requirements contribute to a secure and cost-effective electricity system, while maximising the use of renewable energy and incentivising investments in ESS.

Most of the flexibility required to maintain power system reliability in Korea is provided by dispatchable thermal power plants, pumped storage and, to a lesser extent, hydropower. Rising flexibility needs and changes in the composition of the power plant fleet such as the addition of new and renewable energy and the retirement of coal-fired plants increases the need for alternative sources of flexibility to maintain grid stability and security of supply. Reinforced power grids can help even out fluctuations in the supply of weather-dependent variable renewables. Grid assets, such as high voltage direct current interconnections, can also provide flexibility services such as fast ramping or voltage control directly.

Pumped storage hydropower plants store electricity by pumping water up from a lower reservoir to an upper reservoir then releasing it through turbines when power is needed. The flexibility and storage capabilities of reservoir plants and pumped storage hydropower facilities (and reservoir plants) are unmatched by any other technology. Higher shares of variable renewables will transform electricity systems and raise flexibility needs. With low operational costs and large storage capacities, existing reservoir hydropower plants are the most affordable source of flexibility today. Korea already has substantial pumped storage resources, with seven plants providing around 4 700 MW of capacity. According to the 11th BPLE, the construction of pumped storage plants is expected to add 5.7 GW of capacity (a total of nine units).

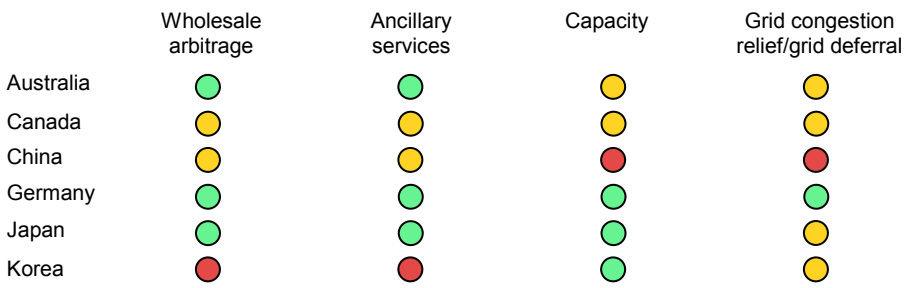
Korea plans to use ESS (i.e. batteries) for short-term flexibility measures and long-term flexibility measures; and in the short term to respond to volatility, such as frequency maintenance and real-time supply and demand balance. In the long-term, it plans to respond to fluctuations of VRE and manage output control and load management. To deploy these storage systems, market conditions need to foster the

deployment of these technologies. Battery technologies do not have access to revenues from ancillary services and a real-time balancing market. Korea is currently in the process of opening a reserve market in parallel to the real-time market.

Battery ESS also provide fast-response grid stabilisation, ensuring frequency and voltage control while reducing the risk of renewable energy curtailment. Korea's Carbon-Free Energy Initiative, which aims for 70% carbon-free electricity by 2038, emphasises battery deployment at both grid-scale and decentralised levels, supporting integration with renewable projects, industrial facilities and behind-the-meter applications.

While the battery sector in Korea is strong, the energy storage market is facing challenges. Battery manufacturing supply-chain constraints, particularly regarding lithium and other critical minerals, pose a risk. Fire safety concerns prevalent in Korea also require improved regulation. Furthermore, battery storage remains expensive, and its high upfront costs continue to be a challenge for large-scale deployment, despite ongoing price reductions and efficiency improvements.

Comparison of eligibility of battery storage by type of use across selected countries, 2024



Green = legally eligible; Orange = eligible only in some districts, or in pilot projects, or for some services only; Red = not eligible or not available.

Sources: IEA analysis based on IEA (2024), Batteries and Secure Energy Transitions; Flow Batteries Europe, Report on regions: Asia Pacific; Battery Storage and Grid Integration Program (accessed March 2025).

Developing energy storage capacity in the power sector is a priority, with capacity additions for utility-scale battery storage increasing to over 300 MW in 2023. Korea's

11th BPLE contains the target to build an additional 23 GW of energy storage by 2038, including 1.25 GW of pumped-hydro storage.

Grid codes play a critical role in building trust between the system operators and stakeholders. They support the smooth operation of the system, amending connection requirements to ensure grid users remain connected in a wider range of conditions and resources can contribute to essential system services. Grid connection codes define technical requirements, regulations and behaviour for all active participants in the power system, including power generators, adjustable loads, storage and other units. KEPCO should work with all industry stakeholders to ensure that Korea's grid codes are fit-for-purpose and that connection requirements are reasonable and balance the needs of the energy storage service providers and the power system.

A broad set of solutions exists to help ensure that power system flexibility needs are met, ranging from mechanisms to ensure that enough flexible capacity is available when needed to system-friendly contracts and support schemes for VRE, and demand-side solutions. Owing to their ability to ramp up and down very quickly, batteries are well-suited to compensate for the variability of VRE. Lithium-ion batteries are technologically mature and, with falling costs, deployment is picking up in Korea. Other battery technologies, such as redox-flow and metal-air batteries, have the potential to provide longer duration storage from hours to days. Beside short-term flexibility, batteries can deliver a wide range of system services and contribute to system stability and grid congestion management.

Most power systems offer a separate ancillary services market to procure frequency control and other services to balance supply and demand on the system. Frequency control and ancillary services markets procure fast response from generators, storage providers and demand response units to manage frequency deviations in the grid. Large-scale battery storage systems can offer a faster response rate to signals from the system operators than a thermal plant can.

In Korea, these services are procured through monthly or annual contracts. This hinders storage operators from competitively generating revenues in the ancillary services market. To incentivise the efficient expansion of energy storage in Korea, a more sophisticated daily or weekly rolling ancillary services market structure is needed. Other markets in the region, such as Chinese Taipei and Japan, introduced day-ahead and week-ahead ancillary services markets.

Ancillary services provide an important revenue stream for energy storage operators, but the opportunities in Korea are presently limited. Implementation of effective ancillary services markets could play an important role in kickstarting the development of energy storage and supporting Korea's energy transition.

Recommendations

10 Accelerate the rollout of a centralised contract market for energy storage services to ramp up the deployment of battery storage

Korea is a successful manufacturer of battery storage technology. Electricity storage can provide a range of services to the power system, including maximising the use of variable renewables, helping to manage congestion on the network, and providing a range of network services, such as frequency response and reactive power. To incentivise investment and deployment of electricity storage, revenues renumerating the technology for the benefits it brings to the system are required. These revenues are not currently visible to investors or open to market competition. In July 2025, Korea expanded the Centralised Contract Market for ESS established on Jeju Island to the mainland. This mechanism is a market-based competition mechanism which provides developers to predictable revenue stream over the life of the project. Future iterations of this market should be open and accessible to a range of technologies.

Annexes

Acknowledgements

The IEA review team visited Seoul on 21-25 October 2024 and met with government officials and public and private sector stakeholders across the energy sector. This report is based on information from these meetings, the review team's assessment of Korea's energy policy and detailed research by the IEA. The review team members were Conor McCabe (Ireland, team leader), Mirthe Kuenen (Netherlands), Hannah Clapham (United Kingdom), Eva Centeno López (Sweden), Franco Michel-Sendis (Nuclear Energy Agency), Manoj Kumar Upadhyay (Observer, India), and Kieran McNamara and Alessio Scanziani from the IEA Secretariat.

Kieran McNamara managed the review and is the main author of the report. The report benefited from reviews and insights from IEA staff, including Herib Blanco, Gyuri Cho, Jieun Choi, Dagmar Graczyk, Mathilde Huismans, Heeweon Hyun, Jinil Kim, Tae-Yoon Kim, Yun Young Kim, Oskar Kvarnström, Teo Lombardo, Michael McGovern, Jose Miguel Bermudez Menendez, Sungjin Oh, Camille Paillard, Francesco Pavan, Apostolos Petropoulos, Uwe Remme, Alessio Scanziani, Max Schoenfisch and Brent Wanner. Fabian Burkard and Anders Caratozzolo designed and prepared the energy data sections of the report, dedicated analysis, figures and tables, supported by Anita Finco, Christina Hounisen, Šimon Olmer, Samuel Talbot and Naomi Trick. Roberta Quadrelli provided support on statistics and data. Isabelle Nonain-Semelin and Astrid Dumond managed the editing process and the production process. Clara Vallois managed the translation process. Jennifer Allain edited the report. Nicolette Groot supported the organisation of the energy review team's visit.

The IEA would like to thank the Ministry of Climate, Energy and Environment and the Korea Energy Economics Institute for organising the review visit and for their

guidance and support throughout the review process. The IEA would also like to thank the following organisations who provided valuable insights during our visit to Seoul: Korea National Oil Corporation, Korea Gas Corporation, Electricity Regulatory Commission, Korea Power Exchange, Korea Electric Power Corporation, Korea Energy Agency, Korea Institute of Energy Technology Evaluation and Planning, Korea East-West Power Corporation, Korea Midland Power Corporation, Seoul National University of Science & Technology, Sun Moon University, Korea Hydro & Nuclear Power Company, Korea Automobile & Mobility Association, Korea Automobile Importers & Distributors Association, Ajou University, Korea Productivity Center Quality Assurance, POSCO Holdings, Korea Chamber of Commerce and Industry, H2Korea, Samsung C&T, SK E&S, LOTTE Chemical Corporation, Hyundai Engineering & Construction, Hyundai Motors and Korea Zinc.

Abbreviations and acronyms

BPLE	Basic Plan for Electricity Supply and Demand
CFE	Carbon-Free Energy
CHPS	Clean Hydrogen Portfolio Standard
ESS	energy storage system
ETS	Emissions Trading System
EU	European Union
EV	electric vehicle
FCEV	fuel cell electric vehicle
GDP	gross domestic product
GHG	greenhouse gas
HRS	hydrogen refuelling station
IEA	International Energy Agency
K-ETS	Korea Emissions Trading System
KAERI	Korea Atomic Energy Research Institute
KEEI	Korea Energy Economics Institute
KEPCO	Korea Electric Power Corporation
KOGAS	Korea Gas Corporation
KOREC	Electricity Regulatory Commission
KRW	Korean won
LNG	liquefied natural gas
LPG	liquefied petroleum gas
MOTIE	Ministry of Trade, Industry and Energy
NDC	Nationally Determined Contribution
PV	photovoltaics
R&D	research and development
SMART	System-integrated Modular Advanced ReacTor
SMR	small modular reactor
TES	total energy supply
TSP	Transmission and Substation Plan
USD	United States dollar
VRE	variable renewable energy
ZEB	zero-energy building

Units of measurement

cc	cubic centimetres
GW	gigawatt
GWh	gigawatt hour
km/L	kilometre-litre

kW	kilowatt
kWh	kilowatt hour
Mt	million tonnes
Mt CO_2-eq	million tonnes carbon dioxide equivalent
MW	megawatt
MWh	megawatt hour
PJ	petajoule
t CO_2	tonne carbon dioxide
TWh	terawatt hour

Explanatory note

Clean hydrogen

In this report, low-emissions hydrogen includes hydrogen which is produced through water electrolysis with electricity generated from a low-emissions source (nuclear and renewables such as solar and wind). Hydrogen produced from biomass or from fossil fuels with carbon capture, utilisation and storage (CCUS) technology is also counted as low-emissions hydrogen.

Production from fossil fuels with CCUS is included only if upstream emissions are sufficiently low, if capture – at high rates – is applied to all CO_2 streams associated with the production route, and if all CO_2 is permanently stored to prevent its release into the atmosphere. The same principle applies to low-emissions feedstocks and hydrogen-based fuels made using low-emissions hydrogen and a sustainable carbon source (of biogenic origin or directly captured from the atmosphere). The IEA does not use colours to refer to the different hydrogen production routes. However, when referring to specific policy announcements, programmes, regulations and projects where an authority uses colours (e.g. “green” hydrogen), or terms such as “clean” or “low-carbon” to define a hydrogen production route, we have retained these categories for the purpose of reporting developments in this review.

See the IEA glossary for a further explanation of many of the terms used in this report.

Infographic sources

Emissions: IEA analysis based on UNFCCC (2025), GHG data (accessed May 2025); Korea, Greenhouse Gas Inventory & Research Center (2025), National and Regional

Greenhouse Gas Statistics (accessed May 2025); Korea, Ministry of Environment (2024), 2023 Greenhouse Gas Emissions (accessed May 2025).

Electricity and hydrogen: IEA analysis based on IEA (2025), World Energy Balances; Korea, Ministry of Trade, Industry, and Energy (2025), 11th Basic Plan for Long-term Supply & Demand (accessed May 2025); Korea, Ministry of Trade, Industry, and Energy (2021), Basic Plan for Hydrogen Economy Implementation (accessed July 2025).

Fuel cell electric trucks and buses: IEA analysis based on IEA (2025), Global EV Outlook 2025; Korea, Ministry of Trade, Industry, and Energy (2019), Hydrogen Economy Roadmap (accessed July 2025).

Nuclear: IEA analysis based on IAEA (2025), Power Reactor Information System (accessed August 2025).

IEA Publications
International Energy Agency
Website: www.iea.org
Contact information: www.iea.org/contact

Typeset in France by IEA - November 2025
Cover design: IEA

Korea 2025

Energy Policy Review

Government action plays a pivotal role in ensuring secure and sustainable energy transitions. Energy policy is critical not just for the energy sector but also for meeting environmental, economic and social goals. Governments need to respond to their country's specific needs, adapt to regional contexts and help address global challenges. In this context, the International Energy Agency (IEA) conducts Energy Policy Reviews to support governments in developing more impactful energy and climate policies.

This *Energy Policy Review* was prepared in partnership between the Government of Korea and the IEA. It draws on the IEA's extensive knowledge and the inputs of expert peers from IEA Member countries to assess Korea's most pressing energy sector challenges and provide recommendations on how to address them, backed by international best practices. The report also highlights areas where Korea's leadership can serve as an example in promoting secure and clean energy transitions. It also promotes the exchange of best practices among countries to foster learning, build consensus and strengthen political will for a sustainable and affordable energy future.