



Saudi energy mix: renewables augment gas

Saudi Arabia is hardly running low on energy, but the kingdom is moving to limit surging domestic demand's impact on exports

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Saudi Arabia abounds, of course, in energy resources, but a new source of demand is cutting into its oil output: domestic consumption, already high, is growing fast and threatens to crimp exports. Electricity use is increasing at about 7.5% annually, just ahead of the about 7% growth in gasoline demand.



Saudi Arabia's present energy demand growth could require 8.3 million barrels of oil-equivalent per day by 2028, which Saudi officials have noted might require diverting of 3 million barrels per day of crude oil to the power sector.

Overall energy demand nationwide was estimated at 3.4 million barrels of oil-equivalent per day (mboe/d) in 2010. At present growth rates, that demand, which combines crude oil, gasoline, diesel, natural gas and fuel oil, could reach 8.3 mboe/d by 2028. As a number of prominent Saudi officials have pointed out, at that point an average of 3 million barrels per day (mb/d) of crude oil might have to be diverted to the power sector, potentially cutting export revenue significantly and taxing world markets that the kingdom sees as its responsibility to keep well-supplied.

Population and prices boost demand

The growth in energy demand reflects Saudi Arabia's 180% rise in inhabitants from 1980 to 2010, according to the United Nations Population Division, more than triple the global average. The population reached 28.3 million at the end of 2012, including more than 8 million foreign residents. And those people are getting richer, with the International Monetary Fund forecasting real gross domestic product (GDP) growth of 4.1% in 2014 and 4.2% in 2015. Abundant and cheap natural gas has attracted large-scale investment in energy-intensive industries over the past three decades, with the Saudi industrial sector now making up 9% of GDP as it supplies 8% of the world market in petrochemicals.

In addition, the largely arid country sustains the world's largest desalination programme, processing more than 3.5 million cubic metres of seawater a day

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programme, processing more than 3.5 million cubic metres of seawater a day. The programme, which is being expanded by 50%, contributes significantly to the country's high energy intensity. In 2010, energy intensity was already 0.53 tonne of oil-equivalent per USD 1 000 (2005 dollars) of GDP. That level is 20% higher than in 2000 and almost twice that of the United States, where, like in most of the rest of the world, energy intensity has been declining. Energy intensity in China fell by 67% between 1980 and 2010, while in Saudi Arabia it rose by 138%.

A principal cause of energy demand growth is very low end-user prices. Electricity costs no more than USD 0.6 per kilowatt hour (kWh), one-quarter the 2013 average for OECD households. Gasoline runs about USD 0.12 per litre – against the USD 1.71 average for premium unleaded in the OECD – to motorists' delight but overwhelming the country's 2.5 mb/d refining capacity enough to force gasoline and diesel imports in recent years.

Long- and medium-term solutions

For now, total demand remains little more than a rounding error when compared with Saudi Arabia's 261 billion barrels of conventional oil reserves, nor does it make much of a dent in the current production capacity of 12.5 mb/d. But besides the impact on export potential from unabated growth in domestic oil consumption, the country's fossil fuel-based power generation system is close to saturation. So the kingdom is moving forward with both short-term fixes and long-term solutions.

Saudi Arabia has long used natural gas to fuel much of its power generation, relying on its 286 trillion cubic feet (tcf) of reserves, plus an estimated 600 tcf of unconventional reserves as well as additional conventional reserves in the northwest and offshore in the Red Sea that are beginning to be developed. Unlike many of its neighbours and despite strong demand in Asia and growing interest in Europe, the kingdom has never exported gas. Instead, from the early 1980s onwards, its Master Gas System has distributed the large quantities of gas associated with oil production around the country exclusively for electricity generation, to supply industry and as feedstock for petrochemicals.

Gas production is expected to rise progressively to 15 billion cubic feet per day (bcf/d) by 2018. Plus projects developed from 2004 to 2010 produce 750 000 barrels per day (kb/d) of natural gas liquids, much of which is blended with crude or for use as petrochemical feedstock, freeing up more gas for power generation. And the kingdom has also earmarked about USD 9 billion for exploration to increase reserves by another 50 tcf.

Gas provides around 43% of Saudi electricity, with fuel oil and diesel providing the rest. In recent years more and more crude oil has been diverted to the power sector, oil that might otherwise be sold internationally to augment national earnings. Since 2011, power generation has consumed more than 500 kb/d, with peak demand in summer now seen topping 900 kb/d.

Overtaxed power infrastructure

Demand is already running up against the kingdom's installed power generation capacity, which the *Middle East Economic Survey* listed at 58.4 gigawatts (GW) as of 2013. It is also a challenge to provide enough fuel, with demand growth in electricity already having outpaced the capacity of the gas and fuel oil sectors to supply the power stations.

In 2011, Saudi Arabia's electricity demand was 210 terawatt hours, or about 7 420 kWh per capita, comparable to Mexico's total consumption but more than three times as high on a per capita basis. Climate is a major factor: the building sector has by far the largest share of energy demand, at up to 80% of total power demand – 70% of which is for air conditioning. This adds to the seasonality of demand, with summer peak demand nearly twice the winter average.

A cause of high demand can cool it off

While higher gas output is the shorter-term solution to surging demand, Saudi Arabia intends to benefit long term from one aspect of the climate that boosts consumption: solar power. The kingdom enjoys twice the direct normal irradiance that is available in the sunniest part of Germany, according to calculations by the US National Aeronautics and Space Administration.

Saudi Arabia aims to have 41 GW of solar power by 2032, 60% of it generated at concentrated solar power plants and the rest from solar photovoltaics such as rooftop panels, at a cost of USD 109 billion. The first gigawatt of solar power, to be installed by 2020, should save at least 1 bcf/d of gas, based on a combined-cycle gas turbine unit's output when operating at average summer conditions. In addition, wind power is to provide 9 GW of capacity for electricity generation and desalination, while the kingdom also has an ambitious target of 17.6 GW of nuclear capacity by 2032.

But solar power systems present challenges in hot dusty conditions: dust impairs operations, and efficiency falls at temperatures above 30 degrees Celsius. A number of research establishments in the Gulf region are working on ways to tackle these problems.

Using power more wisely

Another way to limit consumption is increased energy efficiency, which the IEA sees as a key element of any sustainable energy strategy. As with renewables, investment in energy efficiency not only enhances the system's sustainability but also can promote local employment, foreign investment and the transfer of technology. Most of all, the energy a country does not use is not only its cheapest energy but the one that requires the least fuel and infrastructure.

The building sector's dominant position in electricity demand makes it a good starting point for Saudi energy efficiency, and the government has already revised construction codes. Riyadh recently introduced industry standards, e.g. for buildings and appliances including air-conditioners, which if continued and diligently implemented have the capacity to deliver large savings. The government has announced plans to build 200 000 housing units per year over

government has announced plans to build 200 000 housing units per year over the next decade, offering considerable long-term savings if they are constructed to the latest insulation and ventilation standards. The Saudi Energy Efficiency Centre (SEEC) was created in 2010 at the King Abdulaziz City for Science and Technology (KACST) to work on demand-side energy efficiency programmes. In 2012, the SEEC launched the Saudi Energy Efficiency Program (SEEP).

The quickest route to reduced consumption in buildings is new appliance standards for air-conditioning units, both imported and locally produced. But while the government has announced standards, establishing and implementing them is requiring extensive capacity development. There are some recent success stories: the SEEC persuaded the Ministry of Commerce and Industry to confiscate from stores 50 000 air conditioners that did not meet the country's energy saving requirements as of early 2014. Some minimum energy performance standards have been recently issued, and mandatory insulation of new buildings is being considered. But there is clearly more to do in areas such as enforcement mechanisms in insulation and lighting, and the Saudi Building Code of 2007 is seen as complex, long and in need of updating.

Beyond the activities of the SEEC, key Saudi decision makers have made recent positive declarations which support efficiency efforts. Prince Abdulaziz bin Salman al-Saud, in an article in the May 2014 issue of *Oxford Energy Forum*, wrote that "whereas the vast majority of countries have managed to lower the energy intensity of their economies, the Kingdom's energy intensity increased significantly over the last two decades. ... [I]t is a strategic imperative for the Kingdom that energy efficiency become a major topic for all decisions related to an increase in demand for fuel and feedstock." Nevertheless, as underlined by the prince, the SEEP "does not include price reforms" even though record low energy prices make it difficult to encourage final consumers to make drastic energy savings.

On a national basis, reshaping the grid offers efficiencies. The Saudi Electric Company is already open to supply from independent power producers that bring in international investment (on a project finance basis) and offer global experience in optimising large-scale power systems. Domestically, both the Saline Water Conversion Corporation and Saudi Aramco are on track to become net producers of energy, allowing them to feed into the grid. Also, the IEA recommends introducing smart grids and smart metering as effective means to reduce peak loads in Saudi Arabia, easing the summer strain on the power system.

Sharing that benefits Saudis and others

Finally, the region offers opportunities to bolster the power system. The northern Gulf grid connection that links Saudi Arabia, Kuwait and Qatar is designed to allow the sharing of power on an emergency basis, but already can enable the participants to reduce the spinning reserve that they need to maintain to ensure the stability of their grids.

The kingdom has plans with Egypt to set up a grid connection to take advantage of differences in each national system's daily demand peaks; the connection could operate at a level as high as 3 GW.

An even more ambitious plan under consideration is to share power on a seasonal basis with the Turkish and European grids to take advantage of the very large spare capacity the Saudi system has in the winter months. Such a system could supply as much as 10 GW to help meet European peak winter demand, while sending back power in the summer to cool the Gulf as demand peaks there.

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