



# Country Analysis Brief: South Korea

Last Updated: July 2018

## Overview

*South Korea relies on imports to meet about 98% of its fossil fuel consumption as a result of insufficient domestic resources. The country is one of the world's leading energy importers.*

South Korea ranks among the world's top five importers of liquefied natural gas (LNG), coal, crude oil, and refined products.<sup>1</sup> South Korea has no international oil or natural gas pipelines and relies exclusively on tanker shipments of LNG and crude oil.

Despite its lack of domestic energy resources, South Korea is home to some of the largest and most advanced oil refineries in the world. In an effort to improve the nation's energy security, oil and natural gas companies are aggressively seeking overseas exploration and production opportunities.

Figure 1. Map of South Korea



Source: U.S. Department of State

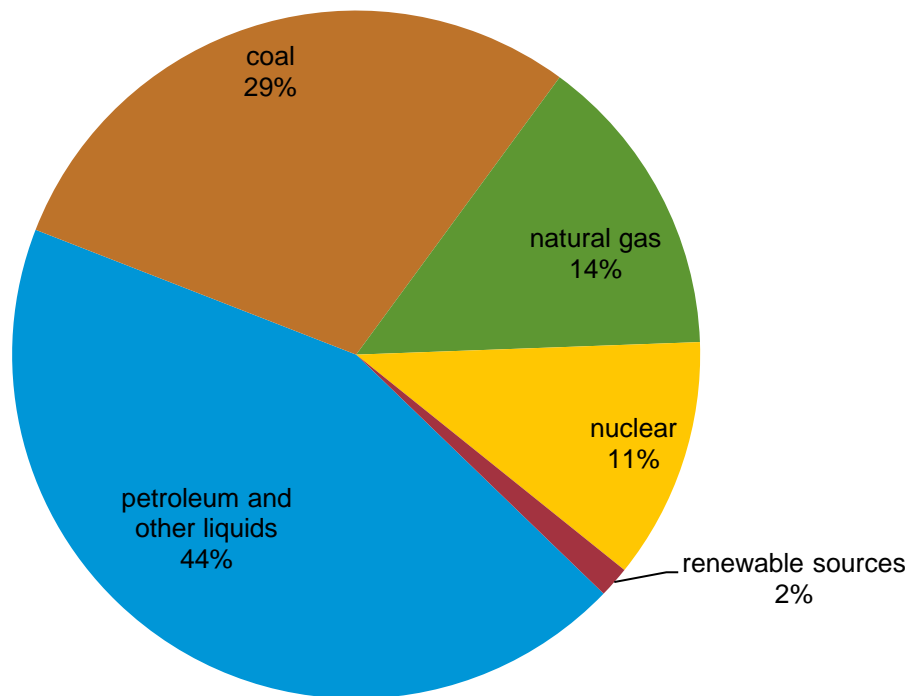
South Korea was the world's eighth-largest energy consumer in 2017, according to estimates from the *BP Statistical Review of World Energy 2018*.<sup>2</sup> South Korea's highly developed economy drives its energy consumption, and economic growth is fueled by exports, most notably exports of electronics, semiconductors, and petrochemicals. The country also is home to one of the world's top shipbuilding industries. Real gross domestic product (GDP) has edged up since 2015 to 3.1% in 2017 as demand for the country's exports strengthened.<sup>3</sup>

South Korea's economy is heavily dependent on export markets, particularly within Asia. Exports in the region have increased over the past two years, which has boosted South Korea's energy use. The country's aging population is expected to dampen domestic energy demand and the overall economic landscape over the long term.<sup>4</sup>

Although petroleum and other liquids, including biofuels, accounted for the largest portion (44%) of South Korea's primary energy consumption in 2017, its share has been declining since the mid-1990s, when it reached a peak of 66%.<sup>5</sup> This trend is attributed to the steady increase in natural gas, coal, and nuclear energy consumption, which has reduced oil use in the power sector and the industrial sector. Higher vehicle efficiencies have also reduced oil consumption (Figure 2).

Following Japan's Fukushima disaster, South Korea's problems with false safety certifications of nuclear parts in late 2012, and several earthquakes that have occurred over the past two years, the government scaled back its long-term plans to rely on nuclear power in its first basic energy plan in 2008 to its most recent power plan, the *8th Basic Plan for Electricity Supply and Demand*, unveiled at the end of 2017.<sup>6</sup> In its most recent plan, South Korea is attempting to balance its fuel portfolio to meet high energy consumption, to moderate its nuclear power generation, to reduce greenhouse gas emissions and fine dust particle pollution, and to offset some fossil fuel imports. As part of this effort, the government is also promoting greater demand-side management, energy efficiency measures, and use of renewable energy.

Figure 2. South Korea total primary energy consumption by fuel type, 2017



Note: Petroleum and other liquids includes biofuels (ethanol and biodiesel)

Source: *BP Statistical Review of World Energy 2018*



## Petroleum and other liquids

South Korea has a large oil refining sector, but the country relies almost entirely on crude oil imports to supply its refineries.

### Overview

South Korea consumed 2.7 million barrels per day (b/d) of petroleum and other liquids in 2017, making it the eighth largest consumer in the world (Figure 3). South Korean oil demand rose by more than 300,000 b/d between 2014 and 2017 as a result of lower oil prices in the transportation sector, greater use of liquefied petroleum gas (LPG) and naphtha in the petrochemical sector, and higher heavy fuel oil consumption in the power sector that followed temporary nuclear-fired capacity shutdowns. According to the Korea National Oil Company (KNOC), South Korea has a small amount of domestic oil reserves, but the country relies almost entirely on crude oil imports to meet its demand. Virtually all of South Korea's total petroleum and other liquids production of 97,000 b/d is from refinery processing gains, non-conventional liquids, and biofuels production.

According to the *Oil & Gas Journal* (OGJ), 3 of the 10 largest crude oil refineries in the world are located in South Korea, making it one of Asia's largest petroleum product exporters.<sup>7</sup> According to Facts Global Energy (FGE), South Korea exported an estimated 1.4 million b/d of refined oil products in 2017, mostly in the form of middle distillates such as gasoil, gasoline, and jet fuel. Oil product imports, nearly 0.9

million b/d in 2017, were primarily naphtha and LPG.<sup>8</sup> Because of increased oil demand in Asia during the past decade, South Korea's exports of refined products have grown rapidly. The future growth rate of oil product exports will depend on demand from regional trading partners and on rising competition from new Asian refineries.

**Figure 3. South Korea's petroleum and other liquids consumption, 1990-2019**



South Korea's oil consumption level has fluctuated with its economic growth, oil prices, and the status of its export markets. Oil consumption grew at a rapid pace with economic growth in the 1990s, but it fell following the Asian Financial Crisis of 1997. Oil consumption then rose steadily until 2007, but it dipped during the global economic downturn in 2008. Oil demand increased rapidly in 2015 and 2016 as a result of low oil prices, a temporary closure of some nuclear facilities following the Gyeongju earthquake in 2016, and new petrochemical facilities that became operational.<sup>9</sup> The pace of oil demand slowed in 2017 after oil prices rose, nuclear facilities returned to service, and liquefied petroleum gas demand moderated.

Naphtha, which is used for the country's sizeable petrochemical and industrial sectors, accounts for the largest share of total oil product demand (41%) and is a primary driver of domestic demand growth.<sup>10</sup> Naphtha demand and import growth were high in 2017 because the product replaced more expensive LPG imports and condensates.<sup>11</sup> Naphtha use is likely to continue expanding in South Korea as a result of capacity additions at ethylene plants and the rising demand for plastics within Asia. South Korea also uses LPG for its petrochemical industry, especially in propane dehydrogenation (PDH) plants and olefin facilities. LPG demand, which accounted for an estimated 12% of petroleum product demand in 2017, has risen after the addition of two large PDH plants in 2015 and 2016.<sup>12</sup> Although demand for LPG

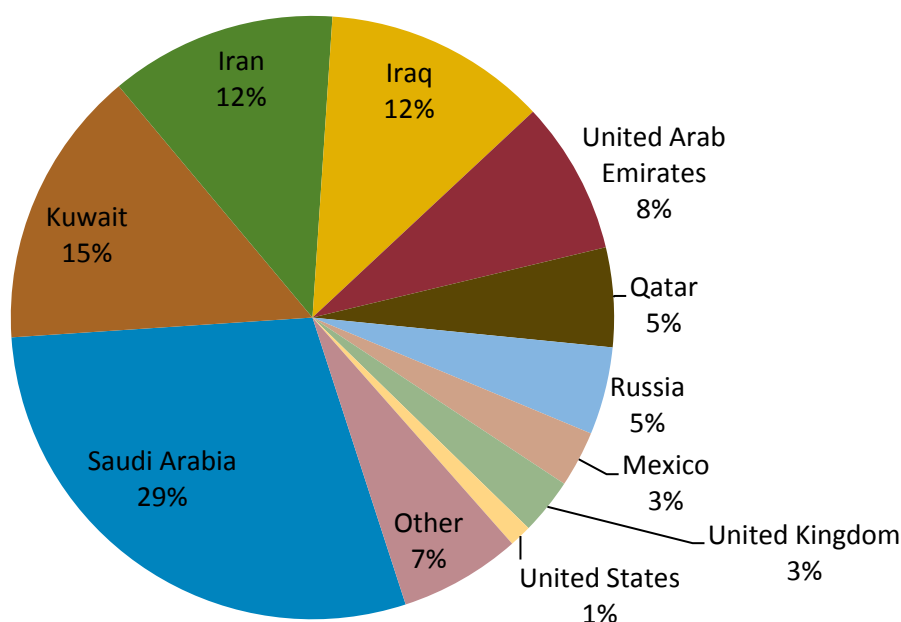
moderated in 2017, several Korean companies are upgrading their olefin plants to process LPG by 2019.<sup>13</sup>

Lower oil prices in 2015 and 2016 spurred growth in transportation fuels, but South Korea's oil demand growth outside of the petrochemical sector is limited in the long term because of the country's declining population growth and aging demographics, greater energy efficiency measures, and competition from other fuels such as natural gas, coal, and nuclear power.

In 2017, South Korea imported about 3 million b/d of crude oil and condensate, making it the fifth-largest importer in the world. South Korea is highly dependent on the Middle East for its oil supply, and the region accounted for more than 82% of South Korea's 2017 crude oil imports. Saudi Arabia was the leading supplier and the source of 29% of South Korea's imports, followed by Kuwait at 15% of total crude oil imports (Figure 4).<sup>14</sup> However, to hedge against geopolitical risks and declining oil production from traditional sources in Asia, South Korea has diversified its imports and received more oil cargoes from other suppliers such as Russia, the United States, Mexico, and the United Kingdom over the past few years.

South Korea reduced its share of crude oil imports from Iran from 10% in 2011 to 4% by 2015 to comply with sanctions imposed by the United States and Europe. The sanctions that resulted from Iran's disputed nuclear program severely limited Iran's sale of crude oil and condensate on the international market. Russia and other Middle Eastern suppliers, such as Iraq, Qatar, and the United Arab Emirates, made up for South Korea's lost imports from Iran through 2015. When Western sanctions were lifted on Iranian oil exports and its financial sector in January 2016, South Korea began increasing shipments of primarily condensate from Iran.<sup>15</sup> Shares of Iranian crude oil and condensate rebounded to 12% of South Korea's imports by 2017.<sup>16</sup> However, South Korea again reduced its imports from Iran in the first three months of 2018, partly because Iranian production temporarily declined. South Korea continues to seek other sources of global condensates as feedstock for its condensate splitters and petrochemical industry because the geopolitical climate with Iran remains tentative.<sup>17</sup>

Figure 4. South Korea crude oil imports by source, 2017



Sources: Global Trade Tracker (accessed April 2018)

### Sector organization

The Korea National Oil Corporation (KNOC) is a state-owned oil company and the largest entity in South Korea's upstream oil and natural gas sector. Through acquisitions of overseas companies and investments with major international and national oil companies, KNOC produced 116,000 b/d of oil and about 170 billion cubic feet of natural gas in 2016 in its overseas operations.<sup>18</sup>

South Korea's downstream sector includes several large international oil companies including SK Energy, the nation's largest international oil company (IOC). SK Energy is the largest marketer of petroleum products, followed by GS Caltex, S-Oil, and Hyundai Oilbank. These companies have historically focused on refining, but some have put increasing emphasis on crude oil extraction projects in other countries. SK Energy also owns the largest stake in the Daehan Oil Pipeline Corporation (DOPCO), which exclusively owns and manages South Korea's oil pipelines, although most of the country's oil is distributed by tankers or trucks.

To compensate for the lack of domestic oil reserves and to secure more crude oil supplies, South Korea's state-owned and private oil companies engage in many overseas exploration and production (E&P) projects. The South Korean government has provided financial support for the country's upstream companies to win bids overseas on E&P projects through the Special Accounts for Energy and Resources (SAER), administered by KNOC.

To reduce South Korea's dependence on foreign energy imports, the Ministry of Trade, Industry and Energy (MOTIE) established self-sufficiency targets in oil and natural gas for South Korean energy

companies based on their domestic and overseas production levels each year since 2008. These targets represented the percentage of the country's oil and natural gas consumption that were to be met by South Korean companies' overseas production, although, very little of South Korea's overseas production has been shipped back to South Korea. KNOC has accumulated massive debt in the past decade because the company purchased several unprofitable assets in a high oil price environment, and the government reversed this energy policy.

Since early 2013, South Korea's energy policy has moved away from self-sufficiency targets to reduction of debt-to-equity ratios (total debt to total assets) of the key energy companies such as KNOC, Korea Gas Corporation (KOGAS), and Korea Electric Power Corporation (KEPCO). KNOC's debt-to-equity ratio has climbed sharply in recent years to 529% in 2016 from 168% in 2012.<sup>19</sup> The government is considering restructuring KNOC and KOGAS, among other state-owned firms, to reduce debt and managerial inefficiencies.<sup>20</sup>

### Exploration and production

South Korea has only one commercially producing oil field among its domestic basins under exploration (Ulleung Basin, Yellow Basin, and Jeju Basin). Discovered in 1998, Donghae-1, Block 6-1, in the Ulleung Basin, has total proved reserves of 3.2 million barrels of ultra-light crude oil (condensates).<sup>21</sup> Natural gas and associated condensate production from Donghae-1 began in 2004. On average, KNOC has produced less than 1,000 b/d of ultra-light crude oil (condensates) from the Donghae-1 natural gas field, representing a negligible portion of its total petroleum consumption of 2.7 million b/d.<sup>22</sup>

Figure 5. KNOC's domestic exploration blocks



Source: Korea National Oil Corporation

Although new discoveries might improve domestic oil prospects, overseas exploration and production play an essential role in South Korea's oil industry. The South Korean government has encouraged private E&P overseas through tax benefits and through the extension of credit lines to IOCs by the Korea Export-Import Bank. South Korea has also provided diplomatic aid in overseas negotiations. As of December 2017, KNOC has invested in 20 producing blocks and 7 fields under development or exploration in several countries.<sup>23</sup>



Figure 6. KNOC's global exploration projects



Source: Korea National Oil Corporation

### Downstream and refining

South Korea had almost 3.2 million b/d of crude oil distillation refining capacity at the end of 2017 and ranked sixth largest for refining capacity in the world (Table 1).<sup>24</sup> The country's three largest refineries are owned by SK Energy, GS Caltex, and S-Oil Corporation (partially owned by Saudi Aramco). No new crude oil refinery projects have been proposed, although Hyundai Oilbank is expanding crude oil distillation capacity by about 80,000 b/d at its Daesan refinery by the end of 2018.<sup>25</sup>

**Table 1. South Korea's Oil Refineries as of January 2018**

Owner	Location	Capacity (barrels/day)
SK Energy	Ulsan	781,200
GS Caltex Corporation	Yeosu	734,700
S-Oil Corporation	Ulsan	622,200
Hyundai Oilbank	Daesan	400,800
SK Energy	Incheon	348,800
Hyundai Lotte	Daesan	120,900
Hanwha Total	Daesan	167,400

## Total Refining Capacity

3,176,000

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Source: FACTS Global Energy

Korean refineries have been producing more light oil products and middle distillates such as diesel, gasoline, and jet fuel as a result of refinery upgrades in recent years. Other upgrades include adding desulfurizing units to produce cleaner-burning oil. The high degree of sophistication of South Korean refineries results in high capacity utilization. As a result, South Korea is expected to remain a leading refiner in Asia, with significant exports to other Asian countries. Demand growth for oil products has improved in South Korea's export and domestic markets over the past two years and has boosted refining margins.<sup>26</sup>

Since 2014, South Korean refiners commissioned several condensate splitters, which are refineries that convert only condensate oil (ultra-light grade crude oil) into products such as naphtha for petrochemical use. Hyundai Oilbank and Lotte Chemical commissioned a 121,000 b/d splitter in late 2016, which brings South Korea's total condensate splitting capacity to about 464,000 b/d.<sup>27</sup> Most of South Korea's condensate imports are from Qatar and Iran. South Korea's refiners have expressed interest in importing more condensate from the United States.<sup>28</sup>

## Petroleum and other liquids storage

To protect against oil supply disruptions and price fluctuations, South Korea holds strategic and commercial oil reserves for both crude oil and petroleum products. KNOC operates nine state-run strategic storage facilities with 146 million barrels of capacity. As of March 2018, KNOC held 96 million barrels of strategic reserves, and about 27 million barrels of inventories are stored as international stockpiles under agreements between South Korea and other governments. South Korea can use these reserves in case of an emergency, although the international joint stockpiling mechanism provides a way to lease out the strategic reserve capacity.<sup>29</sup> Other companies such as SK Energy, GS Caltex, S-Oil, and Hyundai Oilbank also hold stocks for industrial operations, according to the International Energy Agency.<sup>30</sup>

As part of South Korea's efforts to become a major liquids storage and trading hub in northeastern Asia, KNOC, through joint ventures with other firms, has been building the country's first commercial terminals for crude oil and petroleum products at Yeosu and Ulsan, which will hold a total capacity of 36.6 million barrels. The first facility, located in Yeosu in the southwestern region of the country, came online in 2013, with 8.2 million barrels of capacity. The other two facilities are being constructed in two phases in Ulsan in the southeastern region of South Korea and will bring 28.4 million barrels of capacity online by 2026.<sup>31</sup>

## Natural gas

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*South Korea is the third-largest importer of liquefied natural gas in the world behind Japan and China.*

South Korea relies on imports to satisfy almost all of its natural gas demand, which has nearly doubled over the past decade. Domestic natural gas production is negligible and accounts for less than 1% of total consumption. South Korea does not have any international natural gas pipeline connections and

must import all natural gas via LNG tankers. As a result, although South Korea is not among the top natural gas-consuming nations, it is the third-largest importer of LNG in the world after Japan and China.

## Consumption

South Korea consumed an estimated 1.7 trillion cubic feet (Tcf) of dry natural gas in 2017, more than double the amount in 2000 (Figure 7). For the past decade, power generation has required a growing share of South Korea's natural gas supply.<sup>32</sup> Power generation companies accounted for about half of the natural gas sales in 2016. The industrial sector accounted for 17%, and the residential and commercial sectors accounted for about 30% of natural gas consumption. The transportation sector's use of natural gas has grown over the past several years but still accounts for a small portion 3% of total natural gas consumption.

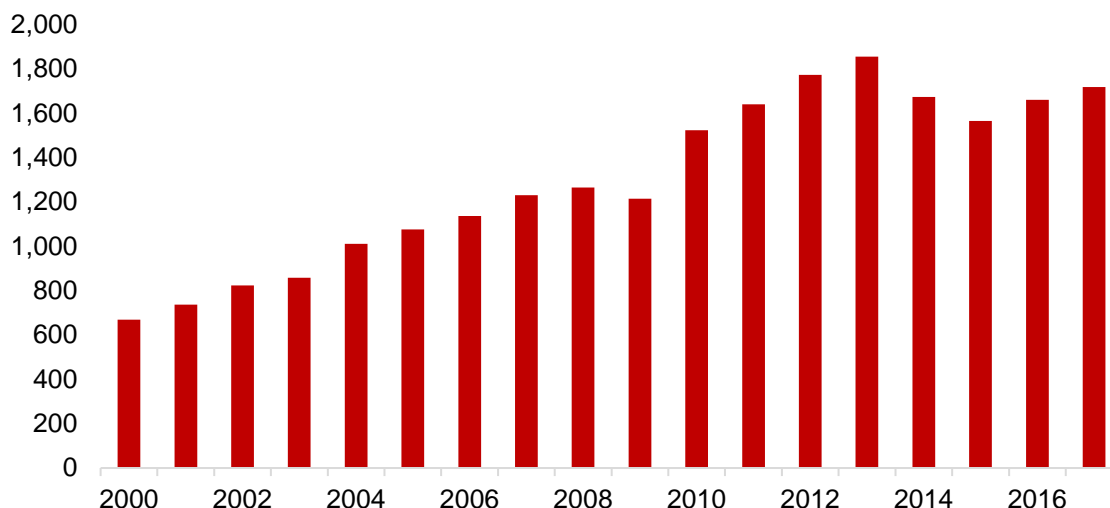
Strong natural gas consumption growth between 2009 and 2013 was driven by electricity demand and economic growth. Natural gas consumption then fell by 16% between 2013 and 2015. Power generators increased the use of coal and nuclear power starting in 2014. Nuclear facilities returned to service following a shutdown in 2012 because of safety problems, and global coal prices plummeted and were lower than the price of imported natural gas. Industries also chose to burn more coal than natural gas based on cost competitiveness.

Natural gas demand rebounded in 2016 and 2017 as a result of the government shutdown of nuclear plants following the Gyeongju earthquake in September 2016 and the recovery in the country's manufacturing sector in 2017. South Korea's energy ministry issued regulations to limit the use of coal-fired and oil-fired power plants and higher sulfur coal use starting in July 2018 to immediately reduce fine dust emissions. This cutback could make natural gas more competitive as a fuel source in the short term.<sup>33</sup>

The South Korean government recently unveiled its long-term natural gas and electricity plans through 2031, which affirm the growth of natural gas through the forecast period, albeit at a much slower pace (less than 1% annually) than the average rate over the past decade. The country plans to reduce electric generation from coal and nuclear power to tackle air pollution, reduce environmental emissions, and manage concerns about nuclear safety issues.<sup>34</sup> However, natural gas in the power sector will compete with lower cost coal-fired generation facilities and new coal- and nuclear-based capacity under construction that will come online in the next few years. Natural gas remains a key source of lower-emitting fossil energy for the country, and, over the long run, key factors determining natural gas demand growth will be LNG market prices, deregulation of the LNG market in South Korea, and government policy.

Figure 7. South Korea's natural gas consumption, 2000-17

billion cubic feet



Source: U.S. Energy Information Administration, International Energy Agency, KEEI

## Sector organization

Korea Gas Corporation (KOGAS) dominates South Korea's wholesale natural gas sector, and the company is the largest single LNG importer in the world. In addition to operating four of Korea's six LNG receiving terminals, KOGAS owns and operates the national pipeline network.<sup>35</sup> Although the government has plans to liberalize the LNG import market by allowing other local importers to resell their LNG cargoes, KOGAS maintains an effective monopoly over the purchase, import, and wholesale distribution of natural gas. Currently, private companies are allowed to import LNG only if they use the natural gas for their own purposes and if the price does not exceed KOGAS' long-term contract prices. In 2016, the government announced plans to deregulate this sector by 2025 and to allow private companies to import and resell LNG, essentially allowing them to compete with KOGAS.<sup>36</sup>

The South Korean central government is the largest KOGAS shareholder, with 26.15% direct equity, a 20.47% share through the state-owned Korean Electric Power Company (KEPCO), and a 7.94% share from local governments. The remaining shares are privately owned.<sup>37</sup> South Korea has more than 30 private distribution companies, and each company has monopoly control in its region. These local companies purchase wholesale natural gas from KOGAS at a government-approved price, and then sell the natural gas to end users.<sup>38</sup>

In the upstream sector, KOGAS has previously focused primarily on overseas LNG liquefaction projects, while the KNOC has handled most exploration- and production-related activities. However, as KOGAS seeks new opportunities for growth, its focus on overseas upstream activities has increased. As part of the effort to develop into a global integrated energy company and to secure more LNG from its own supplies, KOGAS has participated in E&P projects around the world and has invested in foreign natural gas companies with LNG supply. As of the end of 2017, KOGAS held investments in 24 projects, including exploration, production, LNG assets, and downstream facilities, in 13 countries.<sup>39</sup>

KOGAS's equity purchases of upstream and downstream projects overseas in the past decade and cost overruns from some of these projects have increased the company's debt levels. At the end of 2017,

KOGAS' debt-to-equity ratio remained high at 356%. In response to the government's pressure to reduce its debt-to-equity ratio, KOGAS may divest some stakes in its natural gas projects overseas.<sup>40</sup>

## Exploration and production

South Korea produced only 12 billion cubic feet (Bcf) of domestic natural gas in 2017, down from a high of 19 Bcf in 2010. This production was from the Donghae-1 and Donghae-2 natural gas fields in the Ulleung Basin.<sup>41</sup> KNOC plans to continue production operations of the fields until 2019, when the reserves are expected to be depleted. KNOC and Woodside Energy (Australia) are jointly exploring deepwater blocks of the offshore Ulleung Basin and began drilling in 2012.<sup>42</sup>

## Liquefied natural gas

After China surpassed South Korea in LNG imports in 2017, South Korea now ranks as the third-largest global importer of LNG after Japan and China. In 2017, South Korea imported more than 1.9 Tcf of LNG, rebounding after a recent low of 1.6 Tcf in 2015. LNG imports rose 13% in 2017 because of an economic recovery, higher industrial output, more residential consumption, higher volumes from private sector LNG importing companies, and restocking inventory levels by KOGAS.<sup>43</sup>

South Korea currently has six LNG regasification facilities with a peak capacity of 6.1 Tcf per year and an average estimated utilization rate of 35%. KOGAS operates four of these facilities (Pyongtaek, Incheon, Tong-Yeong, and Samcheok), accounting for about 97% of current capacity. The Samcheok terminal, located on the northwest coast, is KOGAS's smallest terminal and was added in 2014. KOGAS is constructing a small terminal at Jeju Island and expects to commission almost 50 Bcf per year of capacity by 2019. South Korea is well-endowed with natural gas storage capacity at its LNG terminals, and KOGAS' goal is to hold 20% of their natural gas demand in storage by 2029.<sup>44</sup>

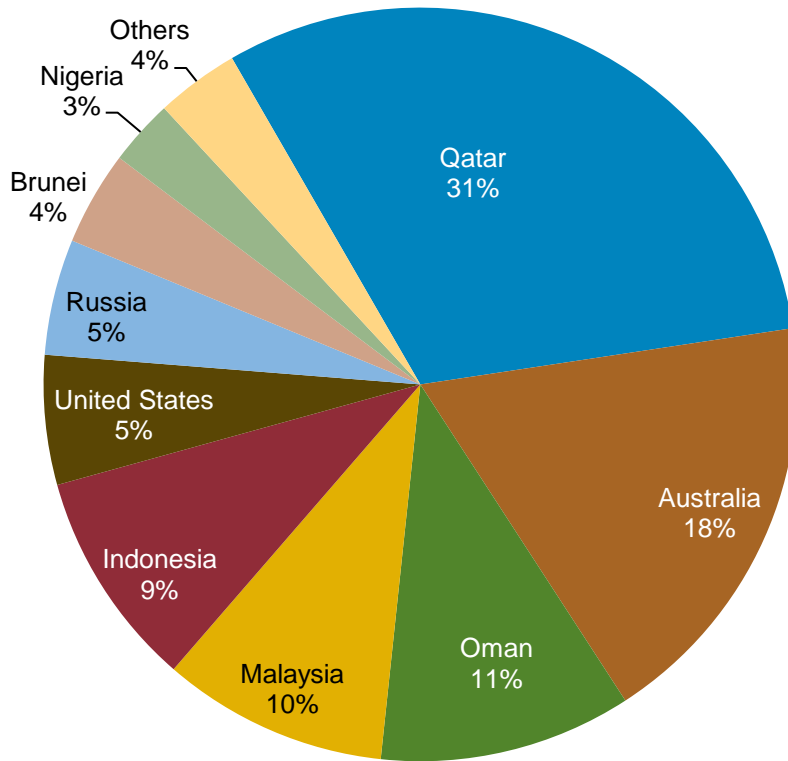
The first privately-owned regasification terminal in South Korea came online in 2005. Pohang Iron and Steel Corporation (POSCO) and K-Power jointly own the Gwangyang regasification facility located on the southern coast. A second privately owned regasification facility at Boryeong, located in the northwestern region, was brought online at the beginning of 2017 by a joint venture between GS Energy Corporation and SK E&S Company. The facility added about 145 Bcf to capacity.<sup>45</sup> Both of these privately owned terminals have very small capacities compared with the capacity owned by KOGAS. However, these private operators have been key contributors to the rise in Korean LNG imports in 2017, and their terminals operate at high utilization rates compared with the national average. Because of KOGAS' monopoly power and high LNG resale prices, private industries have a greater incentive to invest in regasification capacity and purchase less expensive LNG on the global market.

KOGAS purchases most of its LNG through long-term supply contracts, and the company uses spot cargos primarily to correct small market imbalances. Nearly half of 2017 LNG imports came from Qatar and Australia (Figure 8). Indonesia was South Korea's first source of LNG and supplied more than half of South Korea's LNG imports before 2000. As South Korea diversified its LNG imports to secure more sources of natural gas to meet its growing demand, Indonesia lost market share to other countries including Qatar, Oman, Nigeria, Russia, and Australia.

Several South Korean firms own shares in liquefaction projects in the Middle East, Australia, Indonesia, and Canada and signed long-term purchase agreements for LNG coming online from new liquefaction

projects in Australia and the United States. KOGAS and SK Energy hold flexible destination contracts, which allow the companies to resell volumes in the open market, with the Sabine Pass and Freeport liquefaction terminal projects in the Gulf Coast of the United States. Sabine Pass began operations in 2017, and Freeport LNG is expected to be online in 2019.<sup>46</sup> KOGAS also owns shares in upstream exploration and production assets in natural gas fields around the world including Canada, Iraq, and Southeast Asia.<sup>47</sup>

Figure 8. South Korea LNG imports by source, 2017



Source: IHS Energy

Note: Others include Algeria, Angola, Equatorial Guinea, Norway, Papua New Guinea, Peru, Trinidad and Tobago, and re-exports.



## Coal

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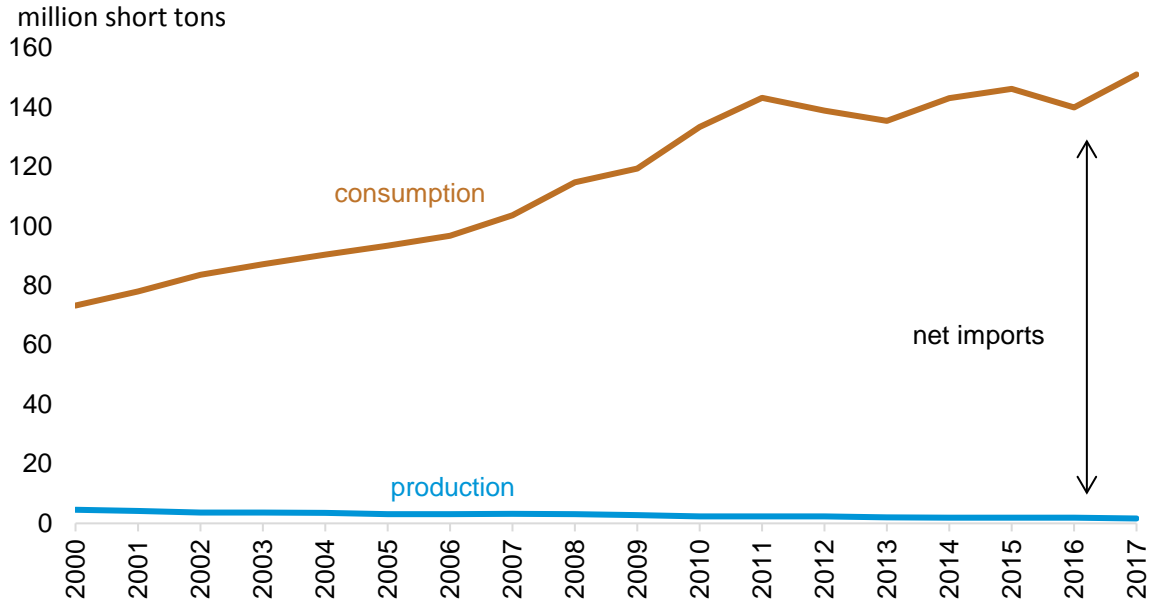
*Rising coal consumption in South Korea and negligible domestic production resulted in the country having to rely heavily on coal imports over the past several years. In 2017, South Korea was the fourth-largest global coal importer.*

South Korea produced an estimated 1.6 million short tons (MMst) of coal from its anthracite reserves, which was a small fraction of its estimated primary coal consumption of 151 MMst in 2017 (Figure 9).<sup>48</sup> Because of this wide supply and demand gap, South Korea is the fourth-largest importer of coal in the world, following China, India, and Japan. Imports have risen in the past few years, from 131 MMst in 2010 to 165 MMst in 2017 as a result of the forced shutdowns of some nuclear plants in late 2012 because of safety issues and because of precautions taken following a major earthquake in 2016. However, weakened power demand and delays in starting new coal-fired plants since 2012 have slowed the growth of overall coal imports. Several large coal-fired plants came online in 2016 and 2017, adding nearly 12 gigawatts (GW) of incremental capacity, and South Korea's manufacturing sector began to recover in 2017.<sup>49</sup> These factors contributed to a 9% increase in South Korea's coal imports in 2017.

Australia and Indonesia historically accounted for most of South Korea's coal imports (more than 60% in 2017). Russia and Canada are other notable sources. Coal imports from South Africa, Colombia, and the United States substantially increased in 2017 when South Korea required more coal (Figure 10).<sup>50</sup> Coal consumption in South Korea increased by more than 50% between 2007 and 2017, driven primarily by growing demand from the electric power sector. The electric power sector accounted for more than 60% of the country's coal consumption, while the industrial sector (primarily steel and cement) accounted for most of the remaining coal demand in 2017, according to KEEI.<sup>51</sup>

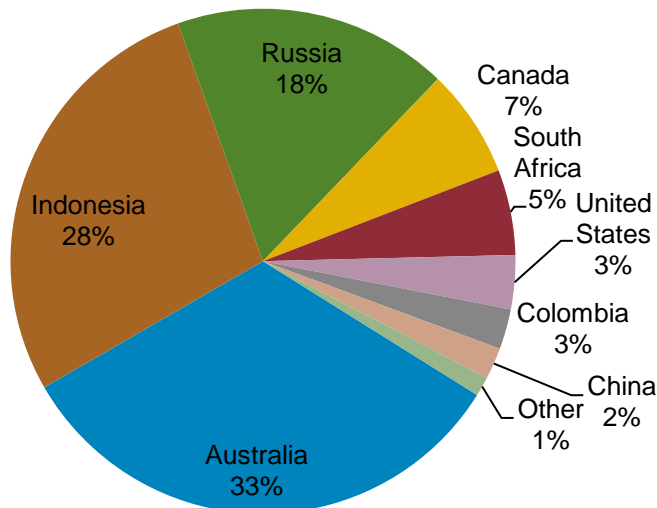
As part of the South Korean government's efforts to mitigate air pollution and environmental emissions, the country's *8th Basic Plan for Electricity Supply and Demand*, suspended plans for new coal-fired capacity not already under construction and is retiring all plants older than 30 years. Also, the government plans to increase the coal import consumption tax in 2018.<sup>52</sup> Even though South Korea intends to reduce its reliance on coal for power in the longer term, coal is likely to continue playing a large role in South Korea's energy demand over the next few years. Several coal-fired facilities are already under construction and will come online by 2024, and coal continues to remain more economical than natural gas and renewable energy, despite the current coal tax.

Figure 9. South Korea's coal production and consumption, 2000-17



eia Source: U.S. Energy Information Administration,

Figure 10. South Korea, coal imports by source, 2017



eia Source: Global Trade Tracker (accessed April 2018)



## Electricity

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*Fossil fuel sources account for nearly two-thirds of South Korea's electricity generation, while the share of nuclear power accounts for almost one-third. Renewable energy is set to grow based on government incentives and power plan targets.*

South Korea generated more than 553 terawatt-hours (TWh) of gross electricity in 2017, according to KEEI estimates. South Korea's power generation growth has remained lower than 3% per year since 2012 after averaging about 5% the previous decade.<sup>53</sup> This significant deceleration, especially through 2015, is attributed to weaker economic demand and export growth and demand side management measures. After electricity generation growth fell to less than 1% in 2014, it began to increase slowly. In 2016 and 2017, power generation growth slightly rebounded to more than 2% each year as a result of stronger export growth and some recovery in industrial demand.<sup>54</sup> In 2017, about 54% of electricity consumption came from industries, 26% from commercial and service enterprises, 13% from the residential sector, and 7% from other sectors such as transportation and agriculture, according to KEEI.<sup>55</sup>

In the *8th Basic Plan for Electricity Supply and Demand*, published in 2017, the South Korean government lowered its anticipated electricity demand growth to 1% annually through 2030. The government intends to cut its greenhouse gas emissions and reduce fine dust particle pollution through energy conservation measures and through the use of cleaner energy from natural gas, nuclear, and renewable energy sources. Also, GDP is expected to grow at a slower pace than previously anticipated, leading to lower power demand.<sup>56</sup>

Fossil fuels generated about 65% of South Korea's electricity in 2016, while 30% came from nuclear power, and more than 5% came from renewable sources, including hydroelectricity (Figure 11).<sup>57</sup> Coal-fired power, which is a baseload source, is the dominant fossil fuel used to generate electricity, and natural gas-fired capacity is the second largest source. Oil products generate very small amounts of power. Nuclear power, also a baseload source, will increase capacity in the short term from plants that are already under construction. However, by 2030, the government intends to reduce the country's reliance on coal and nuclear power generation in favor of renewable energy and natural gas. The country's new power plan calls for shares of coal and nuclear to decrease to 36% and 24%, respectively. These shares are slated to be offset by renewable energy sources rising to a 20% share and natural gas staying at a 19% share in 2030.<sup>58</sup>

### Sector organization

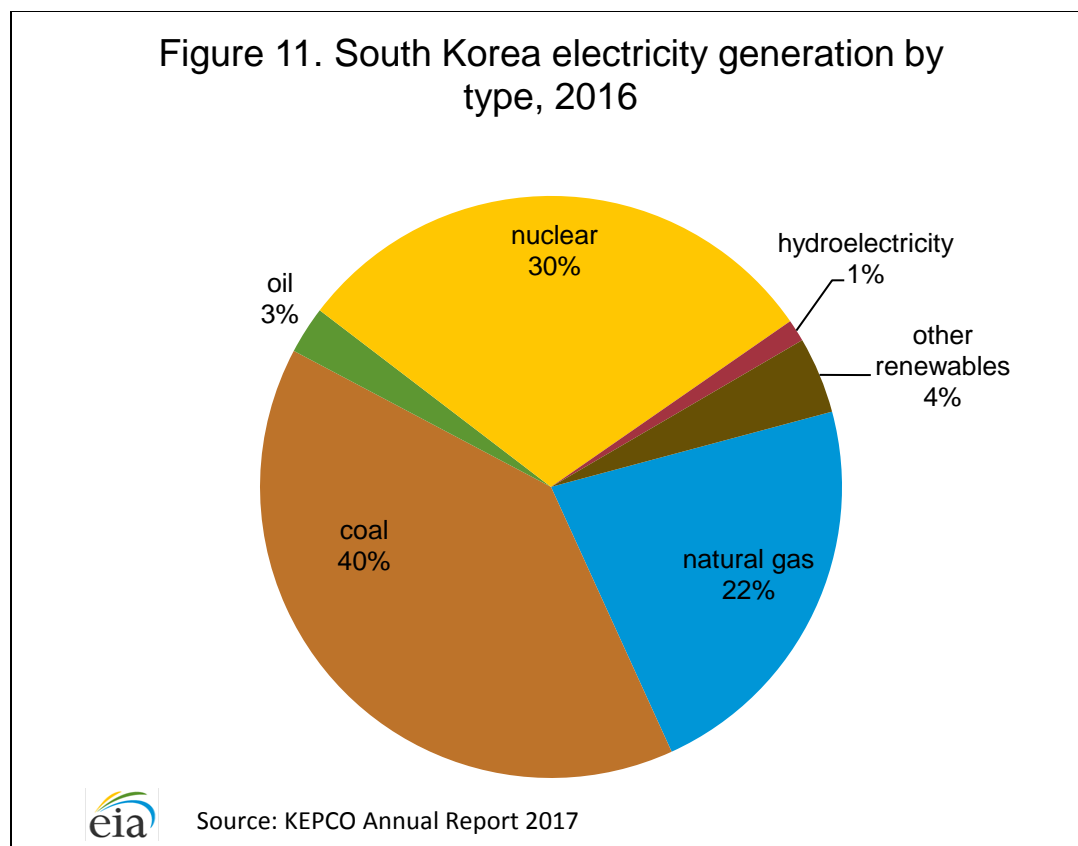
The state-owned Korea Electric Power Corporation (KEPCO) is the primary electricity producer in South Korea and dominates the country's retail sales, transmission, and distribution. In 2001, KEPCO's generation assets were spun off into six separate subsidiary power generation companies. Although the initial restructuring included plans to subsequently divest KEPCO of these generation companies (excluding the Korea Hydro & Nuclear Power Company), KEPCO still owns each of the subsidiaries. KEPCO also owns majority shares of KEPCO Engineering and Construction, Korea Nuclear Fuel, Korea Plant Service and Engineering, and Korea Electric Power Data Network.

The Korea Electric Power Exchange (KPX), also established in 2001 as part of the electricity sector reform efforts, serves as the system operator and coordinates the wholesale electric power market. Several

independent power producers, such as Posco, SK, and GS, can sell electricity into the KPX. KEPCO continues to act as the electricity retailer, and it controls transmission and distribution.<sup>59</sup>

KPX regulates the cost-based bidding-pool market and determines prices sold between electricity generators and the KEPCO grid. An electricity tariff pricing system, designed to protect low-income residents and industrial consumers, historically has not reflected the true costs of generation and distribution, and the pricing system has not provided incentives to conserve electricity. MOTIE must approve all changes in end-use electricity prices. Retail consumer prices remain far lower than electricity prices in other economically developed countries, which has contributed to high overall electricity demand and power shortages during peak seasons, particularly before 2013.<sup>60</sup>

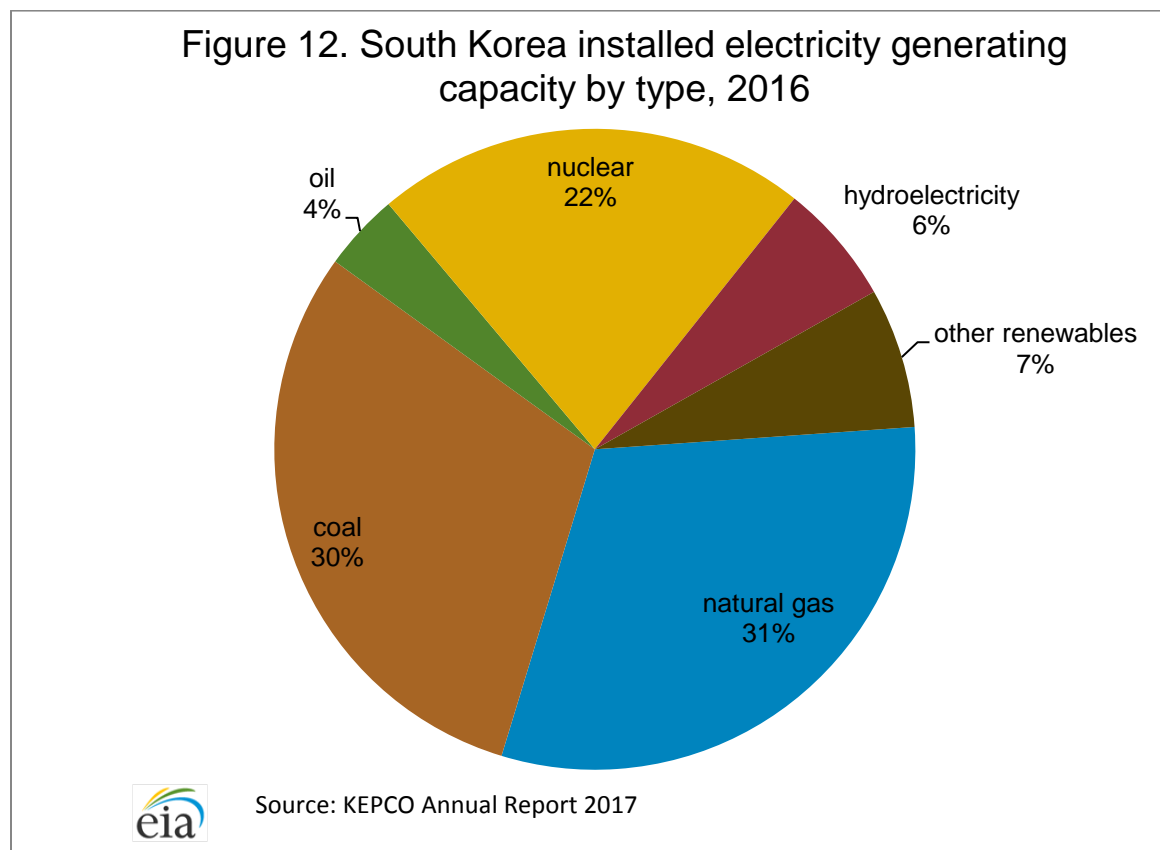
According to KEEI, reserve margins—the difference between peak capacity and peak electricity demand was lower than 10% on an annual basis between 2007 and 2013, resulting in major blackouts in 2011.<sup>61</sup> These low margins were the result of delays in installed capacity additions, low electricity prices, high peak demand during certain years as a result of weather, and insufficient investment in renewable energy and energy efficiency projects until recently. Since 2014, the reserve ratio increased to more than 11% because power consumption eased, more natural gas-fired, coal-fired, and renewable plant capacity came online, and nuclear facilities affected by the safety problems in 2012 returned to service. The speed of incremental capacity additions has increased since 2014, and several more generation facilities are expected online in the next few years. In its latest electricity plan, South Korea projects that reserve margins will reach 22% by 2031.<sup>62</sup>



## Generation structure

Most of South Korea's installed generation capacity is fossil fuel-based, although nuclear power plays a significant role in the power sector. Baseload generation is primarily made up of coal and nuclear power, while peak demand is generally met by the natural gas-fired power. According to KEPCO and KEEI, South Korea's generating capacity at the end of 2016 was 106 GW, consisting primarily of natural gas (31%), coal (30%), and nuclear generation (22%).<sup>63</sup> Oil, hydroelectricity, and other renewables made up smaller shares (Figure 11).<sup>64</sup>

Capacity rose from 98 GW in 2015 as coal, natural gas, renewable energy, and nuclear units were added. South Korea intends to reduce its greenhouse gas emission levels by 26% from business-as-usual projected levels (projections of emission levels absent any carbon price scheme) and to cut its fine dust pollution levels by 62% by 2030.<sup>65</sup> To meet these goals, the government is promoting the development of renewable energy and natural gas-fired plants and phasing out of older, less efficient coal-fired plants.<sup>66</sup>



Fossil fuels account for most of the country's installed capacity, which consisted of 69 GW of coal and natural gas power plants in 2016, or about 65% of the total capacity, according to KEPCO (Figure 12).<sup>67</sup> In South Korea plans to retire all coal-fired power plants older than 30 years and to suspend any proposed coal-fired projects either not under construction and not at least 10% complete, which is consistent with the country's goal to incorporate cleaner sources of fuel into the generation portfolio.

By 2022, about 5.6 GW of coal-fired capacity will be slated for closure.<sup>68</sup> These closures are expected to be offset by about 7.3 GW of new coal capacity already under construction and coming online in the same timeframe.<sup>69</sup>

The government intends for natural gas-fired power plants to replace coal-fired facilities after they are retired and the coal-fired power projects that have been shelved as a result of the latest electricity plan. So far, about 4 GW of these conversions have been announced and are scheduled to be online by 2025.<sup>70</sup> Currently, natural gas competes with less-expensive coal and nuclear sources of power, and prices for much of the natural gas sold within the country, particularly by KOGAS, is higher than international spot LNG prices. South Korea is weighing environmental, economic, and nuclear safety concerns and is trying to balance its power generation portfolio accordingly. The country's future slate of fuel for power will depend on fuel costs, the government's tax policies and regulations that favor one fuel over another, and the level of investment for clean energy technology.

Nuclear generation accounts for nearly one-third of South Korea's electricity generation and about 22% of installed generating capacity.<sup>71</sup> As of early 2018, South Korea ranked sixth-highest for nuclear generation capacity in the world and was surpassed by China in 2016.<sup>72</sup> The country's first nuclear power plant was completed almost four decades ago, and since then, South Korea has directed significant resources toward developing its nuclear power industry. South Korea imports all of the uranium needed to fuel its nuclear power plants and does not reprocess or enrich uranium as a result of a 30-year nuclear cooperation agreement with the United States. The countries extended this agreement for 20 years in June 2015, although the new terms did not lift the restrictions on South Korea for producing its own nuclear fuel.<sup>73</sup>

Korea Hydro & Nuclear Power Company currently operates South Korea's four nuclear power stations, which have 25 individual reactors with a net power generation capacity of 23 GW. The latest reactor came online in early 2016, and the country has added 5.3 GW of capacity at new plants since 2010.<sup>74</sup> Five reactors with 6.7 GW of capacity are under construction and scheduled to come online by 2022. Meanwhile, about 7.9 GW of capacity are scheduled to close by 2030 under the government's policy not to renew licenses for older nuclear reactors.<sup>75</sup> Although South Korea has historically relied on nuclear power for a significant portion of its generation, public sentiment has turned negative following Japan's Fukushima disaster in 2011 and several incidents of falsified certificates for components of some South Korea's existing nuclear power plants in 2012.

A renewable portfolio standard for South Korea replaced the previous feed-in tariff system in 2012 and requires South Korea's major electric utilities to gradually increase the renewable energy share in their power generation portfolios to an average of 10% by 2024.<sup>76</sup> Renewable sources (primarily solar, wind, biomass, and waste) remain a small share of South Korea's electricity generation (6% in 2016), although robust growth in generation from renewable sources has occurred.<sup>77</sup> South Korea's latest power plan targets the share of power generation from renewable energy to rise to 20% by 2030, mostly by developing wind and solar capacity.<sup>78</sup>

## Notes

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- Data presented in the text are the most recent available as of July 16, 2018.
- Data are EIA estimates unless otherwise noted.

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