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King Abdullah Petroleum Studies and Research Center

Saudi Arabia Energy Report

Abeer Al Ghamdi

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About KAPSARC

The King Abdullah Petroleum Studies and Research Center (KAPSARC) is a non-profit global institution dedicated to independent research into energy economics, policy, technology and the environment across all types of energy. KAPSARC's mandate is to advance the understanding of energy challenges and opportunities facing the world today and tomorrow, through unbiased, independent, and high-caliber research for the benefit of society. KAPSARC is located in Riyadh, Saudi Arabia.

This publication is also available in Arabic.

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Key Points

In 2018, the Kingdom of Saudi Arabia had around 298 billion barrels of proven reserves, up from 296 billion barrels in 2017, representing 57% of all Gulf Cooperation Council (GCC) reserves. Saudi Arabia's gas reserves reached around 6 trillion cubic meters (tcm) in 2018, making it the world's sixth-largest holder of gas reserves.

In 2018, Saudi Arabia produced 12.3* million barrels per day (MMb/d) of oil per day, representing 13% of total global oil production, and exported an estimated 8.5 MMb/d of crude oil and refined products. The Kingdom's direct oil use reached 0.41 MMb/d in the same year, and natural gas production reached 112 billion cubic meters (bcm), representing 3% of total global natural gas production. There is more domestic demand for natural gas (708.6 MMb) than any other petroleum product. Natural gas demand is followed by premium gasoline demand at 194 MMb.

In 2018, Saudi Arabia produced 1,028.3 MMb of refined products. This represented a 1.9% fall from 2017. Diesel was the most refined product at 392 MMbd, followed by gasoline and fuel oil at 199 MMb.

Oil refinery throughput reached 2.7 MMb/d in 2018, which accounted for 3% of global refinery throughput and 47% of all GCC oil refinery throughput.

Saudi Arabia's electricity consumption in 2018 was around 289.8 terawatthours (TWh), a slight increase of 0.42% from the 2017 level of around 288.6 TWh. Electricity peak load was 61.7 gigawatts (GW) in 2018, down by 1.5% from 2017 (62.1 GW), while electricity power generation capacity decreased by 1.7% in the same year to 68.8 GW from around 70 GW in 2017.

Saudi Arabia's installed renewable energy capacity was 142 megawatts (MW) in 2018, with wind power accounting for 3 MW, and photovoltaic (PV) 139 MW. Saudi Arabia accounted for 20% of total GCC installed renewable energy capacity.

* Oil production includes crude oil, shale oil, oil sands, condensates (lease condensate or gas condensates that require further refining) and natural gas liquids - ethane, LPG and naphtha separated from the production of natural gas.

Summary

Saudi Arabia is one of the world's leading oil producers and exporters. It has the second-largest proven crude oil reserves after Venezuela. Saudi Arabia's oil reserves have made it one of the most significant players in the global oil market. The country also possesses vast reserves of natural gas and, in 2018, had the sixth-largest reserves of natural gas, just below the United States. In 2018, Saudi Arabia also accounted for 13% of world oil production and 3% of all natural gas production. Saudi Arabia has a massive electricity distribution network that covers all major cities, towns and villages across the country. In 2018, Saudi Arabia's electricity generation reached 384 terrawatthours (TWh), representing 55% of all Gulf Cooperation Council (GCC) countries' total generation.

While the economy of Saudi Arabia is still dependent on oil and petrochemicals, it recognizes the importance of having a diversified energy mix for its economic prosperity. The country is also looking at alternative energy sources, including solar energy, as it receives some of the most intense sunlight in the world. Saudi Arabia has one of the largest renewable production capacities in the GCC, accounting for 19% of total GCC wind production and 18% of total GCC solar production. It has an ambitious plan to deploy more renewable energy and has successfully tendered for large-scale projects in wind and solar energy. The Kingdom has major oil fields and oil refineries, most of which are located in the Eastern Province, including the largest onshore field, Ghawar, and the largest offshore field in the Arabian Gulf, Safaniya.

Saudi Arabia is the world's biggest oil exporter. In 2018, it exported an estimated 8.5 million barrels per day of crude oil and refined products. The country plays an important role in the global energy industry. Its policies regarding its production and export of oil, natural gas and petroleum products have a major impact on the energy market and the global economy.

This report provides a comprehensive overview of Saudi Arabia's energy profile. It gives an overview of the country's primary and secondary energy mix, with a focus on the 2018 key energy data indicators. The first section details the Kingdom's oil and gas reserves, production and consumption and provides data on Saudi Arabia's renewable energy potential. The second section focuses on Saudi Arabia's secondary energy, which includes refinery capacities and electricity consumption. This report is also available in a digital version, which includes machine-readable data and dashboards and will be updated annually.

Saudi Arabia Fact Sheet (2018)

Population	34,173,498 (July 2020 est.)
Population growth rate	1.6% (2020 est.)
Area	2,149,690 sq km
Natural resources	Petroleum Natural gas Iron ore Gold Copper
Number of housing units	3,591,098 data
Climate	Dry desert with significant temperature extremes

Sources: CIA (2020); KAPSARC.

Access this link for Saudi Arabia's country profile.

Primary Energy

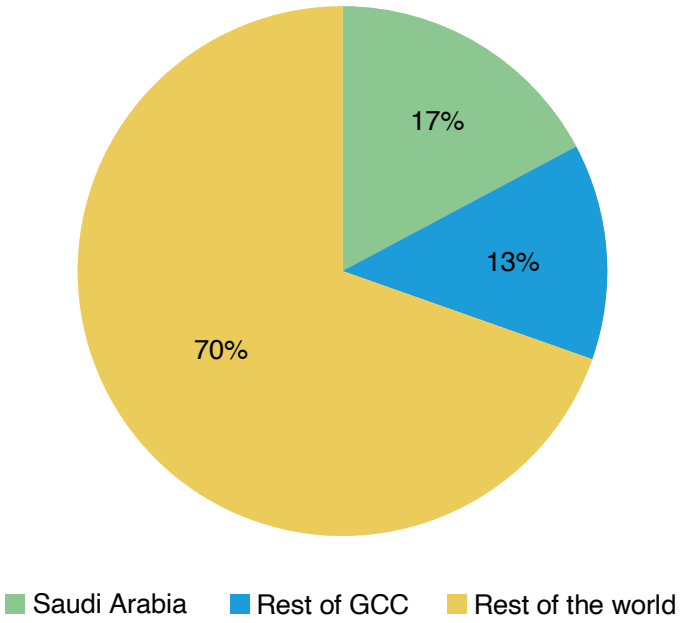
Reserves

Oil

Saudi Arabia holds 16% of the world's proven oil reserves, second only to Venezuela with 18%.

According to the BP Statistical Review of World Energy 2019, the Kingdom had around 298 billion barrels of proven reserves in 2018, up from 296 billion barrels in 2017, which represented 57% of all Gulf Cooperation Council (GCC) reserves (over 500 billion barrels). There were more than 1,700 billion barrels of total world reserves in 2018.

Figure 1. Saudi Arabia's oil reserves (2018).



Sources: BP (2019); KAPSARC analysis.

Gas

Saudi Arabia accounted for 3% of total world gas reserves in 2018 (around 6 trillion cubic meters [tcm], up from 5.7 tcm in 2017), making it the world's sixth-largest holder of gas reserves. Total world gas reserves in 2018 stood at 203 tcm. Saudi Arabia holds 16% of the total GCC gas reserves of more than 39 tcm.

Oil fields

State-owned Saudi Aramco, established in 1988, is the world's largest oil-producing and exporting company. It owns oil fields linked to an extensive network of integrated facilities that send crude oil to multiple plants for processing. The five main oil fields are the Ghawar field in Al-Ahsa, Eastern Province, the Safaniya oil field, Shaybah, Khurais, and Zuluf on the Arabian Gulf. There are also other more minor fields spread throughout the country (KAPSARC Data Portal 2020).

1. Ghawar field

Ghawar, discovered in 1948, is the world's biggest onshore oil field by reserves and daily output, and is located in Al-Ahsa. The field is owned and operated

by Saudi Aramco. Ghawar accounts for more than half of the total cumulative crude oil production in the Kingdom, with a production capacity of over 5 million barrels per day (MMb/d).

2. Safaniyah field

Safaniyah is the world's largest offshore field, located north of Dhahran. Most of the field lies offshore in the Arabian Gulf. It was discovered in 1951 and is owned and operated by Saudi Aramco. It has a production capacity of around 1.5 MMb/d, is approximately 50 kilometers (km) long and 15 km wide.

3. Shaybah

Shaybah is located on the northern edge of the Rub' Al-Khali/Empty Quarter. It was established in the 1990s and is fully operated by Saudi Aramco. The field has a total production capacity of 1 MMb/d. Shaybah has become a key part of Aramco, bringing prosperity to the country and providing energy to the world. Shaybah has enough reserves to supply the entire world's oil requirements for over 160 days.

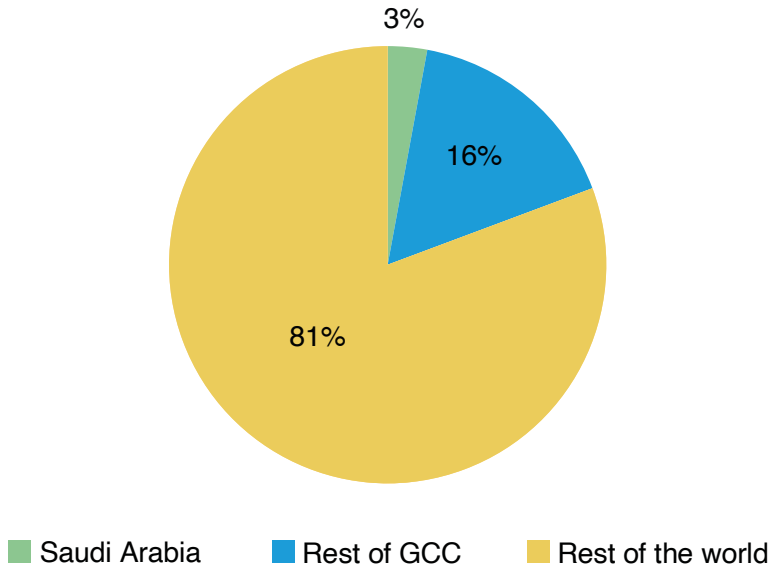
4. Khurais

The Khurais field is Saudi Arabia's second-biggest oil field, after Ghawar. It is located 250 km southwest of Dhahran. The oil field started production in 2009 and has a capacity of around 1.5 MMb/d. The Khurais complex, which comprises the Abu Jifan and Mazalij fields, is around 106 km long and 18 km across at its widest point.

5. Zuluf

Zuluf is a giant offshore field located 240 km north of Dhahran in the Arabian Gulf, is approximately 40 meters deep, and is owned and operated by Aramco. It has a capacity of 800 thousand barrels per day (Kb/d) of Arab medium crude oil, and is undergoing a major expansion to add 600 Kb/d of Arabian heavy crude production (Aramco 2019a; NS Energy 2020).

Figure 2. Saudi Arabia's gas reserves (2018).



Sources: BP (2019); KAPSARC analysis.

Oil field reserves

In the last 15 years, Saudi Arabia has diversified its crude oil production by adding additional production capacity to large young fields. This has included the expansion of the Arabian extra light production capacity at Shaybah from 500 Kb/d to 1.0 MMb/d, the expansion of the Arabian light production capacity at Khurais to 1.45 MMb/d, and the Arabian heavy production capacity at Manifa to 900 Kb/d. The following table shows the reserves of the five principal oil fields, as of December 31, 2018.

Table 1. Saudi Arabia's oil field reserves.

	Liquid reserves[1] (MMb)	Combined reserves (MMboe)	Maximum sustainable capacity (MMb/d)
Ghawar	48,254	58,319	3.8
Khurais	20,100	21,402	1.45
Safaniyah	33,664	34,029	1.3
Shaybah	13,617	14,864	1
Zuluf	30,417	31,313	0.825
Others	80,718	96,963	3.625
Total	226,770	256,890	12

Source: Saudi Aramco (2019b).

Note: MMb = million barrels; MMboe = million barrels of oil equivalent; Maximum sustainable capacity = the average maximum number of barrels per day of crude oil that can be produced for one year during any future planning period, after taking into account all planned capital expenditures and maintenance, repair and operating costs, and after being given three months to make operational adjustments.

[1] Liquids reserves consist of crude oil, condensate and NGLs.

Production

Oil

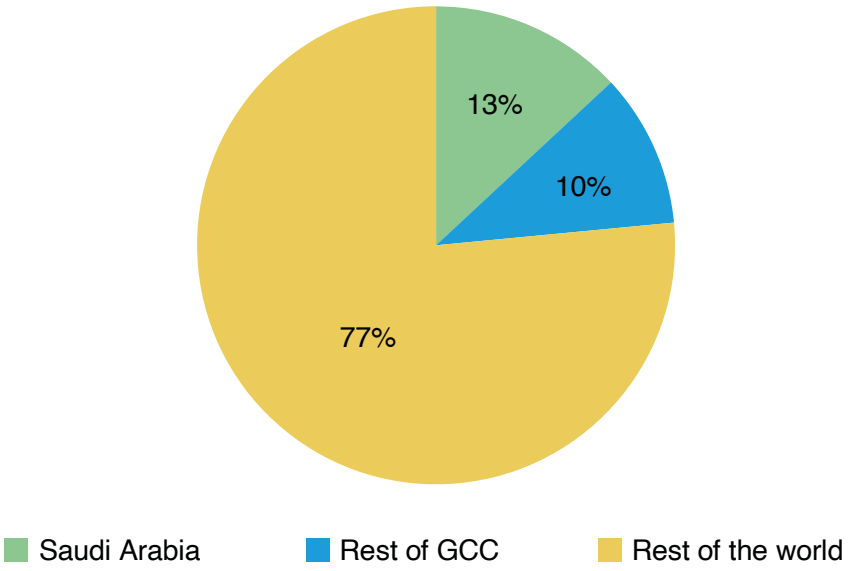
Saudi Arabia produced around 12.3* MMb/d of oil per day in 2018, representing 13% of total global oil production (94 MMb/d), and a slight increase on its 2017 oil production of around 11.9 MMb/d. In 2018, it produced 56% of total GCC oil production of around 22 MMb/d.

Figure 3. Saudi Arabian oil fields and oil facilities.

Source: KAPSARC.

Access this link to discover more about Saudi Arabia's oil fields.

Figure 4. Saudi Arabian oil production (2018).



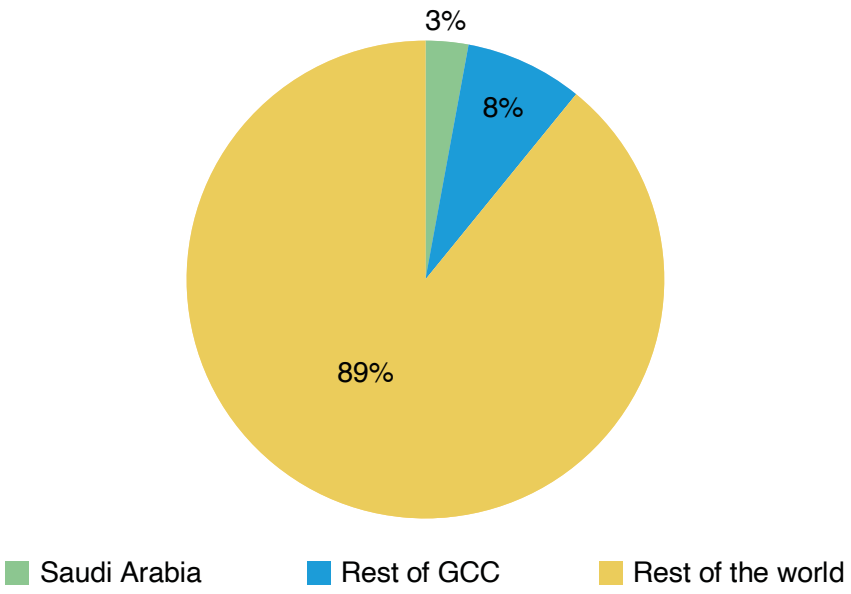
Source: BP (2019).

* Oil production includes crude oil, shale oil, oil sands, condensates (lease condensate or gas condensates that require further refining) and natural gas liquids - ethane, LPG and naphtha separated from the production of natural gas.

Gas

In 2018, Saudi Arabia produced 112 billion cubic meters (bcm) of natural gas, representing 3% of total global natural gas production of 3,849 bcm. This was a 1% increase from the 109 bcm of natural gas it produced in 2017. The Kingdom accounted for 27% of all GCC natural gas production, which stood at around 420 bcm.

Figure 5. Saudi Arabian natural gas production (2018).



Source: BP (2019).

Consumption

Crude oil direct use

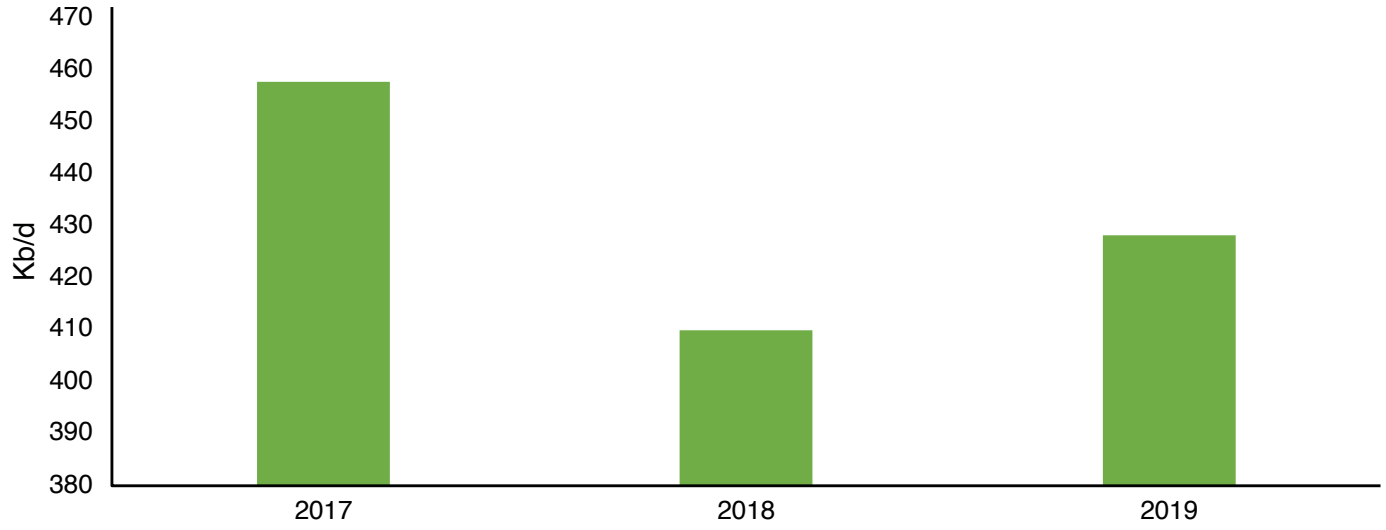
According to the Joint Organisations Data Initiative (JODI), Saudi Arabia's direct oil use (unprocessed oil) in 2018 was 0.41 MMb/d, an 11.7% decrease from its use of 0.46 MMb/d in 2017. In 2019 it increased slightly to 0.43 MMb/d. Saudi Arabia burns more crude oil for power generation than any other country. In 2015, its average use of oil in power generation peaked at 0.9 MMb/d. In 2018, it reported its lowest average of crude oil used for power generation since 2009 at 0.4 MMb/d, 41% lower than in 2015 (EIA 2020). This indicates that Saudi Arabia's domestic energy reform aims to use more gas than crude, which would drastically reduce the amount of oil burnt to generate power.

Domestic consumption of petroleum products

Premium gasoline is the most consumed refined product in Saudi Arabia, with steady yearly growth due to increasing demand. Between 2009 and 2016, gasoline demand grew by 52% for public consumption. It started to decrease gradually in 2016 (203.3 MMb), and fell to 194.5 MMb in 2018. Domestic demand for premium gasoline is followed by diesel, which also experienced a yearly increase between 2009 and 2016 for both public and industrial consumption. Demand for premium

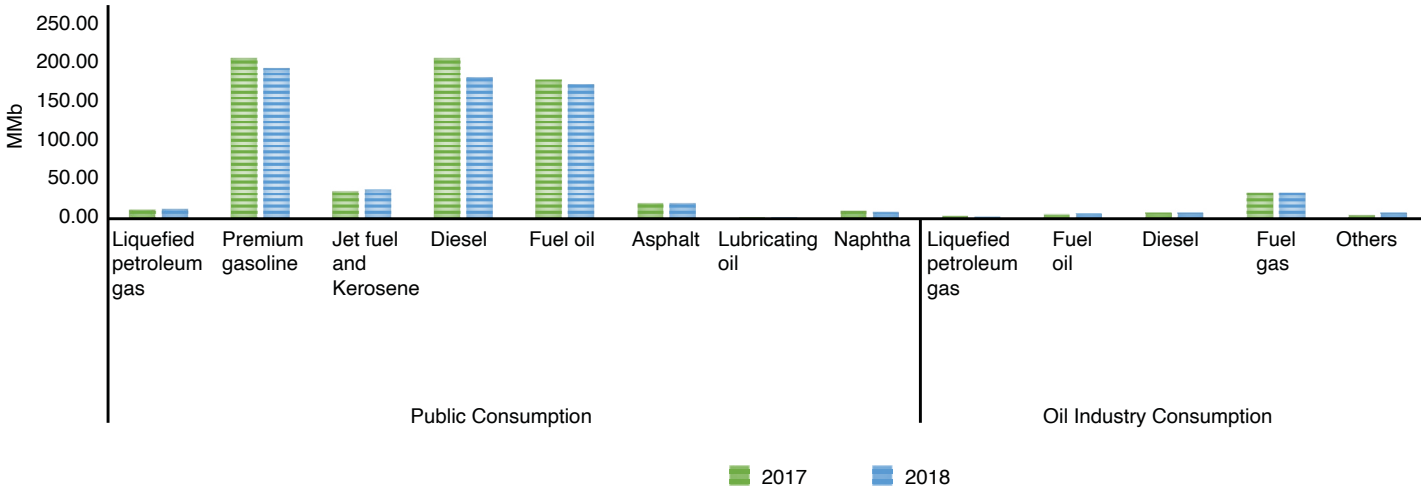
gasoline decreased from 2016 (248.5 MMb), falling to 182.7 MMb in 2018. This decrease in demand was likely due to the country's fuel price reform and the consequent rise in the price of premium gasoline. Fuel oil for public consumption decreased by 3.6% in 2018 (174 MMb) from 2017 (180 MMb), while demand for fuel oil from the oil industry increased by 4.5%, reaching around 7 MMb in 2018 from 6.6 MMb in 2017. Figure 7 shows the public's and the oil industry's consumption of refined products.

Figure 6. Saudi Arabia's oil direct use (2017-2019).



Source: JODI (2020).

Figure 7. Domestic consumption of petroleum products (2017-2018).



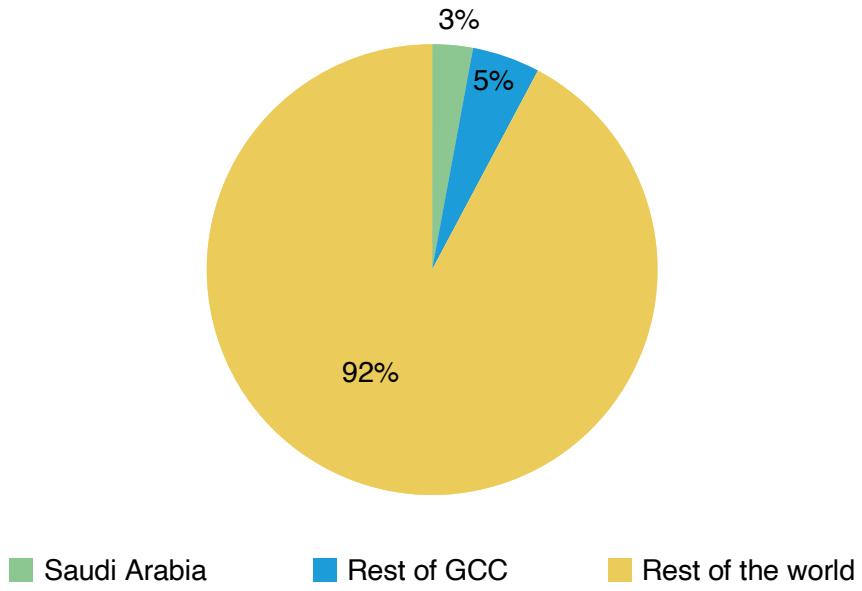
Source: SAMA (2019).

Gas

Natural gas consumption

Saudi Arabia consumed 112 bcm of natural gas in 2018, which represented a slight increase compared with 2017 (109 bcm). In 2018, global natural gas consumption was 3,849 bcm, with Saudi Arabia consuming the seventh-largest share (3%) of this total, following Japan. Saudi Arabia accounted for 37% of the GCC's natural gas consumption in 2018.

Figure 8. Saudi Arabia's natural gas consumption (2018).

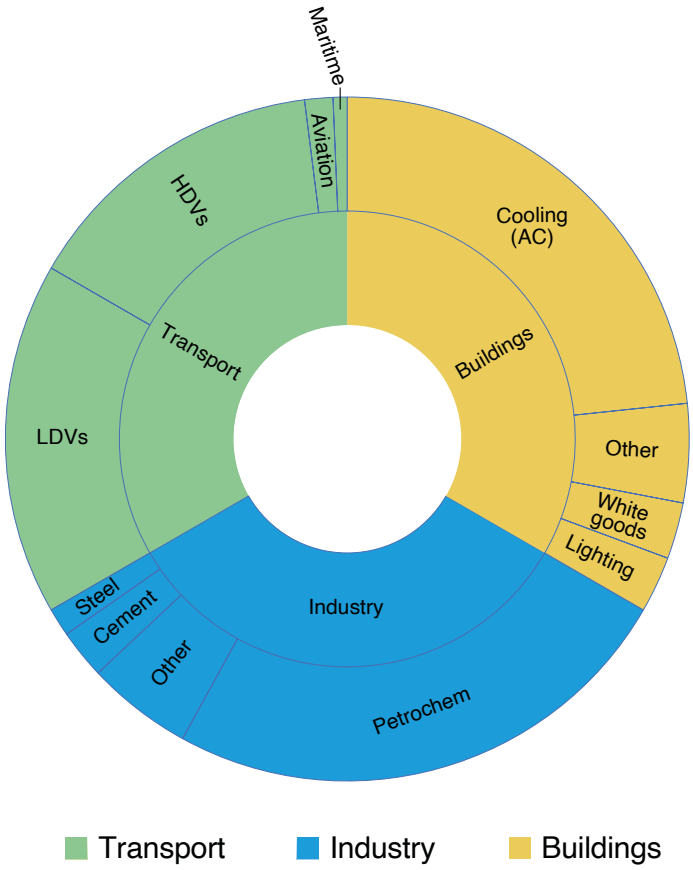


Source: BP (2019).

SEEC

According to the Saudi Energy Efficiency Center (SEEC), which aims to rationalize and increase the efficiency of energy production and consumption, 90% of domestic energy consumption in Saudi Arabia is consumed by the construction, transport and industry sectors. The industry sector consumes 47% of the country's primary energy, 70% of which is consumed by the petrochemical, iron, and cement industries. The buildings sector consumes 29% of Saudi Arabia's primary energy, which represents around 75% of the country's electricity production. The transportation sector's consumption of electricity increased by 21% in 2017.

Figure 9. Saudi Arabia's energy consumption by sector.



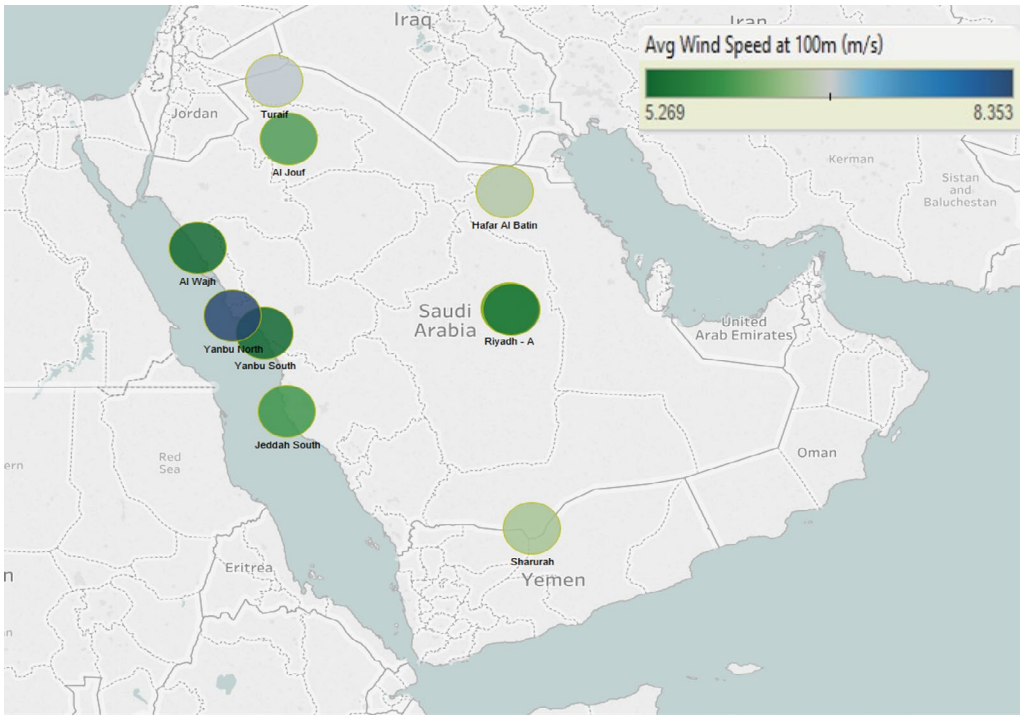
Source: SEEC (2020).

The utilities sector, which is one of Saudi Arabia's most fuel-intensive sectors, and an energy supply sector, accounts for around 38% of the country's total primary energy consumption. In 2017, the utilities sector's fuel consumption, used for producing electricity and seawater desalination, reached 4,230 million British thermal units (Btu). Saudi Arabia aims to reduce its energy consumption in the coming years. The SEEC has targeted all sectors through its energy efficiency policies. It has also formulated energy efficiency labels for some energy systems in order to achieve its energy conservation goals. The Saudi Energy Efficiency Program (SEEP), which focuses on the demand side, was established by SEEC to improve energy efficiency.

Saudi Arabia's renewable energy potential

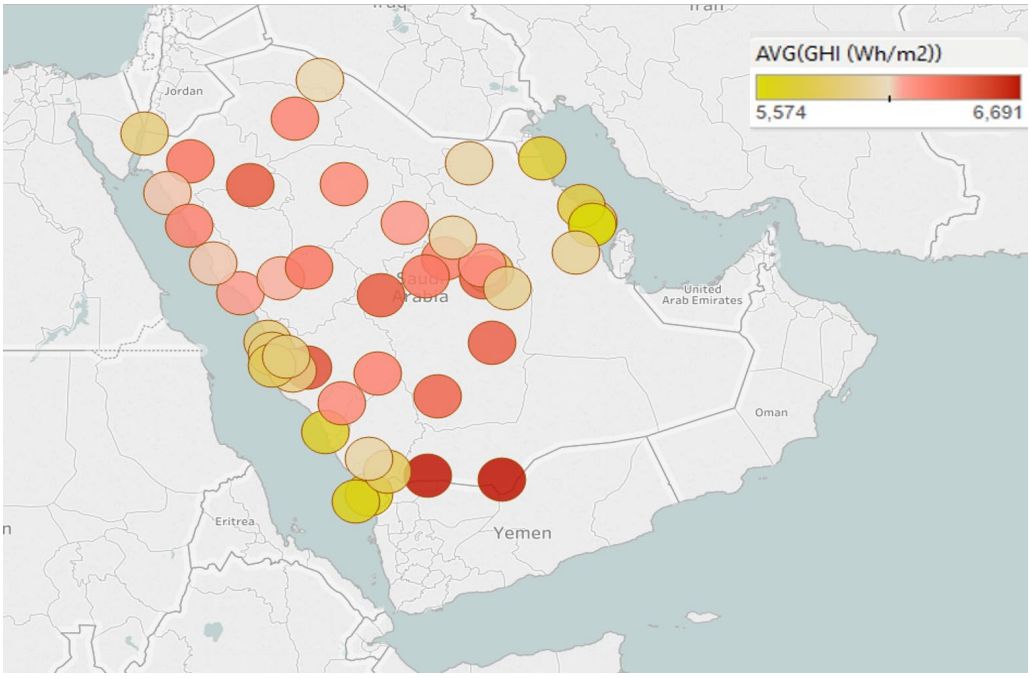
Saudi Arabia has a high potential for renewable energy production, with a focus on solar power, as the country lies in the middle of the 'sunbelt,' and wind power, as the annual average onshore wind speed is relatively high and well above the standard for most countries. The government's commitment to unlocking the renewable energy sector is in line with one of the goals of Saudi Vision 2030: to achieve environmental sustainability. Saudi Arabia is currently ranked sixth for solar energy potential worldwide, and thirteenth for wind potential.

Figure 10. Average wind speed at 100 meters (meters per second).



Source: KAPSARC; Author's calculations based on data from KACARE (2016).

Figure 11. Average global horizontal irradiance (GHI) (Watthours per meter squared [Wh/m^2]).



Source: KAPSARC; Author's calculations based on data from KACARE (2016).

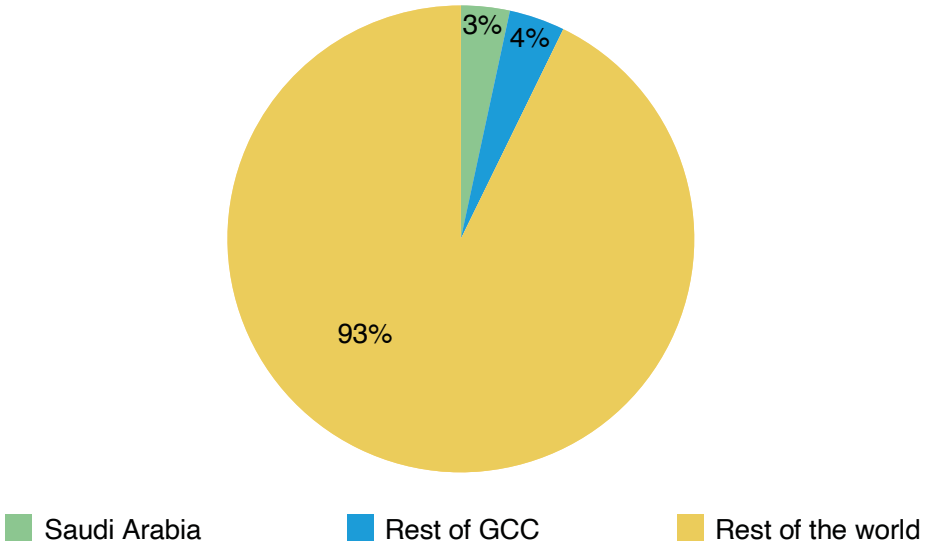
Note: Renewables data are available in the period of years provided by the source.

Secondary Energy

Refinery capacity

In 2018, Saudi Arabia's oil refinery throughput of 2.7 MMb/d accounted for 3% of global refinery throughput (83 MMb/d). The country's refinery capacity decreased slightly year-on-year from 2.8 MMb/d, a decline of -1.1%. The country also accounted for 47% of all GCC oil refinery throughput of around 5.4 MMb/d.

Figure 12. Saudi Arabia's refined products production (2018).



Source: BP (2019).

Oil refineries

Saudi Arabia has nine main oil refineries located in various regions, with a total capacity of around 3 MMb. Saudi Aramco is responsible for refining oil and distributing it. It has also been integrating its oil refineries with petrochemical facilities. Petro Rabigh was the first of these, developed jointly in 2005 with Sumitomo Chemical and begun in 2005 on the west coast.

1. Ras Tanura

Ras Tanura, the largest and most complex oil refinery in the GCC and the oldest in Saudi Arabia, is located on the Kingdom's east coast. Established in 1945 with an initial processing capacity of around 50 Kb/d, it now has a capacity of 550 Kb/d (EPC Engineer 2017).

2. SATORP

The Saudi Aramco Total Refining and Petrochemical (SATORP) refinery is one of the world's largest refining and petrochemical centers. It is located in Jubail, on Saudi Arabia's east coast, and has been operational since 2014. The refinery has a production capacity of around 440 Kb/d (SATROP 2020).

3. Samref

Samref is one of the leading refineries in the Middle East. It was established in 1981 for the development, construction, and operation of crude oil refining facilities in Yanbu, Saudi Arabia. Its design capacity when it began operating in 1984 was 263 Kb/d of Arab light crude. Through a continuous improvement of its facilities, it now processes about 402 Kb/d (Samref 2020).

4. Yasref

The Yanbu Aramco Sinopec Refining Company (Yasref), located in Yanbu Industrial City on the West Coast of Saudi Arabia, is a joint venture between Saudi Aramco and the China Petrochemical Corporation (Sinopec). It was established in 2012 and now has a refining capacity of around 400 Kb/d. It focuses on high-quality clean fuels for use in transportation (Yasref 2020).

5. Petro Rabigh

Rabigh Refining and Petrochemical Company (Petro Rabigh), located in Rabigh, Saudi Arabia, was founded in 2005 as a joint venture between Saudi Aramco and Sumitomo Chemical. The company produces and markets refined hydrocarbon and petrochemicals. It has a capacity of 400 Kb/d (Petro Rabigh 2020).

6. SASREF

SASREF is a highly complex refinery owned by Saudi Aramco and located in Jubail Industrial City. The refinery processes crude oil into petrochemical products. Its main products are liquefied petroleum gas (LPG), naphtha, kerosene, diesel, fuel oil and sulfur. The refinery has a production capacity of 305 Kb/d (SASREF 2020).

7. Saudi Aramco Yanbu Refinery

Saudi Aramco Yanbu Refinery began operating in 1983. It produces LPG, gasoline, jet fuel, diesel oil, and fuel oil. The refinery was built on 165 hectares in Yanbu Industrial City and has an operational capacity of around 250 Kb/d (EPC Engineer 2020).

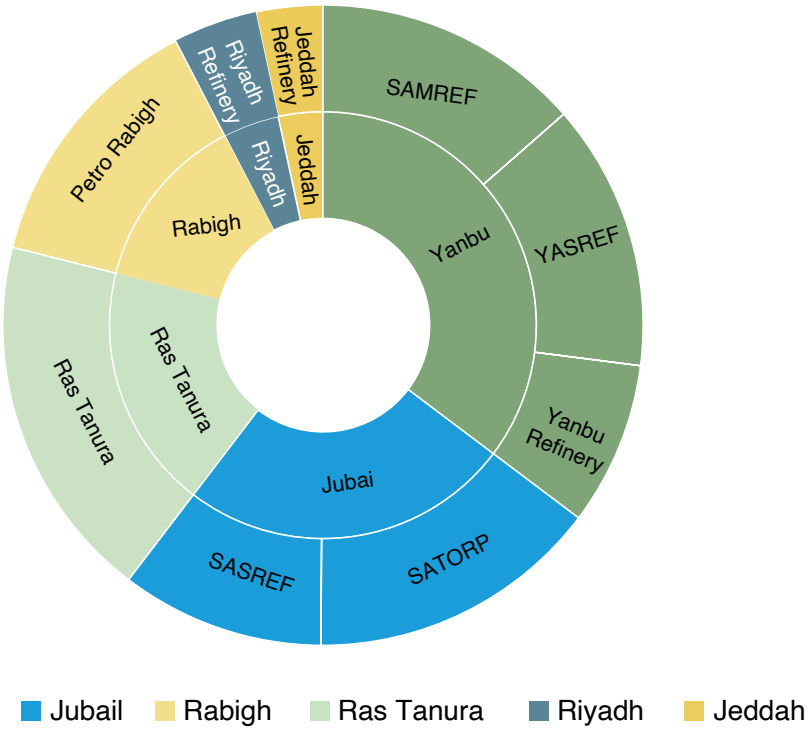
8. Saudi Aramco Riyadh Refinery

Saudi Aramco Riyadh Refinery is located in the central Riyadh Province. It is supplied with domestic crude oil from the East-West Pipeline and has an operating capacity of 120 Kb/d (EPC Engineer 2020).

9. Saudi Aramco Jeddah Refinery (closed)

This medium-sized simple refinery began operating in 1967 and was one of the oldest in Saudi Arabia, with a refinery capacity of around 100 Kb/d. Saudi Aramco shut the refinery in 2017 and converted the complex into a hub for oil products distribution (Alshar Alawsat 2017).

Figure 13. Saudi Arabia oil refineries.



Sources: Yasref (2020); Samref (2020); Petro Rabigh (2020); Total (2020).

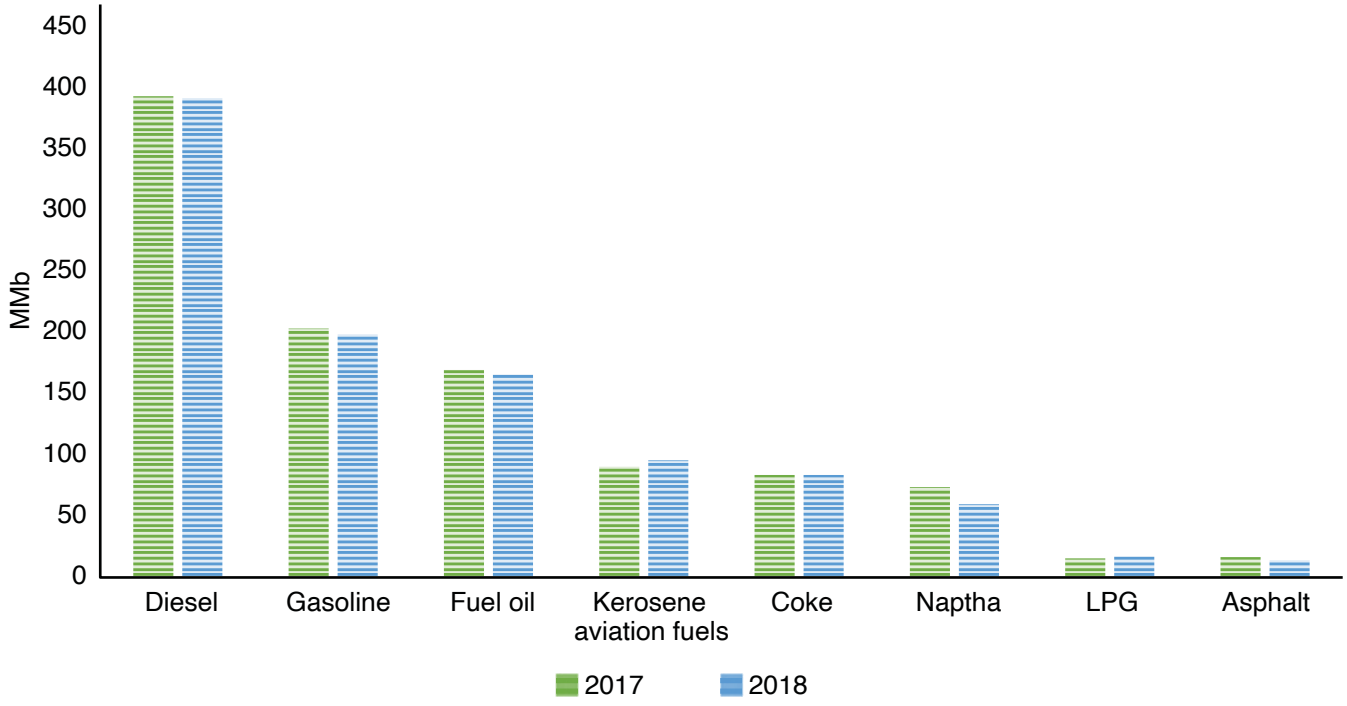
Figure 14. Saudi Arabia oil refineries.

Source: KAPSARC.

Refined products production

In 2018, Saudi Arabia's total refined products stood at 1,028.3 MMb. This represented a 1.9% fall from 2017, when total production stood at 1049 MMb. In 2018, diesel was the most produced refined product at 392 MMbd, followed by gasoline and fuel oil at 199 MMb and 166 MMb, respectively. However, compared with 2017, fuel oil production decreased by 2.3%, gasoline by 2.2% and diesel by 0.61%. Other products that saw large year-on-year falls in 2018 were naphtha (-23.5%) and asphalt and others (-16%). The only products with increased production in 2018 were LPG, kerosene and coke, at 9.7%, 5.8% and 0.45%, respectively.

Figure 15. Saudi Arabia's refined oil products production (2017-2018).



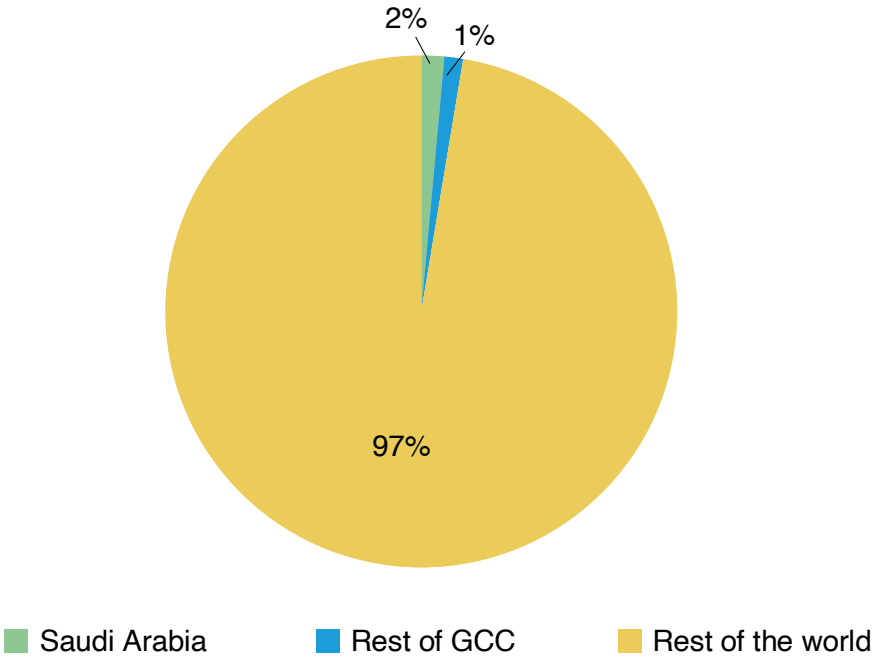
Source: SAMA (2019).

Electricity

In 2018, Saudi Arabia's electricity generation stood at 384 terrawatthours (TWh). It accounted for 55% of total GCC electricity generation, and 2% of global electricity generation. According to BP, the country was the eleventh-largest electricity generator, following France.

Saudi Arabia also uses its desalination plants to generate electricity by using the steam emitted from the desalination process. In 2018, its electricity peak load reached more than 61,000 megawatts (MW), and its power generation capacity around 53,500 MW.

Figure 16. Saudi Arabia's electricity generation (2018).



Sources: BP (2019); KAPSARC.

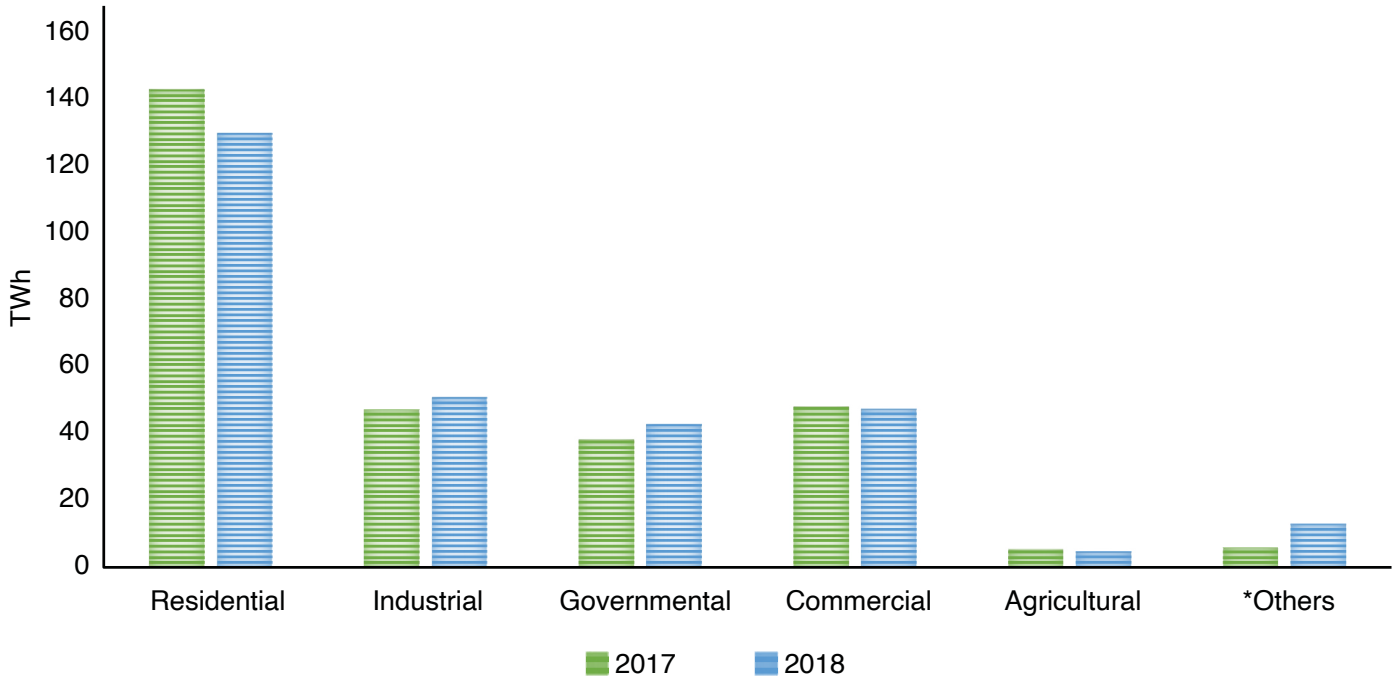
Electricity consumption by sector

Saudi Arabia is a major consumer of energy, with rapidly growing domestic demand. Total electricity consumption in 2018 was around 289.8 TWh, a slight increase of around 0.42% from the 2017 level of around 288.6 TWh. The sectors that had noticeable changes between 2017 and 2018 were the residential sector, with a 9% fall, and the industrial sector, with an increase of 8.3% (Figure 17).

Peak load

In 2018, Saudi Arabia's total electricity generation capacity was around 85 gigawatts (GW) (ECRA, 2019), which includes cement plants, refineries, independent power producers (IPPs), and thermal desalination plants. The grid-connected capacity was 68.8 GW, down by 1.2 GW from 2017 (~70 GW). In 2017, Saudi Arabia's peak electricity load was 62 GW, decreasing slightly to 61 GW in 2018. Figure 18 shows Saudi Arabia's electricity generation capacity and peak load for 2017 and 2018.

Figure 17. Electricity consumption by sector (2017-2018).

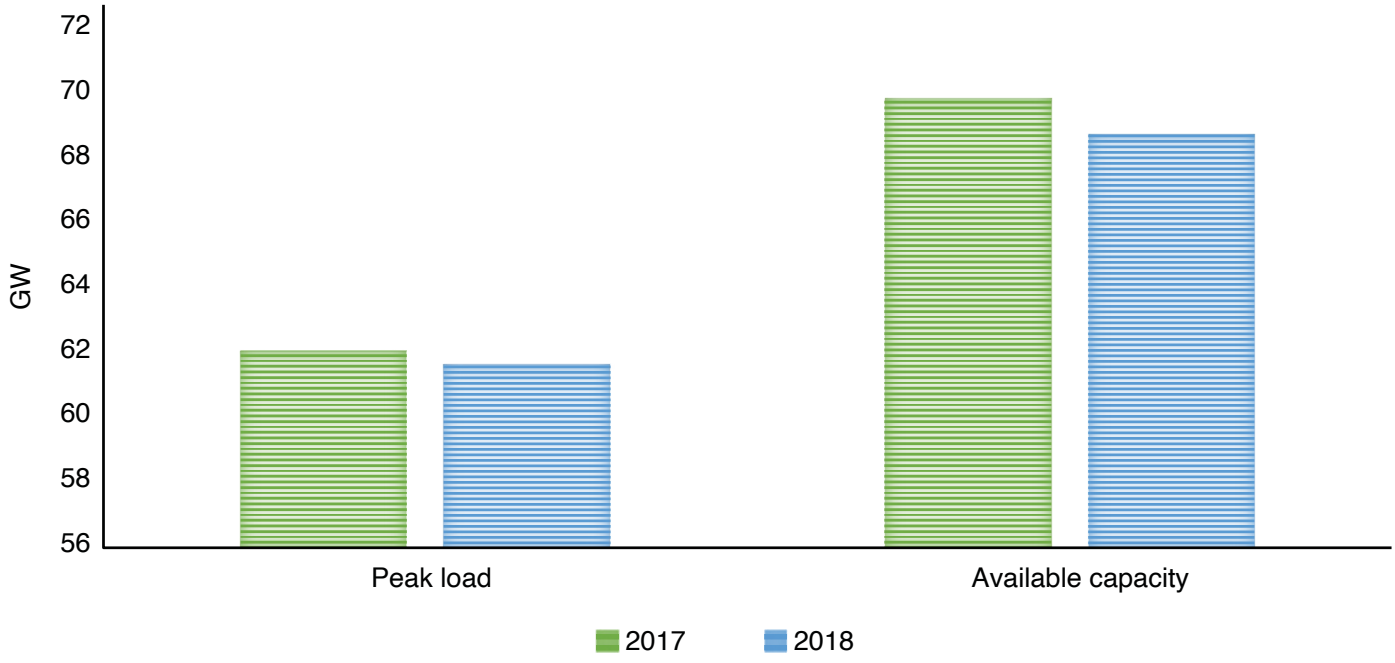


Source: SAMA (2019).

Access this dataset for machine-readable data of Saudi Arabia's electricity consumption by sector.

* Includes consumption for educational, health and desalination purposes.

Figure 18. Available electricity capacity and peak load (2017-2018).



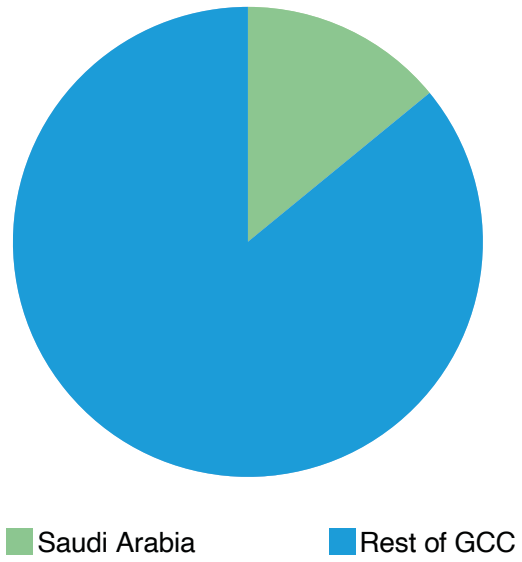
Source: ECRA (2019).

Access this dataset to find more data for Saudi Arabia's electricity generation capacity.

Renewables

Saudi Arabia has recently increased its use of renewable energy, with a focus on wind and solar power. Saudi Arabia's installed renewable energy capacity as of the end of 2018 was 142 MW, with wind power accounting for 3 MW, and solar power 139 MW, of which 89 MW was photovoltaic (PV), and 50 MW concentrated solar power. In 2018, the GCC's total renewable capacity was around 867 MW. Total global renewable production stood at around 2,468 TWh in 2018, and Saudi Arabia accounted for a small percentage of global renewable production (0.01%) at 0.4 TWh. However, in 2018, the country's renewable generation doubled from 2017 (0.2 TWh).

Figure 19. Saudi Arabia's and the GCC's renewable energy capacity (2018).



Sources: IRENA (2019); BP (2019).

In 2018, under the National Renewable Energy Program (NREP), Saudi Arabia has launched two renewable energy projects, located in the Northern region: a 300 MW solar PV power plant (see AlGhamdi [2020]), and a 400 MW onshore wind project.

End Notes

Data have been collected and compiled from public sources, with a focus on the 2018 key energy data indicators.

The accompanying datasets are mostly available on the KAPSARC energy data portal and will be updated as new data are available.

Some of the GCC indicators (e.g., Bahrain) were estimated based on historical data to form GCC statistics.

Data will serve as a reference for researchers and support in performing their analysis.

A digital version of this report is also available in the following link.

You can access energy-related machine-readable data here.

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About the Author

Abeer AlGhamdi

Abeer is a senior research associate working on energy data management and data analysis for research use, with a focus on data from Saudi Arabia and GCC countries. Her experience has focused on analyzing the Saudi energy data in various energy fields, and she has led related energy data projects such as the Saudi Arabia energy balance, and energy themes database. Abeer has worked on building and developing the KAPSARC data portal, has published a large number of data sets, and has worked on developing KAPSARC research apps for energy and transportation.

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