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مركز الملك عبدالله للدراسات والبحوث البترولية
King Abdullah Petroleum Studies and Research Center

# Commentary

## Industrial Energy Consumption in Saudi Arabia

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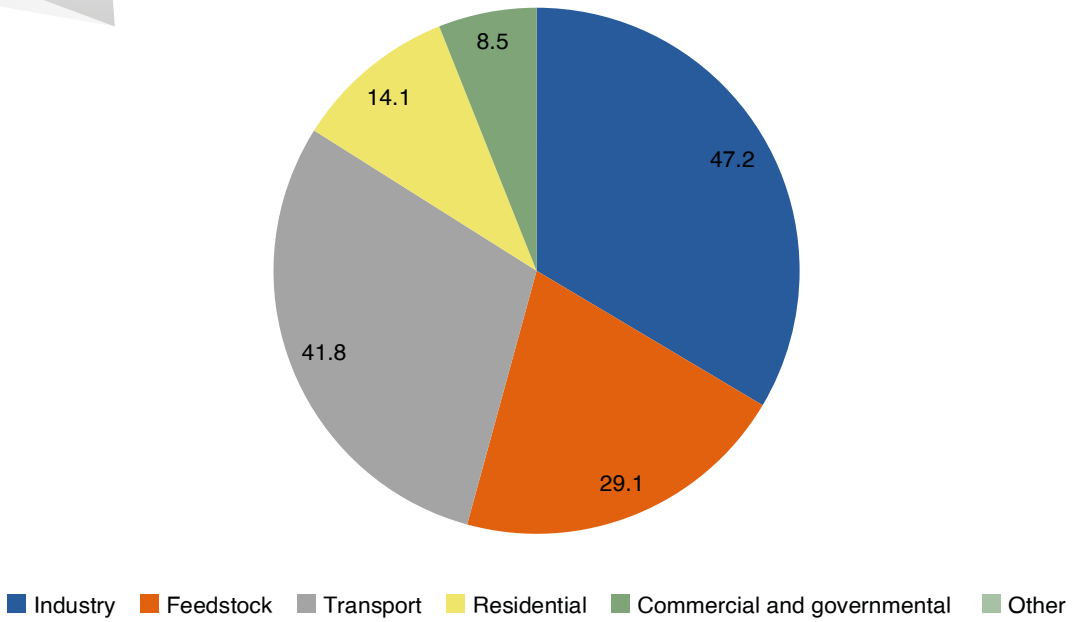
## How much energy does industry really consume?

In 2017, Saudi Arabia's total final energy consumption was 140.7 million tonnes of oil equivalent (Mtoe). Total final energy consumption is defined as energy used by final consumers (or end users). It includes electricity use in residential buildings, gasoline use in cars, and fuel use by industries producing cement, chemicals, and steel.

Figure 1 breaks Saudi Arabia's total final energy consumption down by sector for 2017. It shows that industry consumed 47.2 Mtoe, a third of the country's total final energy consumption. This makes the industrial sector the largest end user of energy in Saudi Arabia. Furthermore, feedstock use in the Kingdom in 2017 amounted to 29.1 Mtoe. Feedstock refers to the use of energy as a raw material. Almost all feedstock in Saudi Arabia is consumed by industry as a raw material in the production of petrochemicals. Feedstock is generally shown as a separate sector (sometimes referred to as 'non-energy use'). However, combining the feedstock sector's consumption with that of industry gives the industrial sector's true consumption as 76.3 Mtoe, more than half of the Kingdom's total final energy consumption.

The largest energy-consuming sectors after industry are transport (road, rail, and air), residential (mainly electricity use in buildings), and commercial and governmental (electricity use in buildings). "Other" in Figure 1 refers to sectors such as agriculture and fishing, which together consume insignificant amounts of energy (less than 1 Mtoe). It is therefore not visible in Figure 1, as it is too small to register.

**Figure 1.** Breakdown of Saudi Arabia's total final energy consumption by sector in 2017 (Mtoe).



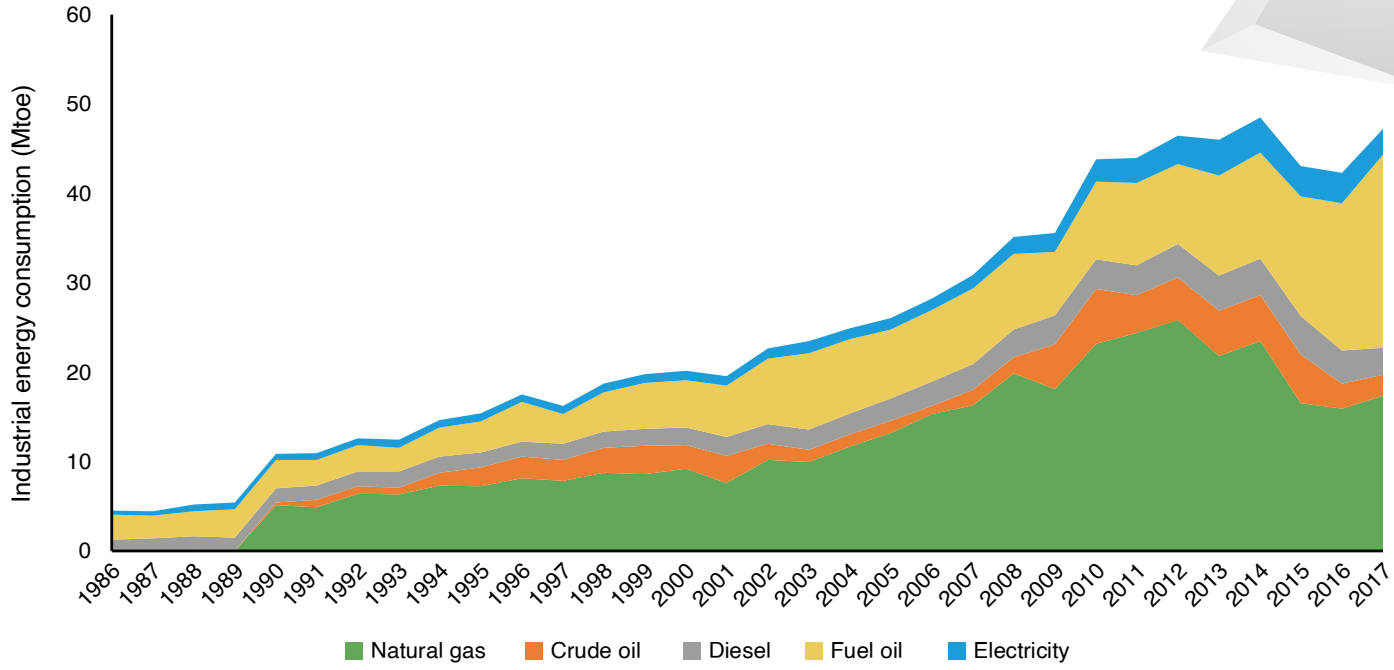

Source: IEA (2019).

## How has industrial energy consumption evolved?

Between 1986 and 2017, industrial energy consumption in Saudi Arabia (excluding feedstock) increased more than tenfold. Natural gas is the main fuel consumed by the industrial sector, with fuel oil the second most consumed fuel. Figure 2 shows the growth of industrial energy consumption in Saudi Arabia by fuel type.

As can be seen, the Kingdom has experienced steady, rapid growth in industrial energy consumption since 1986, but there was also a fall in industrial consumption in 2015 and 2016. This fall appears to be due to the first wave of energy price reform, initiated in 2015, which led to higher fuel and electricity prices for households and industry. Nevertheless, industrial energy consumption appears to have recovered in 2017, with significant growth observed in that year.

**Figure 2.** Growth of industrial energy consumption in Saudi Arabia by fuel type.




Source: IEA (2019).

## The impact of industrial fuel price reform

Saudi Arabia's economy is dependent on oil exports, which account for most of the government's revenues. However, revenues from oil exports can be volatile. The Fiscal Balance Program (FBP) (SV2030 2018) was launched in 2016 to tackle this issue, among other goals. It is one of the key executive programs of Saudi Vision 2030, the Kingdom's blueprint for economic diversification, and it aims to achieve a balanced government budget by 2023. The FBP encompasses several important initiatives, such as a value-added tax, expatriate levies, and energy price reform. The latter is arguably one of its most important initiatives.

The first wave of energy price reform substantially increased the prices for industry of many fuels, including natural gas and fuel oil (Table 1). Natural gas, which comprises methane and ethane, is the key fuel consumed by industry. Table 1 shows that methane and ethane increased by 67% and 133%, respectively, following the first wave of the energy price reform.

**Table 1.** Energy prices (nominal) before and after the first wave of energy price reform in 2015.

| Key industrial fuels | Prices before the first wave of energy price reform | | Prices after the first wave of energy price reform | | Percentage change |
|---|---|---|---|---|---|
| **Natural gas** | **SAR/MMBtu** | **US$/MMBtu** | **SAR/MMBtu** | **US$/MMBtu** | |
| Methane | 2.81 | 0.75 | 4.69 | 1.25 | 67% |
| Ethane | 2.81 | 0.75 | 6.56 | 1.75 | 133% |
| **Crude oil** | **SAR/barrel** | **US$/barrel** | **SAR/barrel** | **US$/barrel** | |
| Arab Light | 15.90 | 4.24 | 23.81 | 6.35 | 50% |
| Arab Heavy | 10.01 | 2.67 | 16.50 | 4.40 | 65% |
| **Other petroleum products** | **SAR/barrel** | **US$/barrel** | **SAR/barrel** | **US$/barrel** | |
| Diesel (industry) | 34.20 | 9.12 | 52.50 | 14.0 | 54% |
| Diesel (transport) | 39.75 | 10.60 | 71.63 | 19.1 | 80% |
| Heavy fuel oil | 7.80 | 2.08 | 14.25 | 3.80 | 83% |

Notes: SAR = Saudi riyals; US$ = United States dollars; MMBtu = million British thermal units.

Sources: Saudi Aramco (n.d.); MEIM (n.d.); ECRA (2013); Akhbaar24 (2015); Alriyadh (2015); Matar et al. (2015).

## Modeling industrial energy consumption using econometrics

To better understand industrial energy consumption, we used Harvey's (1990) structural time series model to estimate an econometric model of industrial energy consumption in Saudi Arabia.

Aggregate industrial energy consumption was modeled as a function of:

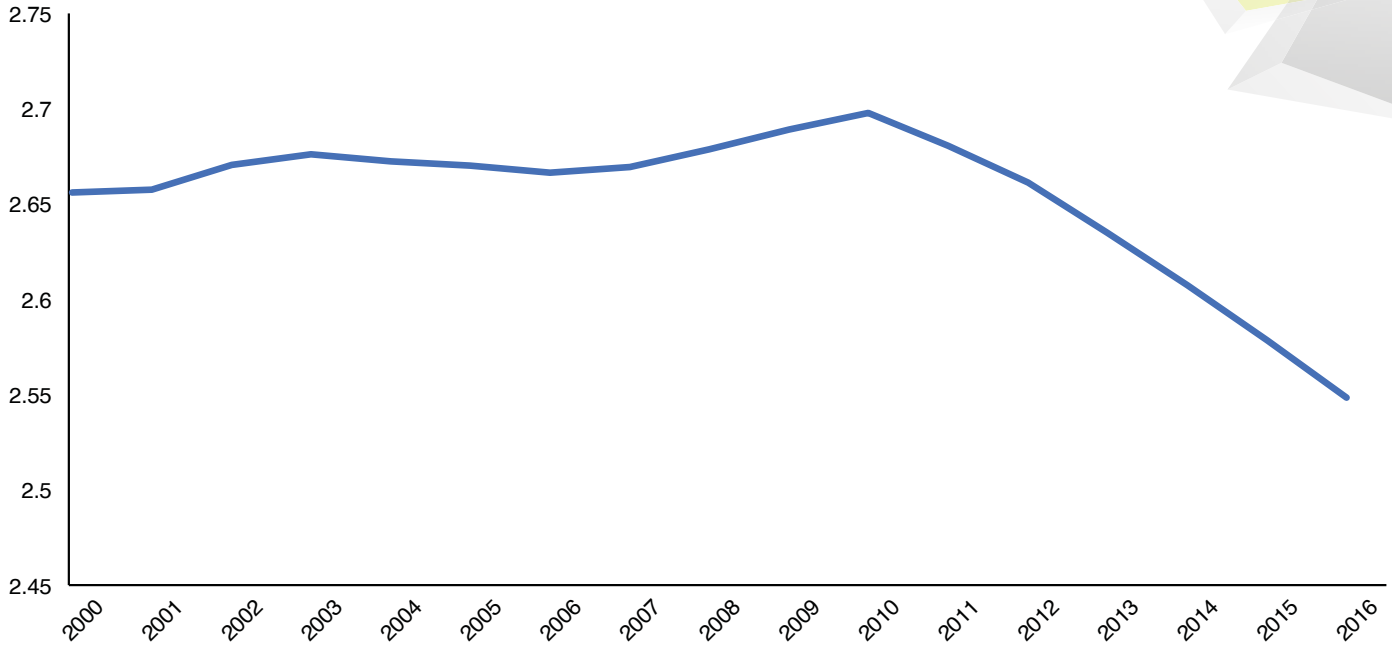
- Industrial output
- The average energy price for industry
- A factor that captures how specialized Saudi Arabia is in energy-intensive production
- An underlying energy demand trend (UEDT), which captures the time-varying impact of external factors such as energy efficiency on industrial energy consumption

## Energy efficiency improvements in industry

One of the advantages of the structural time series model is that it generates a UEDT through the estimation process (Hunt et al. 2003). Figure 3 shows the UEDT for industrial energy consumption in Saudi Arabia.

From 2000 to 2010, the UEDT was largely flat. From 2010 onward, it became downward sloping. This suggests that there was an external force (excluding industrial output, energy prices, and specialization, which were already accounted for in the model) that started to exert downward pressure on energy consumption from 2010. This external force was likely improvements in the industrial sector's energy efficiency, which, all other things being equal, reduced energy consumption. The Saudi Energy Efficiency Center (SEEC) was established in 2010 and has since focused on improving energy efficiency in the buildings, transport, and industrial sectors through numerous energy efficiency measures. The UEDT since 2010 likely shows the combined result of these programs on the industrial sector's consumption.

**Figure 3.** Underlying energy demand trend (UEDT) of industrial energy consumption in Saudi Arabia.




Source: KAPSARC analysis.

## The drivers of industrial energy consumption

Several factors appear to have influenced the evolution of industrial energy consumption in Saudi Arabia. One is the rapid growth in the country's industrial output. Another is the Kingdom's increasing specialization in energy-intensive production. Energy-intensive manufactured goods include petrochemicals, iron and steel, cement, and aluminum. Increased production of these energy-intensive goods leads

to higher energy consumption, and their share in total manufacturing in Saudi Arabia increased steadily between the 1980s and 2010s. To examine the impact of each factor on industrial energy consumption over time, we applied a decomposition analysis to our econometric model of Saudi Arabia's industrial energy consumption. This allowed us to break down the change in industrial energy consumption, between any two years, into contributing factors that we refer to as drivers.

According to our decomposition analysis, the growth in industrial output has been the primary driver of the growth in industrial energy consumption over the last few decades. The shift toward energy-intensive manufacturing also contributed to this growth. However, higher energy prices and energy efficiency have recently helped reduce industrial energy consumption. The decomposition analysis reveals that energy efficiency improvements delivered energy savings of almost 7 Mtoe between 2010 and 2016. It also reveals that industrial energy price reform delivered energy savings of around 3 Mtoe between 2015 and 2016.

## Conclusion

Our study reveals the impact of Saudi Arabia's fuel price reform and energy efficiency improvements on its industrial sector's energy consumption. The results suggest that policymakers could build on the energy price reform and energy efficiency measures to keep the growth rate of industrial energy consumption sustainable, increase economic efficiency, and maintain industrial competitiveness.

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