



Independent Statistics & Analysis

U.S. Energy Information  
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# Background Reference: Saudi Arabia

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## Overview

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Compared with other countries, Saudi Arabia is a top holder of proved oil reserves, producer of petroleum liquids, and exporter of total petroleum liquids (crude oil and petroleum products) in the world. Most of Saudi Arabia's exports ship to markets in Asia and Europe.

Saudi Arabia continuously invests in maintaining crude oil production capacity and developing considerable resources in natural gas, refining, petrochemicals, and electric power industries. The country's natural gas and electric power industries, in particular, are designed to meet increasing domestic demand. Investments in refining and petrochemical industries aim to improve Saudi Arabia's ability to compete internationally in these sectors.

In 2016, Saudi Arabia announced a national transformation plan called *Vision 2030*, which encompasses cultural, governance, and economic aspects of Saudi society. On the economic front, *Vision 2030* plans to decrease the large role that revenue from oil production currently plays in the economy by broadening the economic base. The plan outlines far-reaching reforms of the energy sector and includes the partial privatization of state-owned Saudi Aramco. Income from Saudi Aramco's initial public offering (IPO) may help finance the economic transition. Saudi Aramco raised \$29.4 billion from the sale of 1.7% shares through an IPO on the Tadawul (Saudi) stock exchange in December 2019.<sup>1</sup> The company is seeking other means to raise money following the economic downturn and oil price crash in 2020. Other options include two bond offerings and the \$12.4 billion, 25-year crude oil pipeline lease agreement signed with a consortium led by EIG Global Energy Partners in early 2021.<sup>2</sup>

Saudi Arabia is located near two of the world's busiest chokepoints, and most of its crude oil and petroleum liquid exports travel through them. The Strait of Hormuz, which connects the Persian Gulf with the Gulf of Oman and the Arabian Sea, is the world's most important chokepoint. The flow of 20.7 million barrels per day (b/d) of crude oil in 2018 through this strait accounted for about one-third of all seaborne-traded crude oil and other liquids during that year. This strait is an important route for the Persian Gulf countries for oil and liquefied natural gas exports.<sup>3</sup>

Another regional chokepoint, Babel Mandeb, links the Gulf of Aden and the Red Sea. This waterway is a strategic link between the Mediterranean Sea and the Indian Ocean. An estimated 6.2 million b/d of crude oil and refined petroleum products flowed through this waterway in 2018 toward Europe, the United States, and Asia.<sup>4</sup>

Figure 1. Map of Saudi Arabia



Source: Central Intelligence Agency World Factbook

## Total primary energy consumption

Total energy use in Saudi Arabia peaked in 2016 at 10.4 quadrillion British thermal units (Btu) and then fell to 10 quadrillion Btu in 2020 when the effects of the COVID-19 pandemic reduced domestic energy demand. Total use of energy in Saudi Arabia grew steadily between 2006 and 2016, increasing by about 66% over that period.<sup>5</sup> Domestic energy consumption growth during that period was driven by the economic expansion that was supported by historically high oil-related revenues that persisted until mid-2014. Further, large fuel subsidies, which reportedly cost the Saudi government an estimated \$61 billion in 2015, led to energy demand growth of more than 5% per year between 2006 and 2016.<sup>6</sup> The level of energy use in Saudi Arabia has been marked by ups and downs since 2015 for several reasons. The Saudi government introduced subsidy cuts in 2016 and the beginning of 2018, which significantly increased prices on transportation fuels. The government also increased its electricity tariffs in 2015 and natural gas prices in 2016 to encourage more efficient energy use in all customer sectors.<sup>7</sup> In addition to reducing energy use through higher prices, the government encouraged energy efficiency measures.

## Petroleum and Other Liquids

### Sector organization

Saudi Aramco, the national oil company that manages Saudi Arabia's oil and natural gas operations, was the world's largest integrated oil and natural gas company in terms of oil production in 2019, according to Saudi Aramco.<sup>8</sup> The Saudi Aramco Supreme Council, chaired by the country's Deputy Crown Prince, oversees Saudi Aramco.<sup>9</sup> The Ministry of Energy oversees policies related to the country's oil and natural gas sectors. The government regulates the prices of oil products such as gasoline, diesel, fuel oil, liquefied petroleum gas (LPG), asphalt, and kerosene, which tend to be lower than market prices. The

Council of Ministers regulates all natural gas prices, and the Ministry of Energy regulates natural gas sales within Saudi Arabia.<sup>10</sup>

## Reserves

At the end of 2020, Saudi Arabia held the world's second-largest proved oil reserves, at 259 billion barrels, according to *Oil and Gas Journal*. To be more transparent regarding reserves, Saudi Arabia hired consulting firm DeGolyer and MacNaughton in 2017 to conduct the first independent audit of the kingdom's reserves in 40 years, which confirmed the long-standing claims of Saudi Aramco (the national oil and natural gas company) that its petroleum liquids reserves were around 260 billion barrels.<sup>11</sup> Although Saudi Arabia has about 130 major oil and natural gas fields, most of the oil reserves lie in five fields in the eastern part of the country, according to Saudi Aramco. Saudi Arabia's Ghawar field is the world's largest conventional oil field, and Safaniyah is the largest conventional offshore field. Other fields with large reserves include Zuluf, Khurais, and Shaybah.<sup>12</sup>

Saudi Arabia has half of the estimated 5.4 billion barrels of total proved oil reserves located in the Saudi-Kuwait Partitioned Neutral Zone (PNZ).<sup>13</sup> The PNZ consists of the area between the Saudi-Kuwaiti border, which was established in 1922 to settle a territorial dispute between the two countries. Neutral Zone reserves were divided equally between the countries.

Figure 2. Map of the Saudi-Kuwait Partitioned Neutral Zone



Source: Central Intelligence Agency World Factbook

## Production

Ghawar—Saudi Arabia's largest oil field, located onshore in the eastern region—accounted for an average of 40% of Saudi Arabia's crude oil and condensate production from 2014 through 2020,

according to Rystad Energy data. Safaniya, the country's second-largest field, accounted for an average 9% of production over the same period.<sup>14</sup>

Saudi Arabia maintains the world's largest crude oil production capacity, estimated at nearly 12 million b/d including the PNZ shared with Kuwait.<sup>15</sup> Moreover, the country is invested in increasing its maximum sustainable capacity. In 2020, the Saudi government announced it intends to raise capacity to 13 million b/d by 2027.<sup>16</sup> Aramco is able to maintain its high production capacity and to have a level of flexibility in its production levels by not maximizing output from mature fields, regularly bringing new reservoirs online, and developing large expansion projects. Low field depletion rates (just 1%–2% in 2019) and low upstream oil production costs (\$2.80/b at the end of 2019) give Saudi Arabia a competitive edge over other countries in terms of cost savings and long-term production. Saudi Arabia's long-term goal for oil production is to maintain current output by offsetting declines in mature fields with capacity from new fields and expansion projects.<sup>17</sup>

Recent field additions include the 250,000 b/d capacity expansion at the onshore Shaybah field in 2016, the 300,000 b/d expansion at the Khurais field in 2018, and a combined 175,000 b/d expansion from the Ain Dar and Farzan incremental oil projects in early 2021.<sup>18</sup>

Furthermore, Saudi Aramco plans to expand several offshore fields by 2026 and raise output capacity by at least 1.2 million b/d of crude oil. These fields will add heavier grades of oil, replacing lighter grades from the older fields. Development of the Berri and Marjan expansions are underway, and Saudi Aramco intends to award contracts for development of the Zuluf and Safaniyah expansions in late 2021. A smaller play, the Dammam oil field, is under development and is expected to add 75,000 b/d by 2026. The Berri field expansion project is slated to add 250,000 b/d, and the Marjan project will likely provide another 300,000 b/d. Saudi Aramco expects to raise capacity at the Zuluf field by 600,000 b/d of Arab Heavy crude oil. Historically, Zuluf has produced Arab Medium crude oil.<sup>19</sup>

Al-Khafji, located offshore, and Wafra, located onshore, are the primary producing fields in the PNZ, which overlaps the borders between Kuwait and Saudi Arabia. Al-Khafji Joint Operations Company, a joint venture between Kuwait Gulf Oil Company (KGOC) and Aramco, operates the Khafji field, and Saudi Arabia Chevron jointly operates the Wafra field with KGOC. Onshore production in the PNZ centers on the Wafra oil field, which began producing oil in 1954. Wafra is the largest of the PNZ's onshore fields and yields a heavy sour crude oil grade. Oil production capacity in the PNZ averaged 450,000 b/d before output was shut down in May 2015 following a dispute between Saudi Arabia and Kuwait.<sup>20</sup> Output from the PNZ resumed in January 2020.

Although Saudi Arabia's crude oil production is subject to OPEC production targets, non-crude liquids are not subject to OPEC quotas or targets, and production in the country has averaged around 1.6 million b/d since 2017. Upcoming crude oil field expansions will also yield increased natural gas liquids (NGL) production, and Saudi Arabia expects to produce up to 500,000 b/d of condensates and NGLs from the Jafurah natural gas project.<sup>21</sup>

Historically, Saudi Aramco has not required the use of enhanced oil recovery (EOR) techniques, although fields in the PNZ could require steam flooding. In 2009, Chevron developed a full-field steam flood injection EOR project at the Wafra field to offset field declines and to boost production of the heavy oil play. However, because of the dispute between Saudi Arabia and Kuwait and Chevron's difficulty in securing work and equipment permits, Chevron stopped activities in the PNZ from May 2015 until the end of 2019 when the governments reached an agreement and allowed production to restart.<sup>22</sup>

In 2015, Saudi Aramco developed a carbon capture project at the Uthmaniyah field which is part of the Ghawar field. Since then, the pilot project has captured carbon dioxide that is injected into the mature Uthmaniyah field to support oil production.<sup>23</sup>

**Figure 3. Major oil fields in Saudi Arabia**



Source: Saudi Aramco

**Table 1. Major oil fields in Saudi Arabia**

Field	Location	Production capacity as of 2020 (million b/d)	Crude oil grade
Ghawar	Onshore	3.8	Arab Light
Safaniya	Offshore	1.3	Arab Heavy
Khurais	Onshore	1.5	Arab Light
Manifa	Offshore	0.9	Arab Heavy
Shaybah	Onshore	1.0	Arab Extra Light
Qatif	Onshore	0.5	Arab Light
Khursaniyah	Onshore	0.5	Arab Light
Zuluf	Offshore	0.8	Arab Medium

Sources: Saudi Aramco, Energy Intelligence

Note: b/d = barrels per day

## Saudi crude oil streams

Saudi Arabia produces a wide range of crude oils, from heavy to super light. About 65% of Saudi Arabia's total crude oil production capacity in 2020 were light gravity grades, and the remaining crude oil were medium or heavy gravity grades.<sup>24</sup> Lighter grades generally are produced from onshore fields, while medium and heavy grades come mainly from offshore fields. Most of Saudi Arabia's crude oil production, except for the Arab Extra Light and Arab Super Light crude oil types, is considered sour (meaning it contains relatively high levels of sulfur).<sup>25</sup>

## Consumption

Saudi Arabia's economy uses the most crude oil and petroleum products of any economy in the Middle East, particularly for transportation and direct crude oil burn for power generation. Most of the petroleum products used are LPG, diesel, gasoline, and fuel oil.<sup>26</sup> Oil consumption grew by 5% per year on average between 2005 and 2015, mainly as a result of strong economic growth and government-subsidized energy prices.<sup>27</sup> Petroleum use peaked, but it then began declining in 2017. Key drivers behind the weaker demand in recent years were slower economic growth, new vehicle efficiency measures, price reforms that led to raising gasoline prices closer to international averages, and a policy shift to substitute more oil with natural gas in the electric power sector.<sup>28</sup>

Another contributing factor to the petroleum consumption growth before 2015 was the direct burn of crude oil for power generation, which peaked at about 900,000 b/d in July 2014 and June 2015. Direct crude oil burn in the summer months (June–September) from 2014 through 2016 averaged more than 750,000 b/d, according to the Joint Oil Data Initiative (JODI).<sup>29</sup> [Crude oil burn for electric power generation during summer months fell each year between 2016 and 2018](#) compared with year-ago levels. This decrease freed up crude oil for exports and refining. This shift away from directly burning crude oil occurred around the same time that the Wasit natural gas processing plant, with a capacity of 900 billion cubic feet per year, began operations in 2016. More natural gas became available for power generation.<sup>30</sup> Crude oil and petroleum liquids reserves in the country remain plentiful, but Saudi Arabia wants to diversify its mix of fuels for electric power generation, focusing on natural gas, nuclear, and renewable energy generation.

The country's large petrochemical industry consumes most of the LPG and naphtha supply that accounted for almost 30% of petroleum demand in 2020, according to FGE Global Energy.<sup>31</sup> Saudi Aramco intends to integrate its upstream supply with the domestic petrochemical industry through its acquisition of a 70% share in SABIC, the national petrochemical company, in 2020.<sup>32</sup> Two major petrochemical plants are slated to come online in 2024 and will likely increase naphtha and LPG consumption.<sup>33</sup>

The use of hydrocarbon gas liquids (HGLs) in the country's growing petrochemical sector has also driven the growth in oil consumption since 2005.

## Oil processing

Saudi Aramco operates the world's largest oil processing facility and crude oil stabilization plant in the world at Abqaiq in eastern Saudi Arabia. The plant has a crude oil processing capacity of more than 7 million b/d. The plant processes the majority of Arab Extra Light and Arab Light crude oils, as well as NGLs. The facility's infrastructure includes pumping stations, gas-oil separation plants (GOSPs), hydro-desulfurization units, and an extensive network of pipelines that connects the plant to the ports of

Jubail, Ras Tanura, and Yanbu (for NGLs).<sup>34</sup> The Abqaiq processing plant is a vital part of Saudi Arabia's oil infrastructure. Abqaiq processed approximately half of the crude oil produced in the country in 2018.<sup>35</sup>

Houthi rebels from Yemen attacked Saudi Arabia's Abqaiq and Kurais oil processing facilities on September 14, 2019, causing a major global oil disruption. Saudi Arabia immediately removed 5.7 million b/d of crude oil, slightly more than half of their crude oil production at the time, and 2 billion cubic feet per day of associate natural gas (which also shut in some NGL production).<sup>36</sup> Although crude oil production for September 2019 fell by about almost 1.4 million b/d from August 2019, Saudi Aramco was quickly able to restore oil production at the facilities by October 2019.<sup>37</sup>

## Refining

Saudi Arabia has eight domestic refineries, which have a combined crude oil throughput capacity of nearly 2.9 million b/d.<sup>38</sup> Saudi Aramco operates five refineries exclusively (including the Jazan refinery), and the remaining four are joint ventures. Saudi Arabia has continued to integrate its refinery projects with large petrochemicals complexes in industrial cities, which are centered on the country's petrochemicals and heavy industries.

**Table 2. Refineries in Saudi Arabia**

Name	Company	Nameplate crude oil distillation capacity (thousand barrels per day) 2021
Ras Tanura	Saudi Aramco	550
SATORP Jubail	Saudi Aramco, Total S.A.	450
Rabigh	Saudi Aramco, Sumitomo	400
SAMREF Yanbu	Saudi Aramco, Mobil	400
YASREF Yanbu	Saudi Aramco, Sinopec	400
SASREF Jubail	Saudi Aramco	305
Yanbu	Saudi Aramco	245
Riyadh	Saudi Aramco	126
<b>Total</b>		<b>2,876</b>

Source: Saudi Aramco, SATORP, SAMREF, *Oil & Gas Journal*, FACTS Global Energy

Saudi Arabia has expanded its domestic refinery capacity extensively since 2014. In 2014 and 2015, the company added more than 800,000 b/d of capacity from the SATORP and YASREF refineries.<sup>39</sup> The higher refinery output from these projects lifted Saudi Arabia's oil products exports, particularly for diesel.<sup>40</sup>

Saudi Aramco developed the 400,000 b/d Jazan refinery project, which is located in southwestern Saudi Arabia near the Yemen border and which processes Arab Heavy and Arab Medium crude oils. Refinery construction was completed in late 2019, but Aramco has delayed the full commissioning until the adjacent natural gas power plant and air separation units, which have encountered operational and logistical issues, are complete. These facilities are slated to provide electricity to the Jazan refinery. By mid-2021, the Jazan refinery had produced around 200,000 b/d of mostly fuel oil and off-specification products in trial runs. Commissioning could occur as soon as the end of 2021.<sup>41</sup> Apart from Jazan, Saudi Arabia does not expect to add any further refining capacity during the next few years.



## Oil terminals

Saudi Arabia's total crude oil export and loading capacity is about 14.5 million b/d and its primary port is Ras Tanura on the Persian Gulf.

The port of Ras Tanura is the world's largest offshore oil exporting port and has a combined handling capacity of about 6.4 million b/d. All of Saudi Arabia's crude oil grades load at this port, along with condensates and products. The port consists of three terminals: Ras Tanura terminal, Ju'aymah crude terminal, and Ju'aymah LPG export terminal.<sup>42</sup>

Most of Saudi Arabia's export capacity comes from its four primary oil export terminals:

- The Ras Tanura terminal, the largest terminal at the port of Ras Tanura, has an average handling capacity of 3.28 million b/d<sup>43</sup> and 33 million barrels of storage capacity. The terminal can accommodate tankers up to 500,000 deadweight tons (dwt). All of Saudi Arabia's crude oil grades except Arab Super Light are loaded at the Ras Tanura terminal.<sup>44</sup>
- The Ras al-Ju'aymah terminal at the port of Ras Tanura has an average handling crude oil capacity of about 3.12 million b/d,<sup>45</sup> and because of the availability of six single-point mooring buoys, the terminal can accommodate some of the largest tankers (700,000 dwt) for crude oil loadings.<sup>46</sup> Most of Saudi Arabia's crude oil grades are loaded at this terminal, along with bunker fuel (at a maximum loading capacity of 120,000 b/d).<sup>47</sup>
- The Yanbu terminal on the Red Sea has a loading capacity of 4.5 million b/d.<sup>48</sup> The terminal includes four loading berths and can accommodate tankers up to 500,000 dwt. Total crude oil storage capacity at this terminal is 12.5 million barrels. Only Arab Light crude oil grade is loaded at the Yanbu North terminal.<sup>49</sup>
- The Yanbu South terminal on the Red Sea is about 12 miles south of the Yanbu terminal. Saudi Aramco began exports from the overhauled Yanbu South (formerly known as Muajjiz) oil terminal in October 2018. This terminal provides Saudi Arabia with another major Red Sea outlet for its oil exports in case of a disruption at the Strait of Hormuz. Yanbu South, which includes three loading berths, has an export loading capacity of 3 million b/d, which raised Saudi Arabia's total loading and export capacity to nearly 15 million b/d. Before the Iraqi Pipeline in Saudi Arabia (IPSA) was converted to a natural gas line, Muajjiz was used as an export terminal for crude oil from Iraq that flowed through the IPSA. Total crude oil storage capacity at the terminal is 10 million barrels. Yanbu South exports both Arab Light and Arab Super Light.<sup>50</sup>

In addition to these primary export terminals, Saudi Arabia has other smaller ports, including Ras al-Khafji, Jubail, Jazan, and Jeddah.

## Shipping

The National Shipping Company of Saudi Arabia (also known as Bahri) is the world's largest operator and owner of Very Large Crude Carriers (VLCCs) that transport crude oil between the Middle East, Europe, and the U.S. Gulf Coast. It operates a fleet of 89 vessels, including 41 VLCCs, 10 product tankers, 23 chemical tankers, and 15 other cargo carriers.



Bahri and Vela International Marine Limited, Saudi Aramco's shipping subsidiary, merged in 2014, giving Saudi Aramco a stake in Bahri. The Public Investment Fund (PIF) of the Saudi government holds 22.5% of the company's shares, Saudi Aramco Development Company holds 20%, and the remaining shares are traded publicly on the Saudi stock exchange.<sup>51</sup> Bahri is the sole transporter of Saudi Aramco's crude oil using VLCCs.<sup>52</sup>

In addition to tankers, Saudi Aramco owns or leases oil storage facilities around the world, including Rotterdam, Sidi Kerir (the Sumed pipeline terminal on Egypt's Mediterranean coast), Japan, and India.<sup>53</sup>

## Major domestic petroleum pipelines

Saudi Aramco operates more than 90 pipelines and 12,000 miles of crude oil and petroleum product pipelines throughout the country, all of which link production areas to processing facilities, export terminals, and consumption centers.

The 750-mile Petroline, also known as the East-West Pipeline, is significant because of its large capacity and because it connects crude oil production and processing facilities in the east of the country to export facilities in the west, allowing the crude oil to bypass the Strait of Hormuz.<sup>54</sup> The Petroline system, which runs across Saudi Arabia from the Abqaiq complex to the Red Sea, consists of two parallel pipelines with a total nameplate (installed) capacity of 5 million b/d. Although the pipeline has operated well below capacity (transporting 2.1 million b/d of crude oil on average in 2019), Saudi Aramco plans to expand the capacity of the East-West pipeline to 7 million b/d to diversify its outlets for oil exports. Initially, the expansion was slated to be completed by 2023, but Aramco reported it achieved this new capacity temporarily through a conversion of NGL pipelines in 2019.<sup>55</sup>

Running parallel to the Petroline is the East-West NGL pipeline,<sup>56</sup> which serves petrochemical plants in Yanbu. The East-West NGL pipeline is Saudi Arabia's largest NGL pipeline.

## International petroleum pipelines

With the exception of a small pipeline to Bahrain, Saudi Aramco does not operate any major functioning international pipelines. The Trans-Arabian Pipeline (TAPLINE), built in 1947 to transport crude oil from Qaisumah through Jordan to Sidon, Lebanon, has been partially closed since 1984. The portion of the pipeline that runs to Jordan was closed in 1990.

The 1.65 million b/d, 48-inch Iraqi Pipeline in Saudi Arabia (IPSA) runs parallel to the Petroline from pump station #3 (11 pumping stations run along the Petroline) to the port of Muajjiz, just south of Yanbu, Saudi Arabia. The pipeline was built in 1989 to carry Iraq's crude oil to the Red Sea. The pipeline closed indefinitely following the August 1990 Iraqi invasion of Kuwait. In June 2001, Saudi Arabia seized ownership of IPSA as compensation for debts Iraq owed and converted it to transport natural gas to power plants. The portion of the pipeline that goes north into Iraq remains a closed, inactive oil pipeline.<sup>57</sup> Saudi Aramco pumped test volumes of crude oil through the pipeline in response to Iran's threats to close the Strait of Hormuz in 2012.<sup>58</sup>

Saudi Arabia's only functioning international crude oil pipeline system carries Arab Light crude oil from Saudi Arabia's Abu Safah field to Bahrain. A 73-year old complex of four small underwater pipelines was decommissioned after the construction of the current pipeline, which has a capacity of 350,000 b/d and

runs between Abqaiq and Bahrain's refinery at Sitra. The current pipeline was commissioned in October 2018.<sup>59</sup>

## Natural Gas

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Saudi Arabia has been gradually developing its sizeable natural gas reserves over the past two decades to supply its expanding petrochemical sector and natural gas-fired electric power generation.

### Reserves

Saudi Arabia (including the Neutral Zone) has one of the largest proved natural gas reserves in the world. Most of the natural gas produced in Saudi Arabia is associated with petroleum deposits and is found in the same wells as crude oil. However, Saudi Aramco has developed more natural gas from reserves containing nonassociated gas fields since 2014.

### Production and consumption

Nearly half of Saudi Arabia's dry natural gas production in 2020 came from four oil fields: Ghawar, Safaniya, Berri, and Zuluf. Associated natural gas produced at the Ghawar oil field alone accounted for 36% of total production, according to Rystad Energy field-level production data.<sup>60</sup> In the past decade, the share of natural gas produced from natural gas fields increased from 15% to 46% as Saudi Aramco began to focus on developing nonassociated gas. Production of associated gas with crude oil fields has been restrained by the OPEC+ production cuts.

Saudi Arabia does not import or export natural gas, so, aside from changes in inventories, its production is equal to its domestic consumption. Rapid reserve development is part of Saudi Arabia's plans to increase its petrochemical sector and provide fuel for power generation and for water desalination while it frees up crude oil for exports. All current and future natural gas supplies (except NGLs) reportedly remain earmarked for domestic use, in part to minimize the use of crude oil for power generation.

### Natural gas developments

Saudi Aramco's strategy outlines a push for greater nonassociated natural gas development and further expansion of natural gas reserves through new reservoirs near existing fields and new discoveries to help meet growing domestic demand. The company plans to continue increasing its natural gas production, processing, and transmission infrastructure, including unconventional natural gas developments to limit the use of oil in power generation and to provide feedstock to the country's growing petrochemical industry.<sup>61</sup>

In the upstream production stages, Saudi Aramco has focused on major offshore natural gas developments in the Persian Gulf, the southern portion of the Ghawar oil field, and the Jafura unconventional field.<sup>62</sup>

Saudi Arabia's notable offshore nonassociated natural gas fields:

- The Karan natural gas field, discovered in 2006, is Saudi Arabia's first offshore nonassociated natural gas development. The Karan field came online in 2012 and has a production capacity of 1.8 billion cubic feet per day (Bcf/d) of sour natural gas, which is delivered via a 68-mile subsea pipeline to the Khursaniyah natural gas plant.<sup>63</sup>

- The Hasbah offshore field began production in March 2016 for processing at the Wasit natural gas plant. Total natural gas output capacity at the field was originally 1.3 Bcf/d. An expansion of the Hasbah field provided 2 Bcf/d of natural gas to the Fadhili processing plant.<sup>64</sup>
- The Arabiyah offshore natural gas field (known as the Farzad B field on Iran's side of the border) began production in 2016 and has a production capacity of 1.2 Bcf/d.<sup>65</sup>

Saudi Arabia nearly doubled its natural gas processing capacity since 2003 from 9.3 Bcf/d to 18.3 Bcf/d in 2020 after Saudi Aramco added several natural gas processing facilities over the past few years. This capacity does not include the 2.4-Bcf/d Shaybah natural gas processing and NGL plant in the Rub al-Khali (also known as the Empty Quarter) because this facility is solely used to extract NGLs for the petrochemical industry and does not market its dry gas production.<sup>66</sup> Recently-commissioned natural gas plants include the following:

- The Wasit natural gas plant reached full operating capacity in 2016 at 2.5 Bcf/d of dry gas production and 240,000 b/d of NGL output. The offshore Arabiyah and Hasbah natural gas fields supply the plant. Commissioning the Wasit gas processing plant made it possible for Saudi Arabia to reduce the direct burn of crude oil for electric power generation and expand natural gas-fired generation.<sup>67</sup>
- The Midyan natural gas plant, a very small facility at 75 million cubic feet per day (MMcf/d), was commissioned in 2017 in the Tabuk region in northwestern Saudi Arabia to supply a local power plant.<sup>68</sup>
- The Fadhili natural gas plant, located near the Jubail industrial city, began operations in 2019 and reached full capacity in early 2020. The plant, which serves the electric power sector, can process up to 2.5 Bcf/d of raw natural gas from the offshore Hasbah field and the onshore Khursaniyah field, both nonassociated gas fields.<sup>69</sup> The Fadhili plant will reduce the electric power sector's need to burn crude oil by supplying more processed natural gas for natural gas-fired power generation.

Saudi Arabia plans to meet growing natural gas demand by increasing natural gas production capacity and to replace more liquid fuels with natural gas in power generation and the seawater desalination process. Saudi Aramco plans on commissioning two more natural gas projects. The Hawiyah natural gas processing plant, which began operations in 2001, is set for an expansion of its natural gas processing capacity by 1.3 Bcf/d in 2022. This facility processes nonassociated gas from the Ghawar field.<sup>70</sup> In 2020, Saudi Aramco began constructing the 2.5 Bcf/d Tanajib natural gas plant, which will process associated gas from the Marjan, Safaniyah, and Zuluf fields and is scheduled to begin operations in 2025.<sup>71</sup>

Saudi Aramco has an unconventional resource program to assess areas that could yield shale gas and tight gas and associated liquids for development. Saudi Aramco developed its first unconventional natural gas project in northern Saudi Arabia, delivering 55 MMcf/d of natural gas to electrical power facilities in the Wa'ad al Shamal industrial city starting in 2018.<sup>72</sup> Saudi Aramco intends to launch its largest unconventional field, located to the east of the Ghawar field near the Persian Gulf, in 2025. At the end of 2021, Saudi Aramco awarded engineering and construction contracts to energy companies to develop the Jafurah project—a project that the company expects will gradually bring online 2 Bcf/d of dry natural gas, 418 MMcf/d of ethane, and 630,000 b/d of condensate by 2030.<sup>73</sup> Saudi Aramco plans to use desalinated water to develop Jafurah and other shale gas projects.

**Figure 4. Major natural gas fields in Saudi Arabia**



Source: Saudi Aramco

### **Domestic natural gas pipelines**

Domestic demand for natural gas, particularly the delivery of feedstock to petrochemical plants, has driven the expansion of the Master Gas System (MGS), the domestic natural gas distribution network in Saudi Arabia. The MGS, first built in 1975, is an integrated natural gas gathering, processing, and transmission system originally put in place to recover the associated natural gas produced at the Ghawar oil field. Before the MGS came online, all of Saudi Arabia's natural gas output was flared. The MGS transports natural gas from associated and nonassociated fields to natural gas processing plants, which separate out the NGLs. The NGLs are then transported to straddle recovery and fractionation plants in Ju'aymah, Yanbu, Hawiya, Ras Tanura, Wasit, Uthmaniyah, and Shaybah.<sup>74</sup>

Further development of natural gas production will likely require MGS expansion, especially to the western region of the country where natural gas pipeline infrastructure is lacking. In 2018, Saudi Aramco raised the capacity of the MGS by 1.0 Bcf/d to 9.6 Bcf/d, its current capacity.<sup>75</sup> Saudi Aramco's plans include another expansion to 12.5 Bcf/d, but the company has not announced a completion date.<sup>76</sup> If fully implemented, these expansions, combined, will add at least 1,000 miles of natural gas pipeline to the system and will transport natural gas to plants at Yanbu in the west and to natural gas lines in central Saudi Arabia.

## Electricity

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Between 2009 and 2017, demand for electric power in Saudi Arabia rose by an average of 7% per year, but it declined after 2017. Rising demand was driven by:

- Population growth
- A rapidly expanding industrial sector that was led by the development of petrochemical complexes as well as high demand for air-conditioning during the summer months
- Heavily subsidized electricity rates

Saudi Arabia added generation capacity to meet the growing electricity demand. Growth in electricity consumption slowed after a number of government actions (including raising electricity tariffs in 2016 and 2018) improved energy efficiency in buildings and implemented demand management systems to reduce inefficient electricity consumption.

Nearly all of the existing generating capacity is powered by oil or natural gas, but Saudi Arabia plans to diversify fuels used for generation, in part, to free up oil for export. Although the Saudi Electricity Company (SEC) plans to continue reducing direct crude oil burn for electricity generation by switching to natural gas, plans are also in place to develop renewable sources for electric power generation. The National Renewable Energy Program (NREP) has plans to raise Saudi Arabia's renewable energy capacity to 27.3 gigawatts (GW) by 2024 and 58.7 GW by 2030 and to generate 50% of its electricity from renewable sources by 2030.<sup>77</sup> NREP has several solar projects under development and invited tenders for another round of bids in 2021 for solar power projects, which have a combined capacity of 1.2 GW.<sup>78</sup> Although Saudi Arabia has vast potential for renewable energy capacity, these goals are ambitious, particularly given the slow pace of progress on currently planned renewable projects.

The Saudi government issued a scaled-down plan to develop nuclear power capacity in January 2015 and revised its target of building 17 GW of nuclear capacity from 2032 to 2040. In July 2017, the Council of Ministers approved proposals to establish the National Project for Atomic Energy, which includes two large-scale (1.2 GW to 1.6 GW) and two small-scale (10 MW to 300 MW) reactors that would be built in areas that are outside the national grid to provide electricity to desalination plants and industries. Saudi Arabia's King Abdullah City for Atomic and Renewable Energy (KACARE) plans to request proposals from five international firms about the nuclear technology for the large reactors by the end of December 2021 and is assessing technologies for the smaller reactors.<sup>79</sup> Argentine firm INVAP started construction of a 30-kilowatt low-power research reactor in Riyadh in November 2018.<sup>80</sup>

### Sector organization

The Water and Electricity Regulatory Authority (WERA), formerly known as the Electricity and Cogeneration Regulatory Authority, is the regulatory body for the electricity, water desalination, and district cooling industries in Saudi Arabia. WERA is responsible for assuring adequate and reliable supply of electricity and water, reviewing consumer tariffs, and promoting fair competition and investment in these industries.<sup>81</sup>

The National Renewable Energy Program (NREP) is an initiative under the purview of the Ministry of Energy to promote Saudi Arabia's clean energy development and reduce its heavy use of oil-fired power generation.<sup>82</sup>

Saudi Electricity Company (SEC) is the largest provider of electricity in Saudi Arabia. It had a total available generation capacity of 53 GW in 2020, which was around 67% of the country's total installed

capacity. The SEC is responsible for generation, and the National Grid S.A. Company, SEC's subsidiary, is responsible for the transmission and distribution of electrical power.<sup>83</sup>

The state-owned Saline Water Conversion Corporation (SWCC), which provides most of Saudi Arabia's desalinated water, had 7.2 megawatts (MW) of installed electricity capacity in 2020 to produce electricity used in its desalination process.<sup>84</sup> Saudi Arabia plans to rapidly increase its desalination capacity by about 60% by the end of 2023,<sup>85</sup> with an equivalent increase in generation capacity, through the Saudi Water Partnership Company (SWPC), a utility fully owned by the Ministry of Finance. SWPC oversees project development for the privately owned independent water and power producers.<sup>86</sup>

Saudi Aramco continues to build cogeneration plants to generate power for its own needs at various oil and natural gas facilities. By the end of 2019, Saudi Aramco had 6.5 GW of power generation capacity, including 2.5 GW from joint ventures and third-party power producers.<sup>87</sup> The 3.8-GW Jazan Integrated Gasification, Combined Cycle Power Plant is expected to start operations by 2022 to partially serve Saudi Aramco's adjacent refinery.<sup>88</sup>

In 2007, Saudi Arabia began allowing private participation in the electric power sector, approving the first Independent Power Producer (IPP). The first two projects, the Rabigh 1 project in Mecca and the Riyadh 11 project in Dhurma, began operating in 2013. These projects were followed the Qurayyah project in the Eastern Province, which started operations in 2016, and a second Rabigh power plant that came online in 2018. According to WERA data, these four plants have a combined capacity of more than 9 GW.<sup>89</sup> A few other major IPP projects, such as the natural gas-fired Taibah and North Qassim power plants, each with a capacity of 3.6 GW, are under development and expected online by 2025.<sup>90</sup>

Physical improvements are needed to allow more companies to sell power to the grid. SEC has ongoing and planned projects that will link power plants in the eastern, western, and southern portions of the country. To meet peak demand requirements, Saudi Arabia participates in the Gulf Cooperation Council's (GCC) efforts to link the power grids of member countries. The GCC is an alliance between six Persian Gulf states: Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates. The alliance seeks to build closer ties with the member countries, including the construction of electric power interconnections. The GCC Interconnection Authority is owned by the six member countries. The GCC member states' grid interconnection was completed in 2011. In 2020, the member states traded 1.06 gigawatthours of electric power during both winter and peak summer months.<sup>91</sup> Separately, Saudi Arabia signed a power connection agreement with Egypt to connect their electricity grids with 3 GW of capacity by 2025.<sup>92</sup>

## Note

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- Data presented in the text are the most recent available as of December 2, 2021.
- Data are EIA estimates unless otherwise noted.

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