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King Abdullah Petroleum Studies and Research Center

Saudi Arabia's Unfolding Power Sector Reform:

Features, Challenges and Opportunities for Market Integration

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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.

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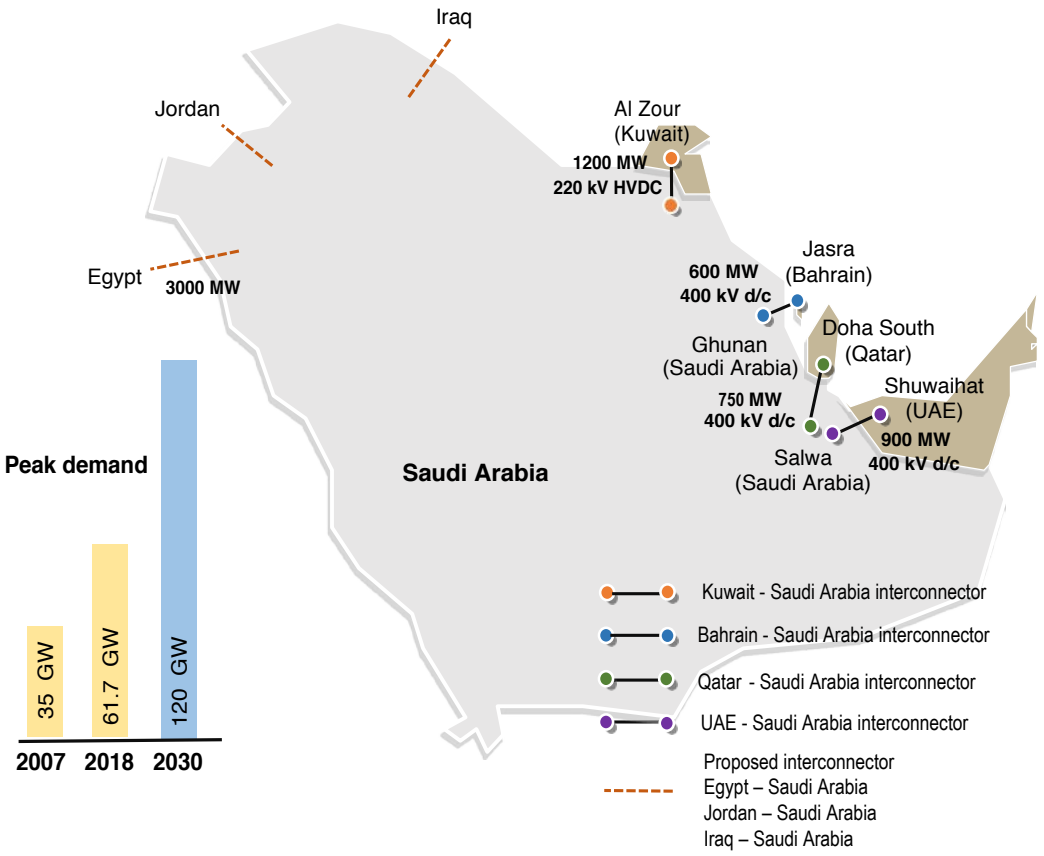
Key Points

Saudi Arabia's electricity sector is one of the largest in the Gulf region. The country's electricity demand is expected to double by 2030. The industry's structural, regulatory, and policy changes are expected to transition the power sector from a vertically integrated utility to a more competitive market-based structure. The key features of Saudi Arabia's electricity market and the challenges and opportunities associated with its liberalization initiatives, along with its increased participation in cross-border electricity trading, are summarized as follows:

> The diversification and sustainability of energy supplies are to be the focal areas for electricity sector reform. This is in line with the objectives and strategic priorities as set out in Saudi Vision 2030, including a larger role for the private sector. Natural gas and renewables are to play an increasingly important role in the energy mix. Saudi Arabia is implementing one of the largest renewable energy capacity expansion plans in the region. To achieve this, integration and other challenges need to be addressed.

Figure 1. Saudi Arabia's electricity demand.



Source: Collated from multiple sources based on information available in the public domain. The map showing regional interconnections is for representational purposes and does not show the exact transmission corridor between the countries.

Key Points

The importance of restructuring the electricity industry to avoid unsustainable outcomes was recognized in the mid-1990s. However, reform efforts have progressed slowly. Large consumers with captive generation facilities are likely to be allowed to sell and purchase electricity directly through bilateral contracts in the interests of developing a competitive electricity market.

Price reform measures introduced in 2015 have led to tariff increases for some consumers, but overall retail electricity tariffs remain low compared with the cost of supply. This is affecting the financial sustainability of the electricity sector. Further, low fuel prices for power generation have been perceived to be one of the most significant barriers for the integration of electricity markets, due to concerns surrounding implicit wealth transfer through cross-border electricity trading.

Electricity tariff and fuel price reforms should be taken up in parallel to restore the financial sustainability of the power sector. The misalignment and/or prioritization of one over the other will continue to exacerbate the current high government subsidies to the sector and the sector's financial unsustainability.

It is desirable to separate the potentially competitive generation and retail activities from the natural monopoly segments of transmission and distribution to establish a competitive wholesale electricity market in the future. A transmission system operator (TSO) model can ensure the sector's independence in operational and investment decisions and guarantee non-discriminatory access to market players. An independent system operator (ISO) model can be a good substitute for a TSO. However, being overly complex, it requires maturity in information exchange and operational coordination between the system operator (SO) and the transmission owner (TO). The ISO is considered more suitable for regions with multiple transmission owners.

Aside from unbundling generation, transmission and distribution functions, a wholesale spot market to be managed by an independent system operator and/or a market operator is being discussed to enhance transparency in market operations and provide a level playing field to market participants.

A principal buyer (PB) has been created to manage commercial agreements such as fuel supply and power purchase contracts. The PB also has an exclusive mandate to handle the import and export of electricity through regional interconnections.

Other issues that will merit further attention in the ongoing restructuring efforts include dealing with the inherited liabilities of the industry in the structural unbundling process, developing an ancillary market to support the changing nature of the country's energy mix and variability requirements, and developing an effective mechanism to channel government support during the transition period.

The electricity industry restructuring plan needs to articulate its objective clearly. The reform strategy needs to be aligned with the restructuring objectives and needs for it to be implemented in a time-bound manner. Intermediate stages on the path to a competitive electricity market should assess and resolve implementation issues and/or market design flaws in a timely manner.

From regulatory oversight to making and revising the rules for the electricity industry, the role of a regulator is of critical importance. Regulatory agencies need to be strengthened, where necessary, so that they can perform their roles and functions more effectively.

Introduction

Today, there is a physical exchange of electricity between Gulf Cooperation Council (GCC) countries. However, this is not the same as competitive trade in electricity. Numerous studies have shown the efficiency benefits of electricity trade among GCC countries. These studies inevitably make simplifying assumptions about several complex issues in the power sector of these countries to focus on the economic gains of trade. However, issues such as the availability of transparent information so that participants can trade, transmission access and pricing, the level of competition in the wholesale electricity market, the coordination of system operations, and the harmonization of power sector structures and market rules are all very important.

A fully liberalized market structure is not a precondition for market integration. However, a certain level of harmonization in power market structures and approaches is critical for enabling and incentivizing market integration and electricity trade. Therefore, it is important to understand the electricity industry design, its functioning, and other associated issues of countries in the region. An understanding of these factors can help to identify and examine the key issues affecting electricity market integration within the GCC and the Middle East and North Africa (MENA) regions, and to suggest potential enablers of market integration. For example, the introduction of generator competition and wholesale market prices, along with clear cross-border transmission rights, will provide price signals for participants within both regions to engage in trade. Competition in distribution will incentivize private retail companies to secure the cheapest sources of electricity for their customers, whatever their national origin.

KAPSARC has initiated a research project to develop insights that can facilitate the creation of a well-functioning integrated electricity market comprising the member states of the Gulf Cooperation Council (GCC).[1] Policy, legislative, regulatory, market design, system operation, and governance aspects of the electricity market will be examined for key countries, to identify good practices in encouraging efficient regional electricity trade. The project will examine the potential value to the GCC region of the experiences of several power systems around the world that have combined to form regionally integrated electricity markets. The research project will help decision-makers in the region fill knowledge gaps and facilitate the ongoing efforts toward regional electricity market integration.

The first phase of the project addresses the features of, and the challenges and opportunities facing, other countries in the region. The analysis discusses reform initiatives, restructuring activities, key market players, and associated issues. It provides an in-depth analysis of the main themes of the regional electricity sector and will serve as the backbone for a subsequent comprehensive study focusing on aspects of regional electricity market design. The subsequent study will also propose a pragmatic approach to guide the transition toward more effective regional market integration. This report focuses on Saudi Arabia's electricity sector. Future reports will look at the market design and market structure-related issues in the context of developing an integrated regional electricity market.

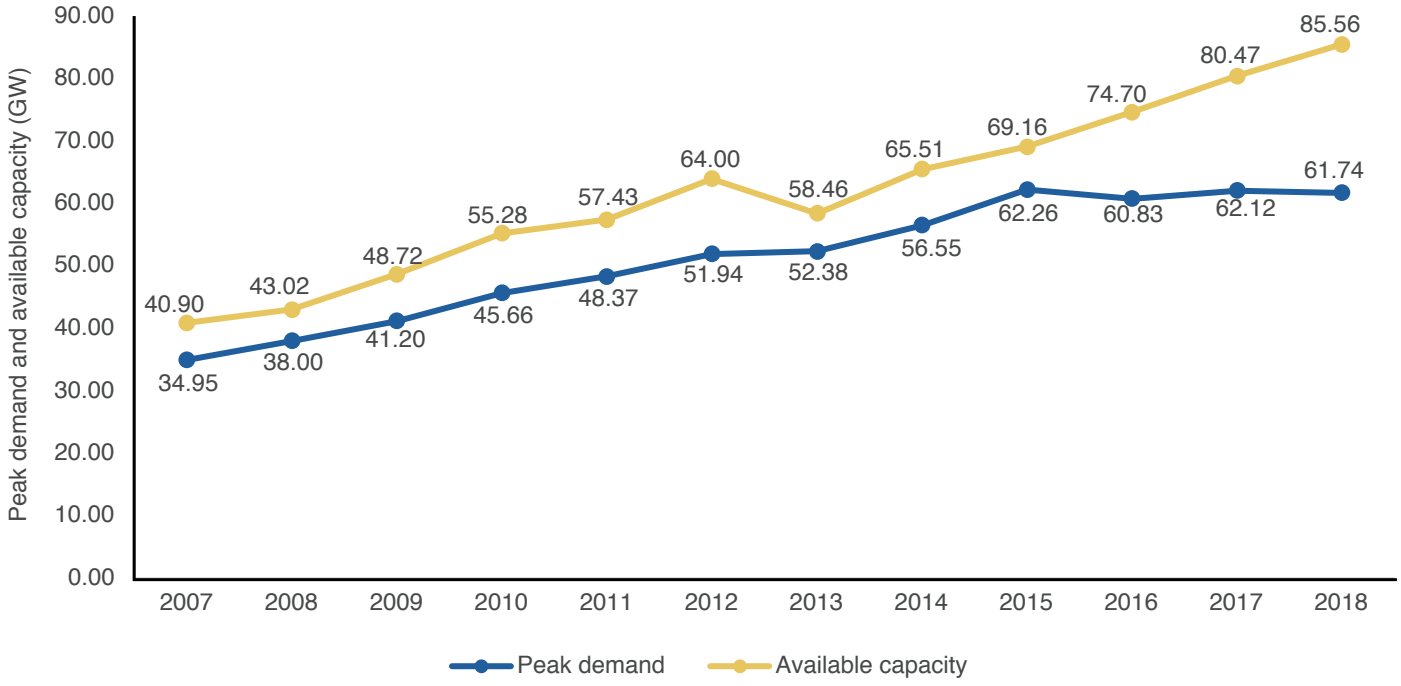
Demand and Supply Overview

With 61.7 gigawatts (GW) of peak demand and 89.2 GW (ECRA 2019) of available capacity in 2018, Saudi Arabia's electricity system is the largest in the Gulf region and the Arab world. It has grown rapidly for over 20 years – doubling in size since 2000 (EIA 2016). Its peak demand increased from 35 GW in 2007 to 61.7 GW in 2018 (ECRA 2019), registering an average 5.31% annual increase in demand between 2007-2018 (Figure 2).

The power system is demarcated into four operating regions: eastern, western, southern, and central. Except for the southern region, peak demand is almost equally distributed (Figure 3). The annual load profile also shows significant seasonal variations, with peak summer demand significantly higher than peak winter demand (Figure 4). In 2018, for example, peak summer demand reached 61.7 GW in September, while peak winter demand was 35.8 GW in February. The demand peaks during the summer months of June to September reflect the impact of the highest temperatures of the year on intensive air conditioning use. Figure 5 shows monthly peak demand variations for 2018 by operating region. With demand stagnation since 2015, peak demand is expected to be lower than the previous projections (120 GW by 2030) of Saudi Arabia's Electricity and Cogeneration Regulatory Authority (ECRA).

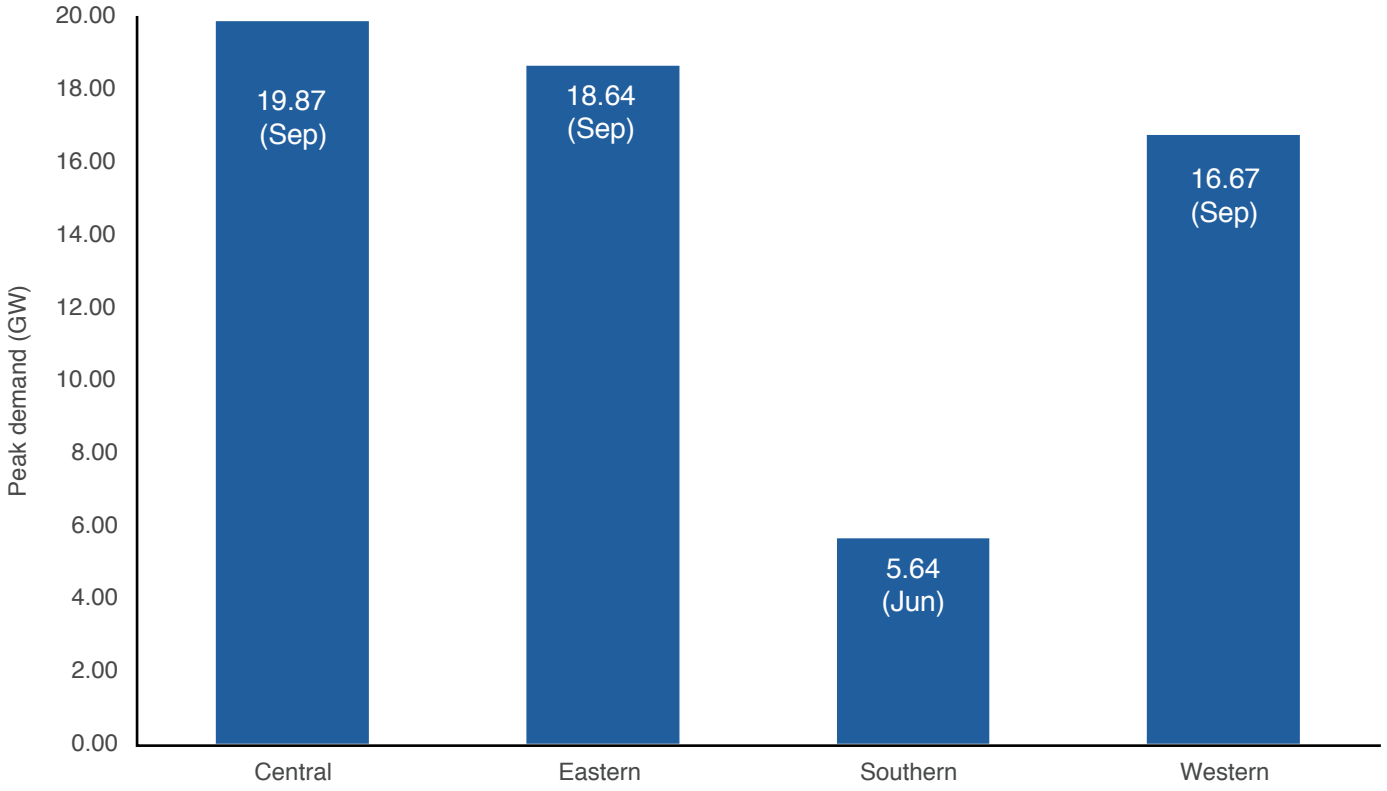
Total electricity consumption in 2007 was approximately 175.05 terawatt-hours (TWh). This increased at an average annual compound growth rate of 5.48%, reaching 299 TWh in 2018 (ECRA 2015, 2018). This growth rate is considerably high when compared with the average growth rate in developed countries, which ranges between 1-2% (Pazheri et al. 2011). Oman and Abu Dhabi recorded much faster growth in electricity consumption during the same period, averaging around 11% and 9.5%, respectively. China had the highest average annual

Figure 2. Peak demand and maximum available capacity of National Grid SA.



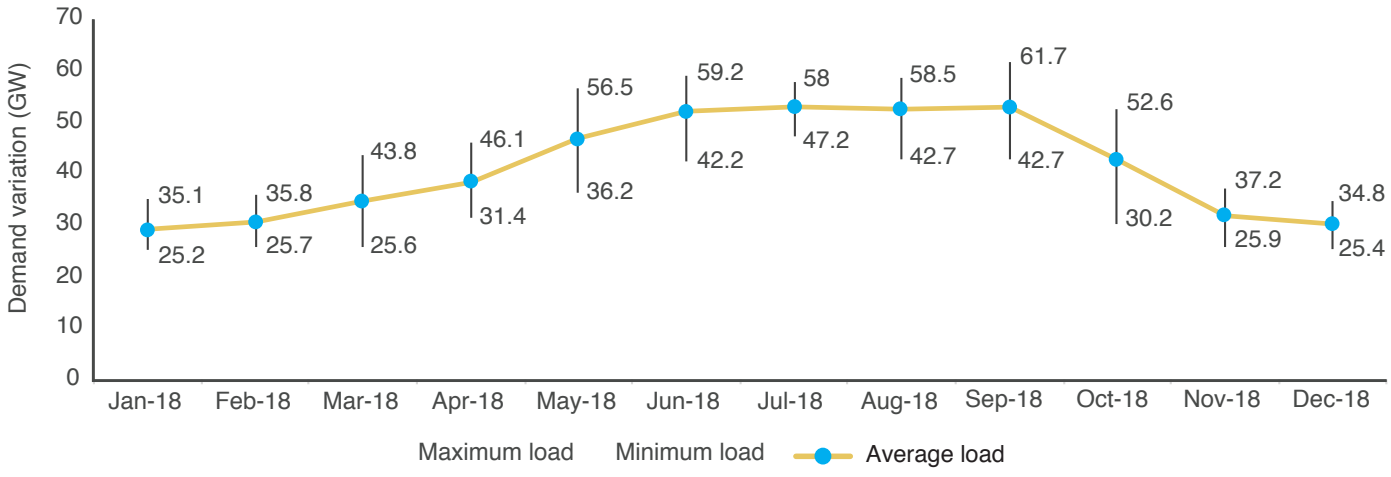
Source: (i) ECRA National Electricity Registry and (ii) Annual Statistical Booklet 2018.

Figure 3. Peak demand by operating regions, 2018.



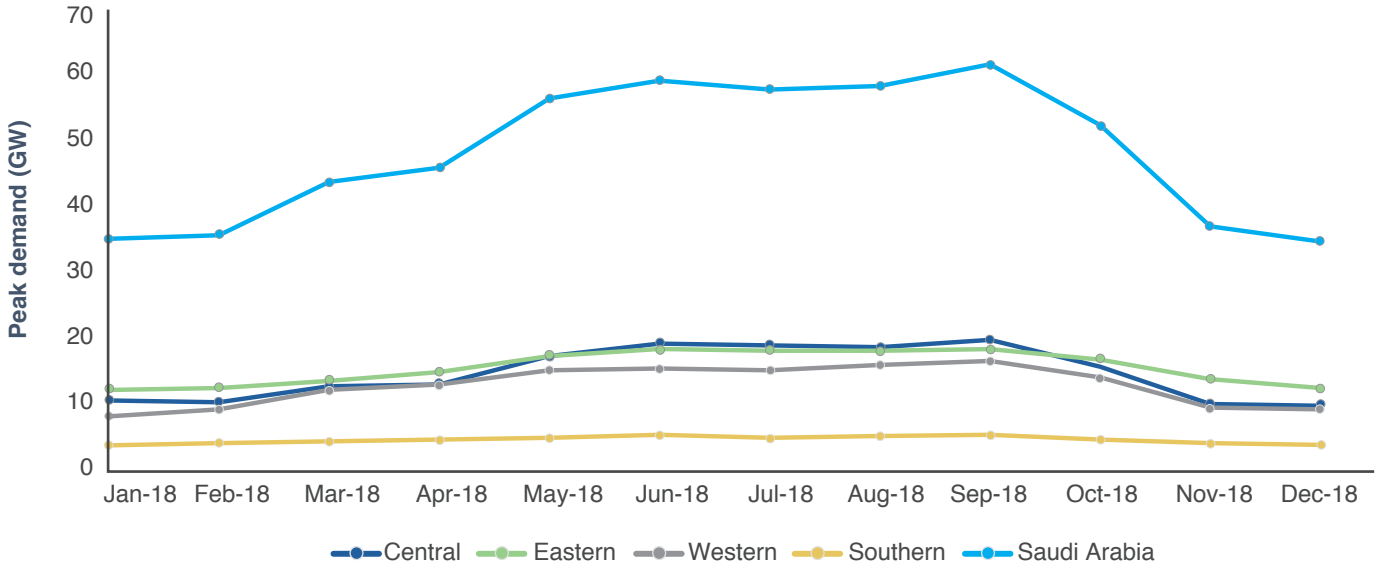
Source: Annual Statistical Booklet 2018, ECRA.

Figure 4. Saudi Arabia's monthly peak demand variation, 2018.



Source: Annual Statistical Booklet 2018, ECRA.

Figure 5. Monthly peak demand variation by operating regions, 2018.



Source: Annual Statistical Booklet 2018, ECRA.

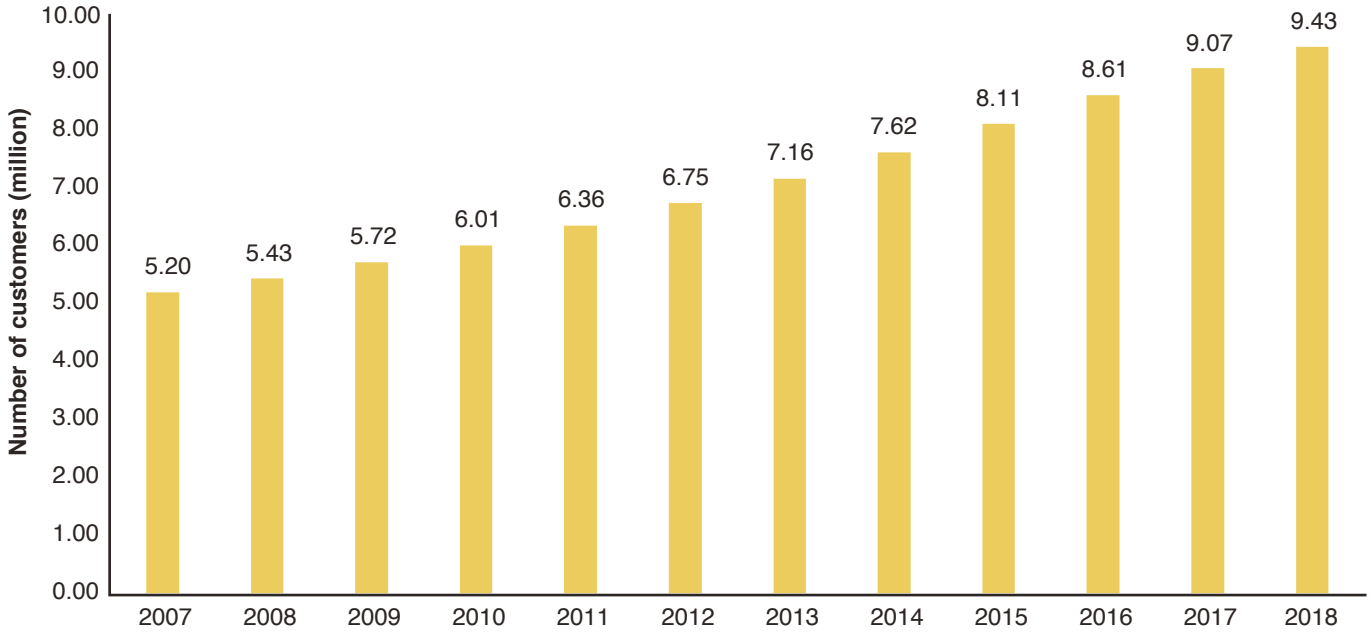
compound growth in electricity consumption (9.5%) among the BRIC economies (Brazil, Russia, India, and China). All other BRIC countries recorded average annual compound electricity consumption growth of 5% or below.

The growth in Saudi Arabia's energy consumption has been driven by population growth, strong economic and industrial development, and improvements in standards of living. Harsh weather conditions and economic policies that aimed to diversify energy-intensive industries, and highly subsidized energy prices were major drivers for the growth (Groissbock and Pickl 2016). From 1960-2018, Saudi Arabia's population increased by more than sevenfold to reach 33.4 million (GAS 2018). The high urbanization rate (83.13%) (GAS 2018) forces cities to provide more services, lifestyle facilities, and housing stock (Al-Mulali et al. 2013). Figure 6 shows the growth in the number of consumers in Saudi Arabia from 2007 to 2018, which averaged 5.57% annually.

Electricity production in Saudi Arabia depends solely on fossil fuels. Figure 7 shows the breakdown of ~86 GW of generation capacity by fuel type and technology. Natural gas and crude oil continue to be the primary energy sources for electricity and water desalination. The other fuels used are heavy fuel oil (HFO) and diesel. The decline in the use of diesel for electricity production over the years has increased the electricity sector's reliance on natural gas and crude oil. In 2018, nearly one-third of Saudi Arabia's total production of 10.32 million barrels per day of crude was used to fulfill the country's domestic energy needs, including electricity production (SAMA 2019, BP 2019).

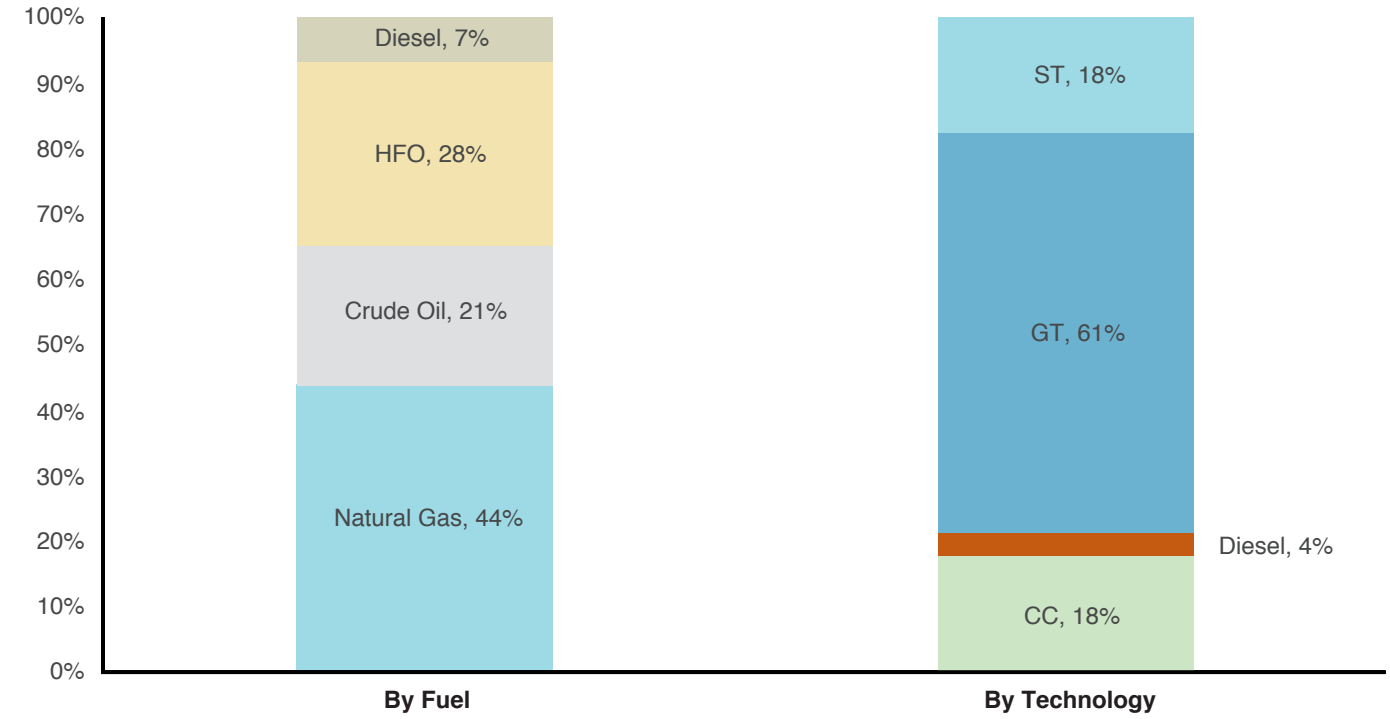
There are a number of reasons for the country's policy shift toward diversifying its energy sources. With steadily rising electricity demand, Saudi Arabia aims to diversify its power generation mix through the use of renewables and nuclear energy to reduce its reliance on fossil fuels, in particular crude oil, which eats into its oil export capacity.

Figure 6. Growing number of consumers in Saudi Arabia.



Source: ECRA National Electricity Registry.

Figure 7. Saudi Arabia's generation capacity by fuel and technology, 2018.



Note: HFO = Heavy fuel oil; ST = Steam turbine; GT = Gas turbine; CC = Combined cycle
Source: Annual Statistical Booklet 2018, ECRA.

Since 1990, annual electricity consumption in Saudi Arabia has increased by 5.86% (ECRA 2019). Saudi Vision 2030 aims to create a sustainable non-oil-based economy through actively engaging the private sector. This strategy will further elevate the contribution of renewables. The King Salman Renewable Energy Initiative, launched in 2017, encourages the private sector to play a pivotal role in the development and investment of renewable energy projects in the country. Saudi Arabia has the potential to exploit renewable energy resources, especially concentrated solar power (CSP), solar photovoltaics (PV), and wind.

In 2013, the King Abdullah City for Atomic and Renewable Energy (K.A.CARE) announced a plan to expand the country's renewable energy generation by 54 GW by 2032. This included 25 GW from CSP, 16 GW from solar PV, 9 GW from wind, and 4 GW from waste-to-energy and geothermal energy (K.A.CARE 2013). This ambitious plan was initially scaled back due to the challenges in implementing it. It was later replaced by the planned energy mix roadmap developed by the Ministry of Energy, Industry and Mineral Resources (MEIM). However, the country's focus on promoting renewable energy remains intact.

In 2016, the strategic plan of the MEIM emphasized the need to add more natural gas and renewable sources to the country's energy mix. The National Transformation Program 2020 (NTP) (SV2030 2016a), part of Saudi Vision 2030, aims to increase the share of the Kingdom's renewable energy capacity in its total energy mix. MEIM formed the Renewable Energy Project Development Office (REPDO) in 2017 to operationalise the NTP objectives and implement the National Renewable Energy Program (NREP) in coordination with other key stakeholders. proposed a more ambitious plan to harness renewables in future energy mix.

The National Renewable Energy Program (NREP) is a strategic initiative under Vision 2030, and aims to diversify local energy sources, stimulate economic development and enhance environmental sustainability, in light of the goals set for Vision 2030. As more renewable energy comes online, there will be increased demand to integrate this new energy into the national grid.

Initially, it was indicated that REPDO would spearhead the development of 30% of the targeted capacity through a competitive tendering process. Saudi Arabia's sovereign wealth, the Public Investment Fund (PIF), would oversee the development of the remaining 70% of the capacity through negotiated deals with international partners for project development. However, this allocation of the targeted capacity between REPDO and PIF has not yet been finalized and announced. NREP's approach places a significant emphasis on increasing local content requirements through manufacturing renewable energy technologies in the Kingdom.

ACWA Power's 300 megawatt (MW) Sakaka PV project located at Al Jouf Province in northern Saudi Arabia is the first renewable energy-based independent power project (IPP) under the King Salman Renewable Energy Initiative. The project achieved financial closure in November 2018 and was commissioned in November 2019. This project is seen as the first step toward energy diversification, enhancing primary energy sources, securing electricity supplies, and growing other strategic sectors with potential economic benefits.

Another 400 MW Dumat Al Jandal wind IPP project near Sakaka solar plant in Al Jouf province has been awarded by REPDO under the first round of its programs.

Preparatory work is also ongoing to assess the readiness of Saudi Arabia to generate nuclear energy at an appropriate time in the future. As per the current plans, ~17 GW of nuclear-based power generating capacity is expected to be added progressively in phases up to 2032 (KACARE 2019). In early 2019, the government announced plans for 3-4 GW of nuclear capacity, expected to be commissioned in 2027. The government is exploring all feasible options for nuclear generation, including advanced small modular reactors.

Oil and natural gas will most likely dominate Saudi Arabian electricity production in the coming decades. There is an ambitious plan to increase the share of renewable energy resources (mainly solar and wind), and grid enhancements will be needed to integrate a large penetration of renewable energy. Some experts state that the current status of Saudi Arabia's grid can only withstand ~14 GW of renewable energy (SAGIA 2019). It is likely that in remote areas where gas infrastructure is unavailable, distributed renewable energy will be deployed instead of natural gas.

Reform Initiatives and Timelines

Until the late 1970s, electricity services in most parts of Saudi Arabia were primarily provided by small private utility companies operating in major cities and towns. Several steps were taken from the mid to late 1970s to better plan and coordinate the developmental activities of the Kingdom's electricity sector. These included the creation of a separate Ministry of Industry and Electricity (hived off from the former Ministry of Commerce and Industry), maintaining the electricity tariff at a uniform rate across the Kingdom, and, most importantly, consolidating small service providers into four regional companies, collectively known as the Saudi Consolidated Electrical Companies (SCECOs). These consolidated companies encompassed IPPs serving eastern, central, western, and southern parts of the country. The northern region is still served by several IPPs (ECRA 2005b).

Since then, demand for electricity has grown substantially across the country as a result of an increasing population, economic growth, and low tariffs supported by government subsidies. As a result, the government took steps to restructure the electricity industry, improve its quality of service, reduce subsidies to ensure financial sustainability, and increase its coverage across the country. In 1998, the government announced plans to merge the four regional SCECOs, electricity corporation projects and small companies operating in the north, into a single joint-stock company, the Saudi Electricity Company (SEC), which was finally established in 2000 after the completion of the merger process. The SEC is a government-owned (direct government ownership of 74.3%, an additional 6.9% owned through Saudi Aramco, with the remaining shares held by the public), vertically integrated utility that currently supplies most of Saudi Arabia's electricity needs. Apart from the area served by Marafiq, the SEC has a near monopoly on transmission, distribution and retail supply in the Kingdom.

The Saline Water Conversion Corporation (SWCC) is a government-owned corporation that desalinates and delivers desalinated water throughout the Kingdom. It is also the second-largest producer of electricity after the SEC. Saudi Aramco is a government-owned company that manages Saudi Arabia's oil and gas production. It is also involved in power generation alongside the SEC.

In 2001, ECRA was established as an independent regulatory authority to oversee the electricity and cogeneration industries (ECRA 2005b). It assesses tariffs, issues licenses, monitors service providers, investigates complaints, establishes the quality of service standards, and promotes fair competition among providers and suppliers (further details are provided later in the report).

In May 2016, the government announced its plan to replace the Ministry of Water and Electricity with the Ministry of Energy, Industry and Mineral Resources (MEIM). MEIM is responsible for developing and implementing policies concerning oil, gas, natural minerals, renewable energy, and electricity (SPA 2016). At the end of August 2019, a Royal Decree further reformed the MEIM into the two separate ministries – the Ministry of Energy (MoEn) and the Ministry of Industry and Mineral Resources. All the responsibilities of MEIM with regard to the energy sector are now looked after by the MoEn.

The government of Saudi Arabia has initiated economy-wide structural reforms in line with Saudi Vision 2030 (SV2030 2016b). Future reform initiatives in the electricity sector are likely to be aligned with Vision 2030, and the NTP's strategic objectives and implementation roadmap. The relevant focus areas for the energy sector, including electricity, are as follows:

Reform Initiatives and Timelines

A larger role for the private sector in developing the energy sector. This includes selling off state-owned assets to optimize financial efficiency, greater private sector involvement in providing various services, and institutional development.

Diversifying energy resources to enhance the sustainability of energy supplies, and enabling the inclusion of renewable and atomic energy in the national energy mix.

Developing the oil and gas sector, including increasing compensating reserves, maintaining the petroleum production capacity, and increasing the volume of gas supplies through the development of exploration and reserves activities.

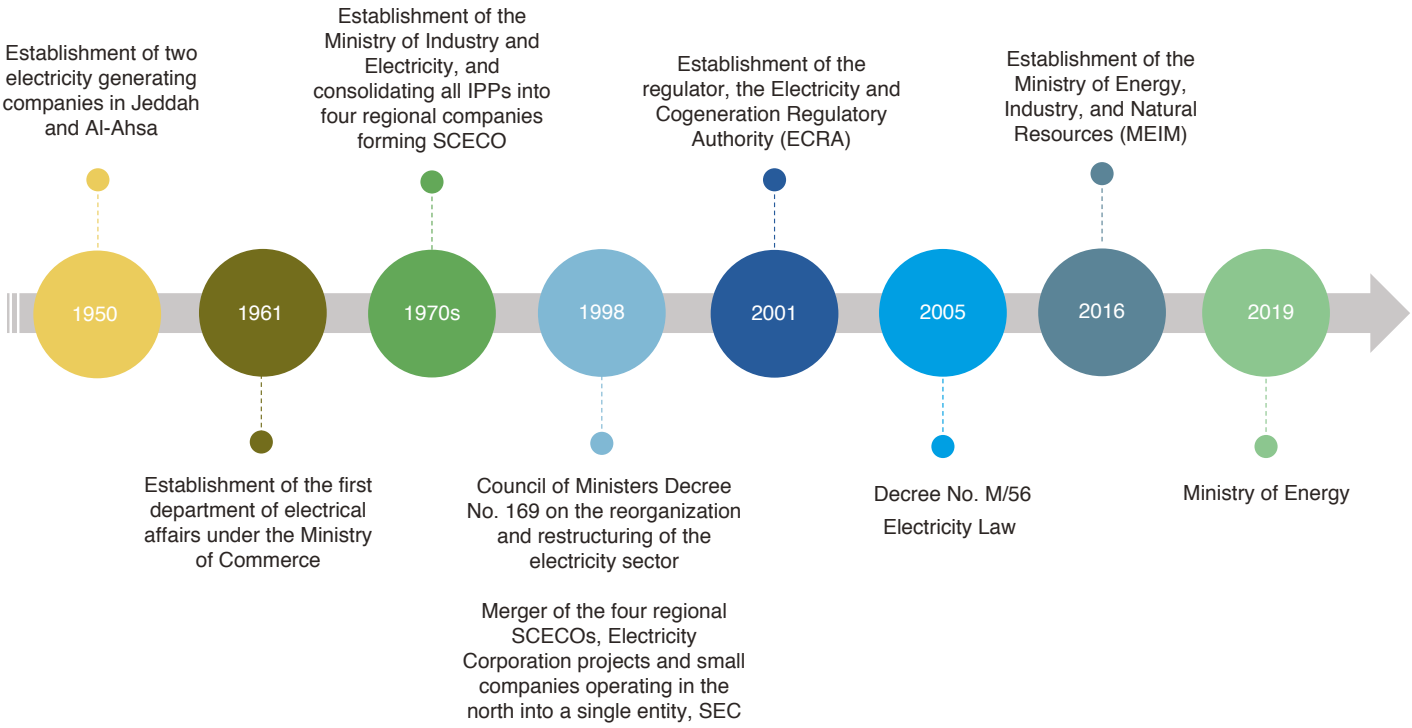
Enhancing the competitiveness of the energy sector, including gradually liberalizing the fuel market, increasing the efficiency of government subsidy programs, and stimulating productivity and competitiveness among utility companies.

Safeguarding the environment and natural resources, including increasing the efficiency of the electricity sector's fuel utilization.

Localizing the renewable energy sector: incentivize the private sector to manufacture goods and provide services locally and encourage both public and private sectors to rely on local products and services.

Enhancing the liveability of Saudi cities: improving the quality of electricity services and increasing the services' coverage.

Key reform milestones



Restructuring of the Electricity Sector: Roles and Entities

Saudi Arabia's economic circumstances improved significantly during the 1980s and 1990s due to its continuously expanding oil and non-oil-based economy. The rapidly growing population, economic growth, low end-user electricity tariffs, and highly subsidized electricity sector contributed to rising electricity demand. In 1995, Saudi Arabia was the first country in the GCC region to undertake a systematic re-evaluation of the electricity sector. The Council of Ministers Decision (CMD) No. 169 of November 30, 1998, announced the Kingdom's decision to restructure its electricity sector to address its low efficiency and sustainability. The decision established the principle that "electricity prices must reflect the economic costs of providing the electricity services, and that the electricity industry must depend for its survival and growth on the income it generates without resort to government subsidies." (ECRA 2005b).

Aside from helping to restore the financial sustainability of the electricity sector, the adoption of cost-reflective tariffs also aimed to encourage demand-side management so as to limit the need to build more power plants in the future. However, the implementation of this reform has moved slowly. In spite of its well-intentioned motives, the 1998 decision to restructure the electricity sector did not significantly alter the structure and performance of the Kingdom's electricity sector (Figure 8).

To progress the reform agenda, ECRA prepared the Electricity Industry Restructuring Plan (EIRP) in 2007 to propose a gradual transformation of the electricity industry from a vertically integrated utility structure to a more competitive electricity sector in three phases over eight years (figures 9 and 10). It envisaged unbundling the generation, transmission and distribution activities of the SEC, and the introduction of competition in both supply and retail. EIRP also suggested creating an independent entity for transmission with a non-discriminatory access policy, an independent system operator (ISO), and a principal buyer (PB). It would serve as a nodal agency to the SEC for arranging bulk supply from existing and new power plants.

Figure 8. Saudi Arabia's electricity industry structure in the late 1990s at the time of CMD #169.

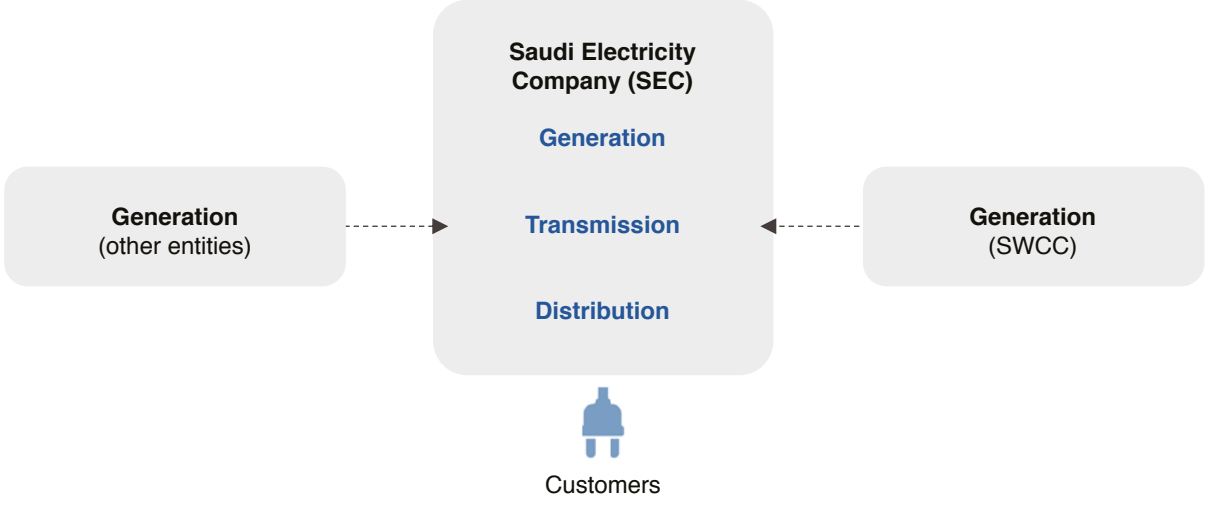


Figure 9. Expected electricity industry structure in Saudi Arabia after the implementation of the first phase of the EIRP (2007).

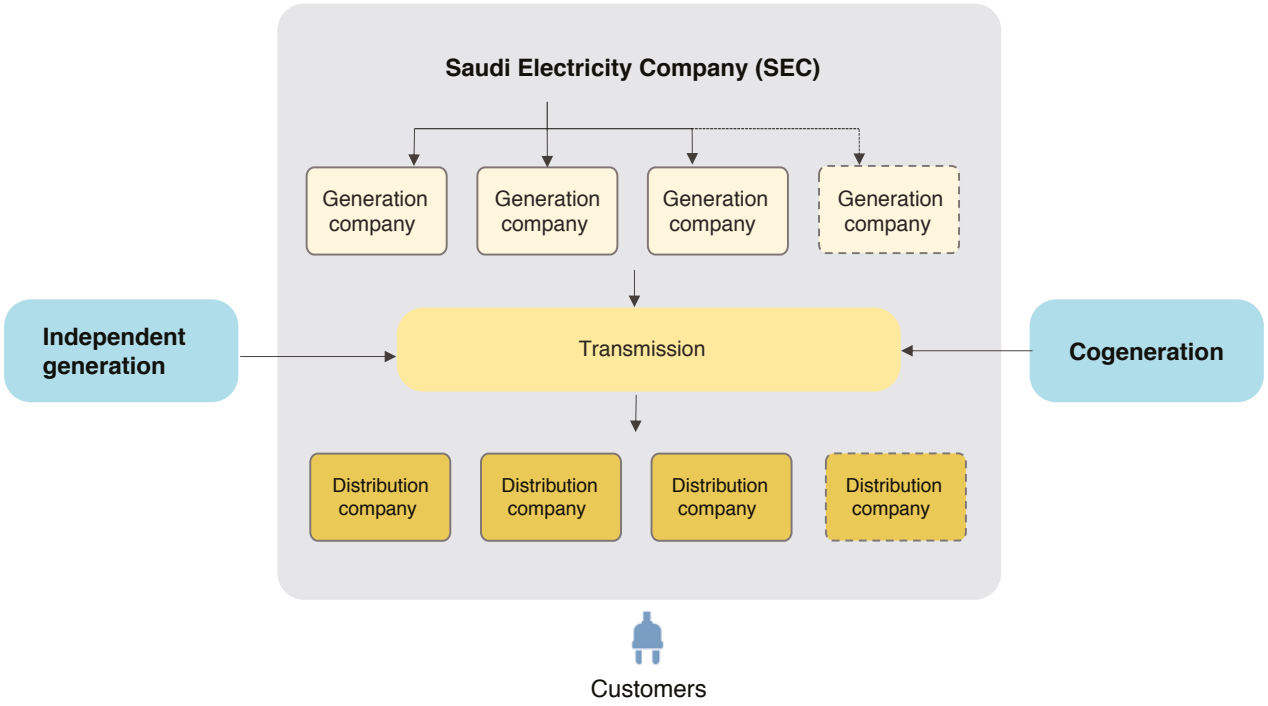
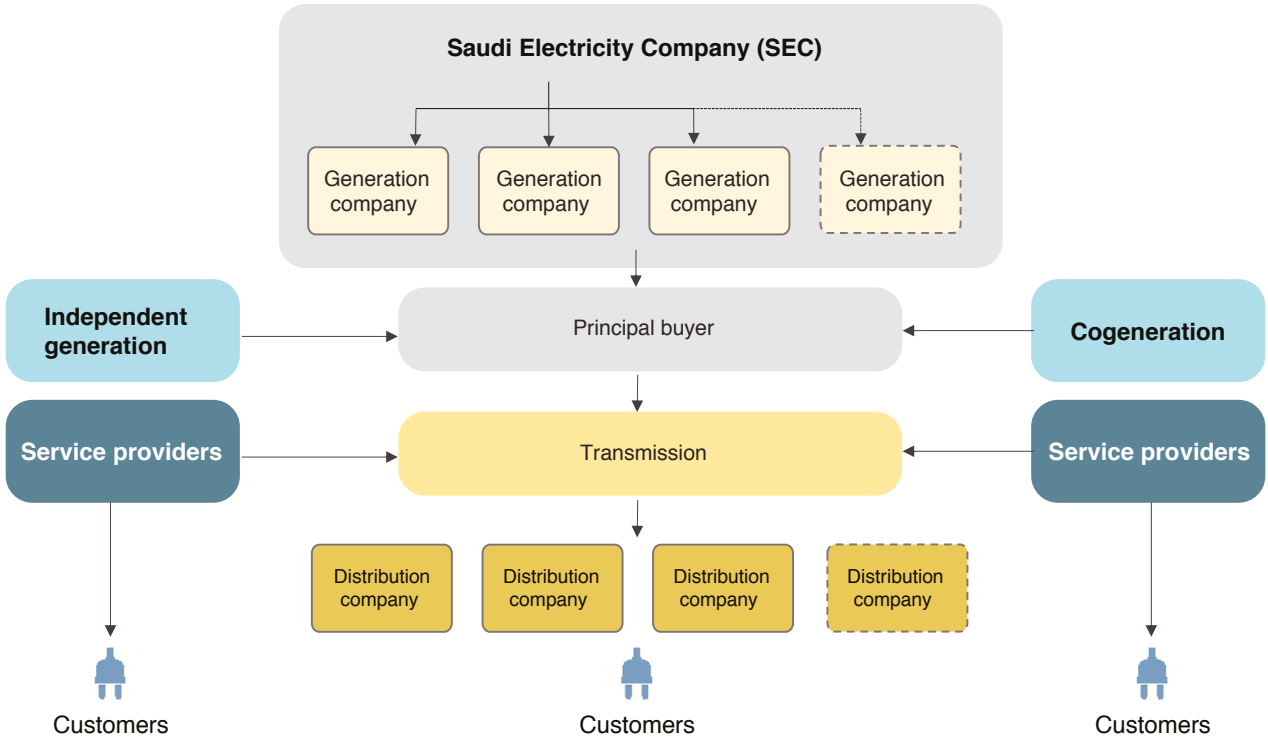


Figure 10. Saudi Arabia's expected electricity industry structure after the full implementation of the EIRP (2007).



Source: ECRA (2009).

In 2014, ECRA revisited its reform blueprint and developed a new roadmap for the design and implementation of a national competitive electricity market (CEM) for Saudi Arabia, based on the experiences gained during the first phase of the EIRP and stakeholder feedback. The recommended market design for the CEM is a wholesale market (Figure 11). The CEM roadmap adopted a 'building block' approach to the market reforms, and suggested five implementation stages:

Stage 1: Unbundling of the SEC, the government financing mechanism, and competitive generation.

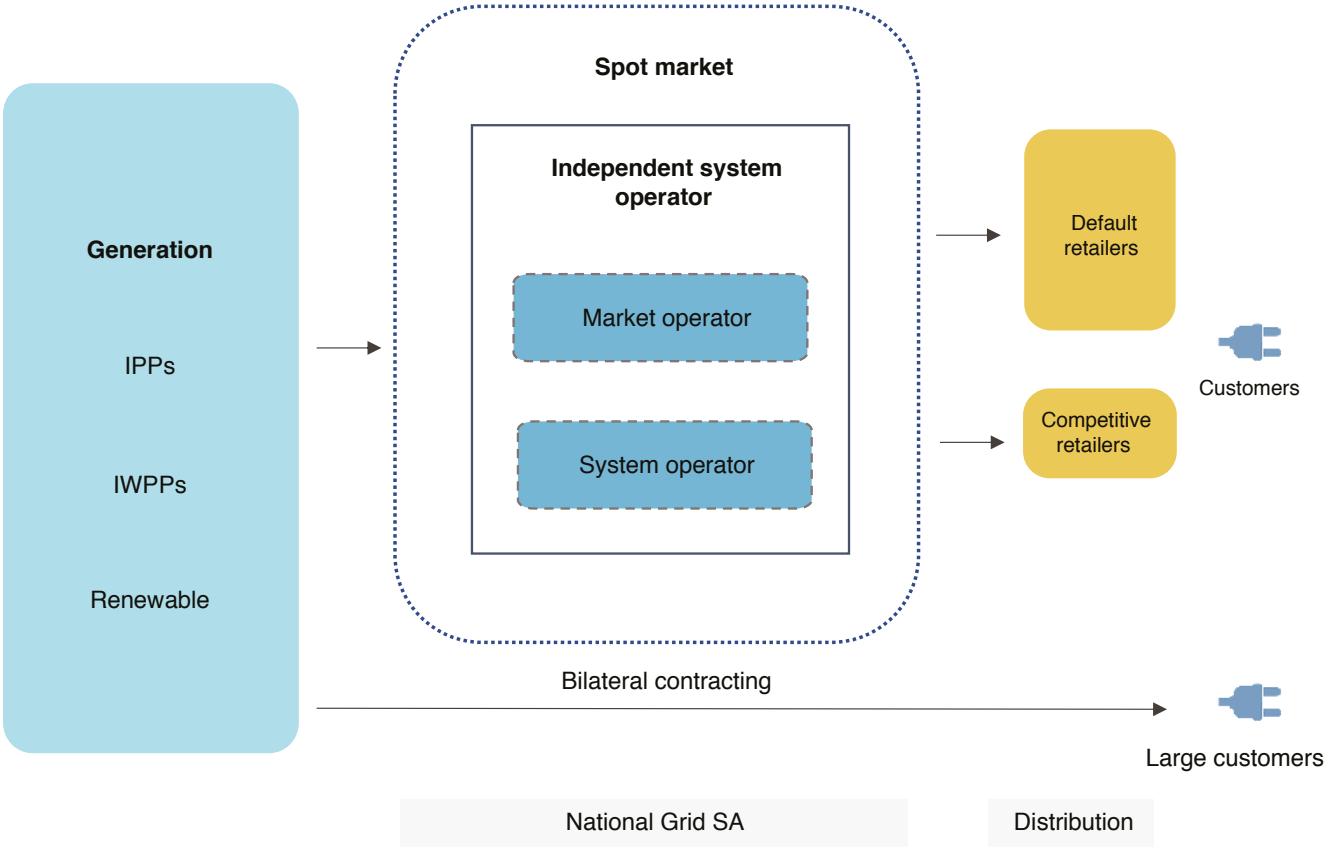
Stage 2: Fuel price reform and consequent changes in electricity contracts.

Stage 3: The introduction of a spot market and bilateral trading between generators and large consumers.

Stage 4: The introduction of a capacity market.

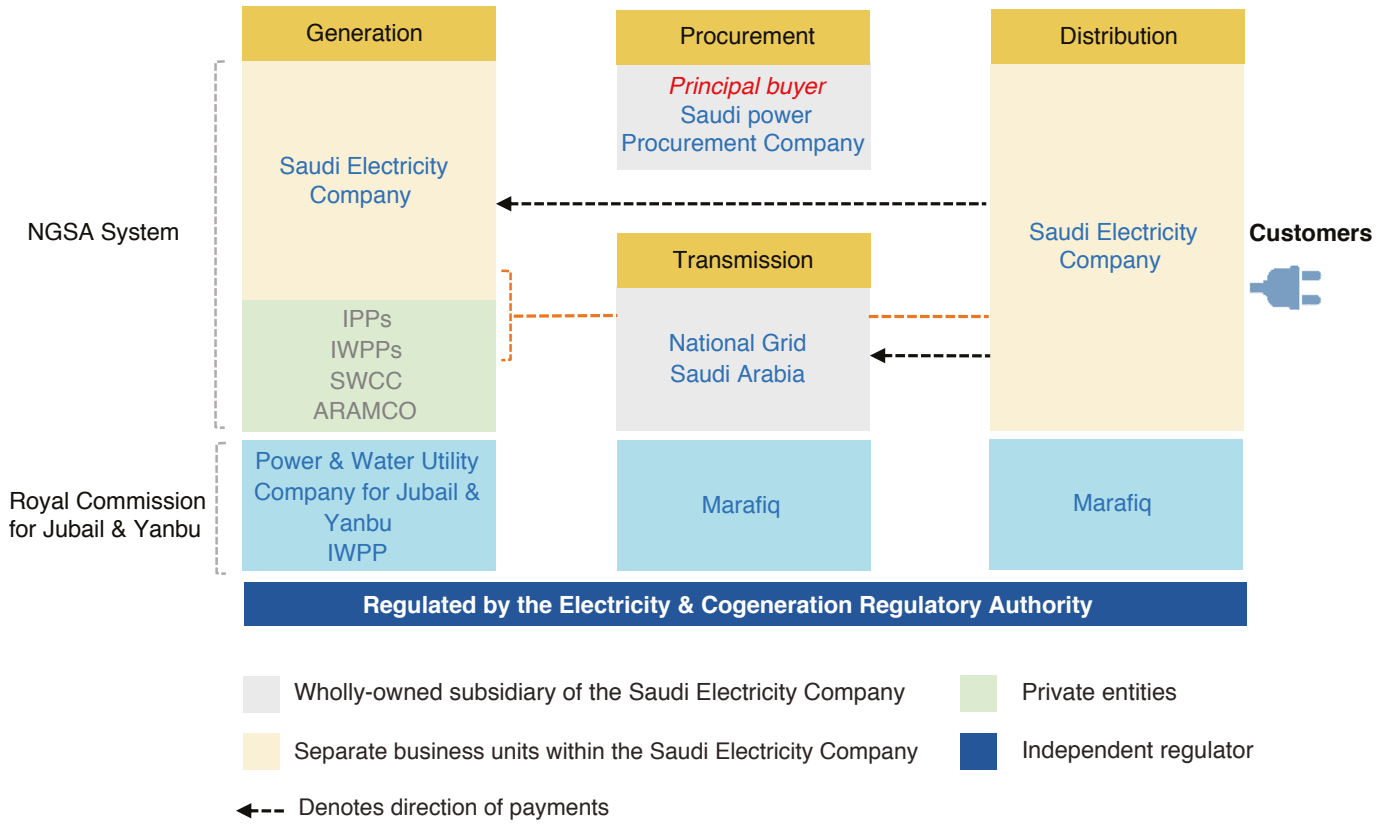
Stage 5: The gradual phase-out of transitional features.

Figure 11. Saudi Arabia's expected electricity industry structure after the implementation of the CEM.



Source: Executive Summary, report on the development of a roadmap for a national electricity market in Saudi Arabia, ECRA, 2014.

Figure 12. Saudi Arabia's current electricity industry structure (2020).



While some progress has been made in implementing the original EIRP, Saudi Arabia's electricity sector remains vertically integrated and operated by the SEC (Figure 12). Unbundling the SEC into multiple generation or distribution companies could not be achieved as per the restructuring plan.

National Grid SA was created in 2012 as a separate independent entity wholly owned by the SEC. The Saudi Power Procurement Company, the PB, was granted a license by ECRA in 2017. An overview of the main participants of the electricity sector, their roles and responsibilities, and key issues is given below:

Policy and development

MoEn (earlier MEIM) is the government body responsible for formulating and implementing national policies concerning electricity, oil, and gas. Its mandate also includes developing overall long-term energy plans. Some of its policy priorities for the electricity sector that aligns with Vision 2030/ NTP 2020 include (i) improving the efficiency of the electricity sector's fuel utilization, (ii) enhancing the primary sources and security of the electricity supply, (iii) improving the quality of services and coverage area, (iv) working toward full privatization of electricity generation through strategic partners, and (v) enhancing the contribution of renewable energy in the future energy mix through increased private sector participation from renewable energy generation to local manufacturing.

Although 2007's EIRP envisaged implementation over eight years in three phases, it went behind schedule. The first phase started in 2012 with the launch of the National Grid SA (NGSA), a wholly owned subsidiary of SEC to oversee and manage the transmission system, and establishing the principal buyer in 2017. In late 2018, the SEC announced its plan to establish a power generation subsidiary company. The second phase envisaged the separation of generation, transmission (NGSA), and distribution companies from the SEC. Separating the NGSA from the SEC has created an independent transmission operator that maintains an open and unbiased access policy to transmission capacity for eligible participants (e.g., generators and large consumers). The third phase is the long-term deregulation of the electricity market (Figure 11). The ownership of the retail company will be separate from the holding company, SEC, as shown in Figure 11 (SEC 2016).

Privatization

In 1997, the government established eight strategic objectives of privatization, along with the principles necessary for achieving these objectives. The objectives include (SWCC 2019):

1. Enhancing the competitiveness of the national economy.

2. Encouraging investment from, and the effective participation of, the private sector in the national economy.

3. Expanding the ownership of productive assets in public enterprises and projects.

4. Encouraging national and international capital markets to invest in the Kingdom.

5. Increasing job opportunities and employment for the national workforce.

6. Providing services to citizens and investors in a timely and cost-efficient manner.

7. Controlling public spending to reduce the burden on the state budget.

8. Increasing state revenues from returns on participation in activities to be transferred to the private sector.

The plans to sell off state-owned power plants, as part of the government's strategy of privatizing the utilities, were first announced in 2007. This was followed by a Royal Decree (No. 2/29) in 2008 to privatize the assets of the SWCC. While some have suggested the delay in privatizing could be due to the government waiting for the finalization of the country's Private Sector Participation Law, others say the complexity of the process may be the cause.

The principal buyer

Like other Gulf countries, Saudi Arabia has also adopted a 'principal buyer' model, also widely known as the single-buyer model, in the inception phase of its market reform. The Saudi Power Procurement Company (SPPC), a limited liability company wholly owned by the SEC, was named as the 'principal buyer (PB)' in 2017 and manages the electricity market within the Kingdom. Its main activities as a principal buyer include – (i) buying and selling electricity, capacity and services; (ii) assessing and acquiring essential fuel and reserve fuel to supply the production licensees; (iii) developing a year-ahead generation plan; (iv) managing commercial agreements such as fuel supply, power purchase agreements, energy conversion agreements and/or on-sale agreements, bulk electricity to retail licensees and to major consumers; (v) act as a counterparty to legacy purchase contracts/agreements; (vi) monitoring fuel use efficiency, independent production and

renewable energy projects according to the power purchase agreements; (vii) tendering for new conventional capacity; (viii) engaging with the regulator in conjunction with the transmission licensee to facilitate the development of market arrangements for trading electricity and/or system services; (ix) participating in the balancing account in a role specified by the regulator and receiving payments from the transmission licensee in respect of system services; and (x) handling the import and export of electricity through regional interconnections. In addition, the PB is also required to provide information to the transmission licensee to ensure compliance with agreements, codes, and other transmission licensee obligations.

With several responsibilities under its domain, the PB is expected to play an essential role while moving toward a future competitive electricity market. The PB and NGSA are participating effectively with REPDO in supporting the development of renewable energy projects by signing power purchase agreements with private developers.

Many countries have used the principal-buyer model for various objectives as part of their reforms. Some have adopted it to attract private financing in new generation assets by shielding private investors from market- and retail-level regulatory risks (Lovei 2000) rather than as a means to introduce competition into the electricity supply. Other countries have followed the principal-buyer model as a transitional arrangement before conditions for introducing liberalized electricity markets are satisfied. Regardless of how the principal-buyer model is used, international experience suggests that it offers some inherent disadvantages. The most commonly cited are the potential to (i) transform a vertically integrated monopoly into a 'monopsony'[2] through a principal buyer, and (ii) imposing large contingent liabilities on the government if state-owned entities are unable to meet their obligations to the generators. Strong regulatory oversight is desirable to avoid the pitfalls of a principal-buyer model within a partially unbundled industry structure still characterized as a vertically integrated market model. Moreover, when decisions about adding generation capacity are taken by other government bodies and the principal buyer is tasked with developing short-term generation adequacy plans, a coherent approach to sector planning and good governance is needed to balance the objectives of multiple players in the industry. These players include policymakers, fuel suppliers, principal buyers, state-owned entities, and IPPs.

Transmission and dispatch

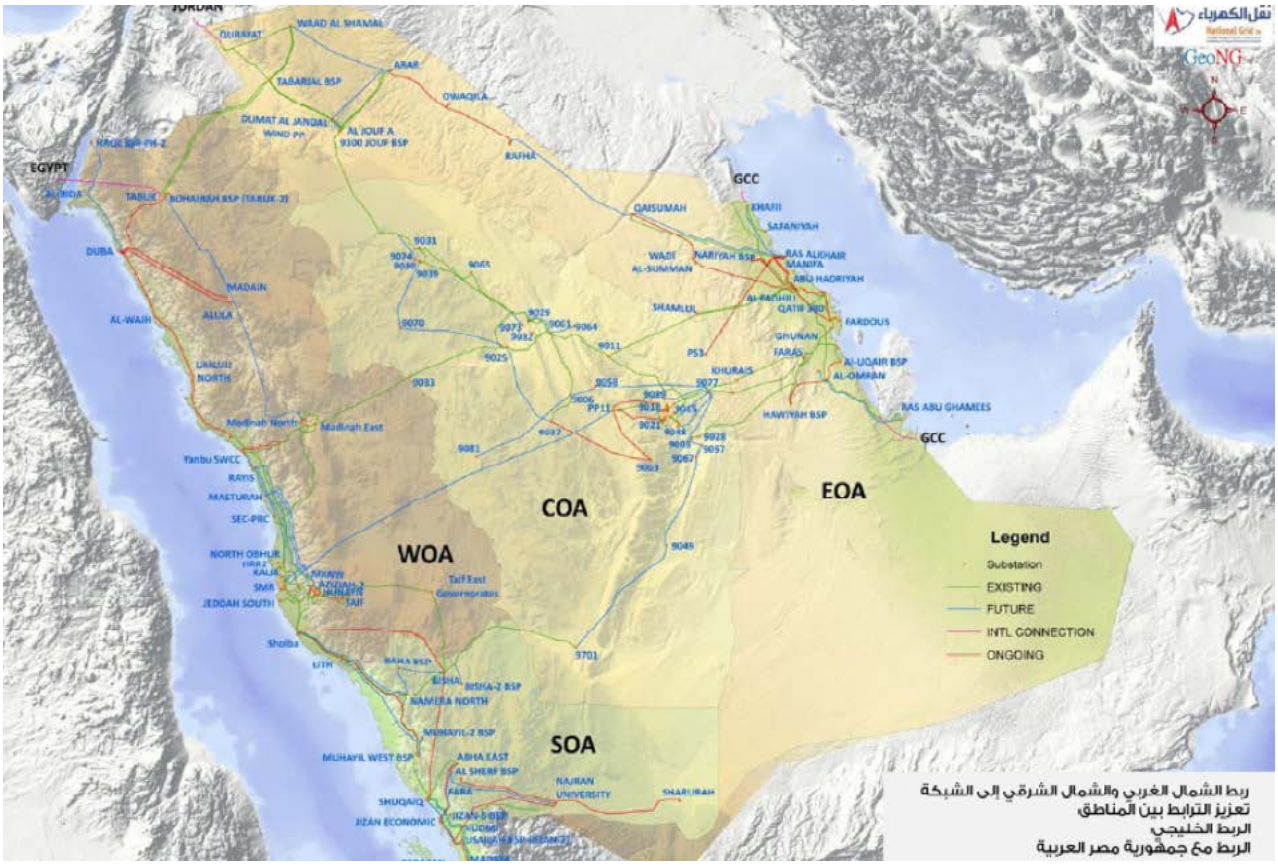
The length of transmission and distribution networks have expanded substantially as a result of the growth in energy consumption and the number of customers. Grid expansion has increased by over 50% since 2000, interconnecting more than 99% of the grid with 83,682 circuit-kilometers (ckm) of transmission lines (overhead and underground lines) and with 1070 sub-stations in 2018 (ECRA 2018). A new generation capacity of 5,612 MW is to be added by 2021, with an additional 13,151 ckm of transmission lines and 166 power substations planned to meet growing demand (SEC 2017 and 2017a). The SEC has also launched a series of projects to overhaul outdated segments of the power grid and lay the groundwork for a modern transmission and distribution system. The modernization plans for the transmission and distribution sectors are estimated to cost $14.7 and $13.7 billion, respectively, over the next decade (EIA 2016).

The transmission network is largely concentrated in parts of the eastern region, the central region, and along the west coast (Figure 13). Except for the

interconnections between the eastern and central regions, other regions either lack connectivity or have limited power transfer capacities. The adequacy of the transmission network to support the proposed renewable capacity targets is currently being examined.

The NGSA is also well connected with other neighboring Gulf countries through the GCC Interconnector, with a combined cross-border transmission capacity of 3,450 MW – around 6% of its peak demand. There is a transmission capacity of 1,200 MW between Saudi Arabia and Kuwait; 600 MW between Saudi Arabia and Bahrain; 750 MW between Saudi Arabia and Qatar, and 900 MW between Saudi Arabia and the United Arab Emirates (UAE). Despite significant transfer capacity, less than 5% of GCC interconnections have been utilized effectively. Outside the GCC grid, the Egypt-Saudi Arabia interconnection, with a total designed capacity of 3,000 MW, is expected to be fully commissioned by 2025. Feasibility studies for the Jordan-Saudi Arabia interconnection are underway. This interconnector is expected to boost electricity import-export opportunities when it is operational by 2022. Saudi Arabia is also exploring interconnectivity options with Iraq.

Figure 13. Saudi Arabia's transmission grid – existing and planned.



Source: (NGSA 2017).

The National Grid SA (NGSA), established in 2012 as a wholly owned subsidiary of the SEC, owns and maintains transmission networks with 110-380 kilovolts (kV) of power. It is also responsible for planning (improving and expanding the electrical grid to meet the expected demand), and designing and implementing transmission projects. The NGSA, as a transmission service provider (TSP), is required to carry out grid planning studies (periodically or as required) to ensure the efficient, safe, reliable, and economic operation of the grid. It uses criteria and standards as approved by ECRA in planning and developing the transmission system. It is also responsible for procuring system services and installing complete metering infrastructure in the transmission network.

The NGSA is currently the system operator (SO) and the owner of the Kingdom's transmission network. However, Saudi Arabia's roadmap to a competitive electricity market (CEM) envisages creating an independent system operator (ISO) as a non-profit organization with complete administrative independence and no ownership rights over future transmission assets. Further, to ensure financial independence, the ISO will be required to generate its resources by levying fees from market participants. The ISO is also expected to play a crucial role in establishing and operating the competitive wholesale spot electricity market. It will likely discharge various essential functions, such as (i) organizing capacity auctions and operating the power system, (ii) generation scheduling, and (iii) planning over the long term (the preparation of 10-year system plans) and short term (coordinating maintenance between powers generators and transmission companies). As in other Gulf countries, the NGSA as a TSP is responsible for scheduling and dispatch functions. It is required to match the forecast demand with adequate supply while ensuring the lowest cost of power procurement in accordance with the relevant purchase power agreements (PPAs).

Distribution/supply

Ownership structure – The retail distribution and supply functions are collectively performed by a single business unit within the SEC. It receives energy from the transmission network and distributes it to customers according to the desired level of service and reliability. The SEC accounts for 97% of total electricity sales (ECRA 2018). It is the dominant player in the Kingdom's electricity market, responsible for the distribution and supply of electricity, and has a vertically integrated utility (VIU) structure. Saudi Arabia's first private integrated power and water utility, Marafiq, has a very small market share. It was set up by Royal Decree in October 2000 to provide efficient and reliable electricity (and water) services to customers in Jubail, in the Eastern Province and Yanbu, a port city on the Red Sea coast. These industrial cities were developed by the Royal Commission for Jubail and Yanbu[3] to expand the country's industrial base as part of the Kingdom's strategy to diversify its economy and to reduce its dependence on oil-based income.

Consumers and sales – Residential users account for 79% of the ~9.4 million electricity customers in Saudi Arabia. In 2018 they accounted for ~43.6% of total electricity sales. Commercial customers account for 17% of the customer base and 16% of sales. Industrial customers account for 0.12% of all electricity consumers but account for ~18% of the electricity sales (Figure 14).

The distribution of consumption among the various categories also shows a marked regional variation. While industrial consumption dominates in the eastern region, residential consumption is dominant in the other operating regions (Figure 15). Residential consumption accounts for over 50% of total consumption in the central and southern regions.

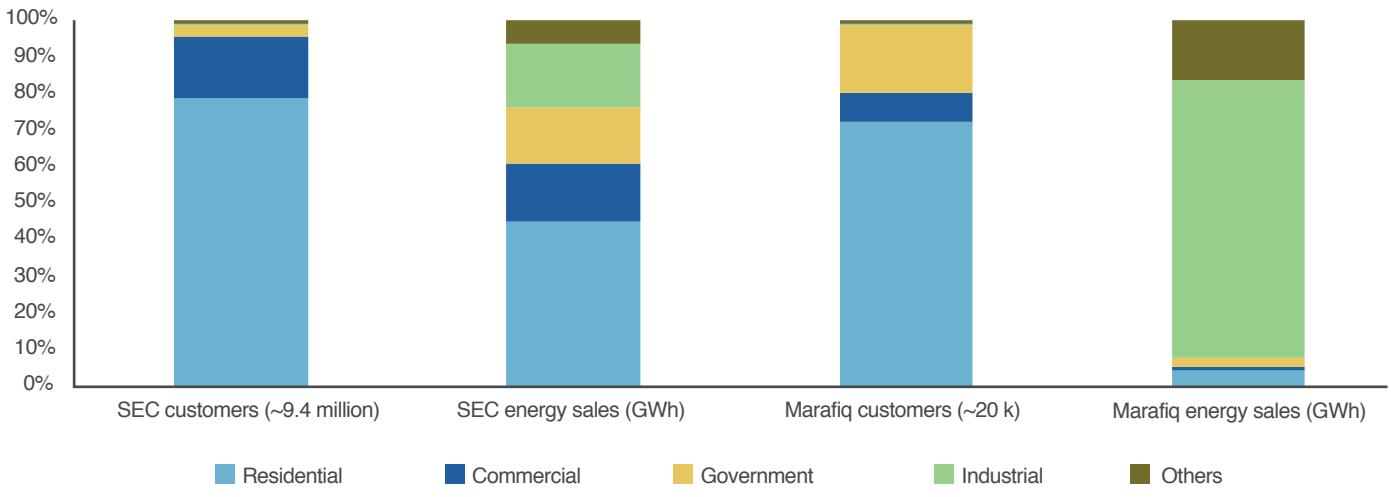
The share of residential consumers in total electricity sales declined from 53.4% in 2008 to 43.6% in 2018. This was mostly due to continued economic development resulting in increased demand from commercial and industrial consumers (Figure 16). Further, tariff reforms initiated in 2015 are also believed to have dampened the demand.

Technical and other features – Figure 17 shows the reported losses in Saudi Arabia's transmission and distribution (T&D) networks[4] as a percentage of the total electrical energy supplied to the grid. A report by the Council of European Energy Regulators (CEER 2017) estimates 'power losses' in T&D electricity networks to have been between 2.24% and 10.44% in 2015 across 27 European countries. Figure 18 presents a worldwide comparison of losses by various country groupings.

T&D losses in Saudi Arabia for 2014 of ~7% (Figure 18) does not look very high when compared with the world average (8.25%) and with countries in other regions. However, improvements in energy efficiency through reducing loss levels will positively impact the financial and operational sustainability of the electricity sector.

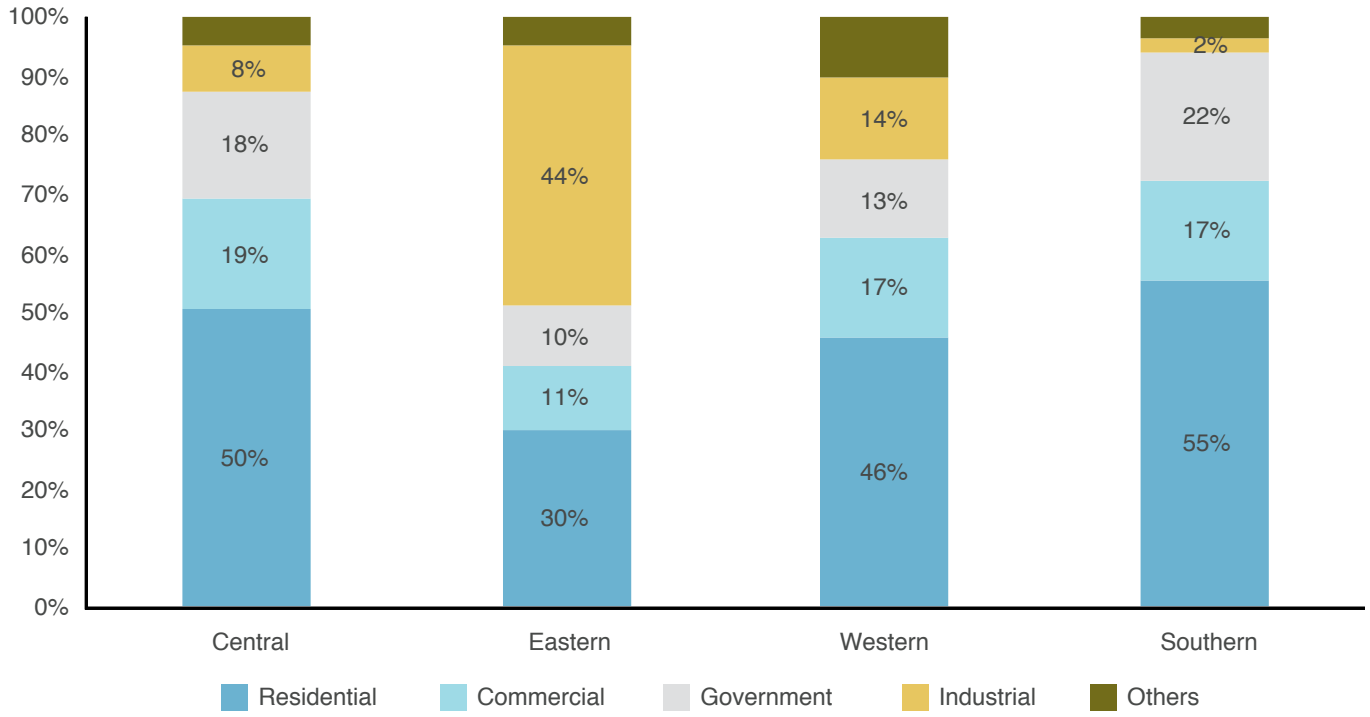
Losses in the grid network are also driven by power quality[5] issues. Due to harsh weather conditions, demand from air conditioning accounts for up to 60% of the total system load during summer months. This highly inductive load affects power quality through voltage fluctuations and delays in voltage recovery following fault events (Al-Mubarak et al. 2009; Alaqeel, Almohaimeed, and Suryanarayanan 2017). It also produces excessive consumption of reactive power from the grid. ECRA notes that air conditioning demand is one of the most explored areas of Saudi Arabia's demand-side management (SEC 2016).

Figure 14. Saudi Arabia's electricity customers and sales by category, 2018.



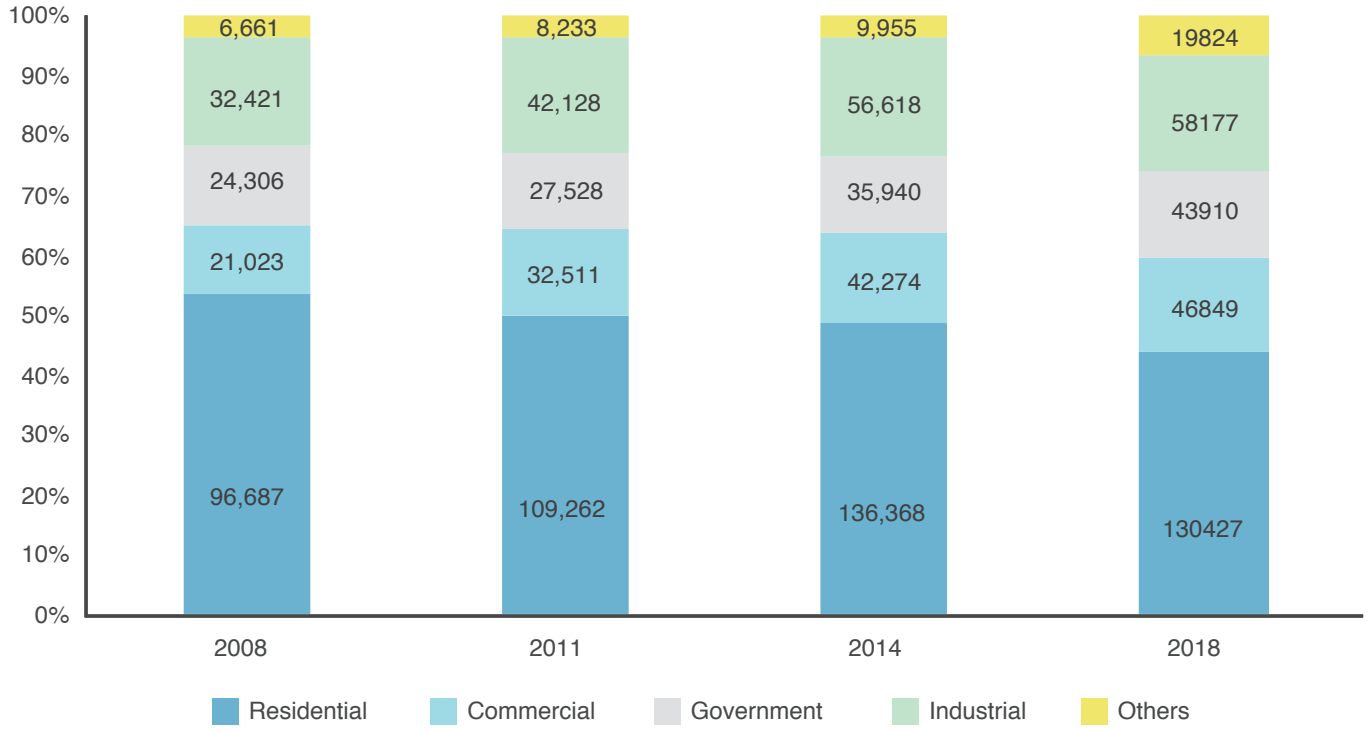
Source: 2018 Annual statistical booklet for electricity and seawater desalination industries, ECRA.

Figure 15. Sources of demand – Electricity consumption by categories and region, 2018.



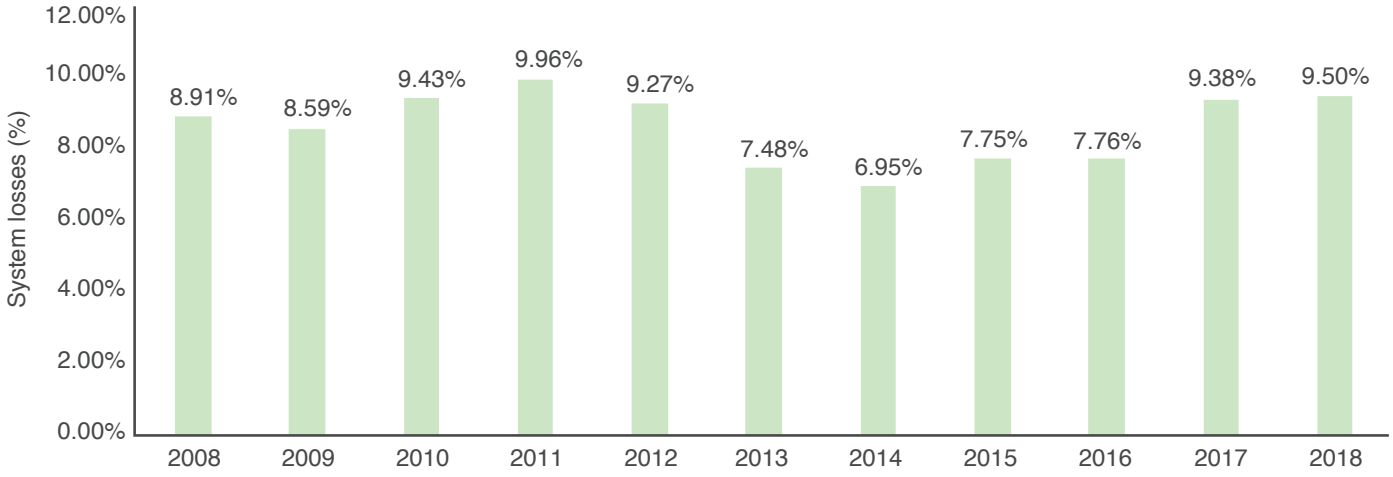
Source: 2018 Annual statistical booklet for electricity and seawater desalination industries, ECRA.

Figure 16. Sources of demand – Electricity consumption by categories, 2018.



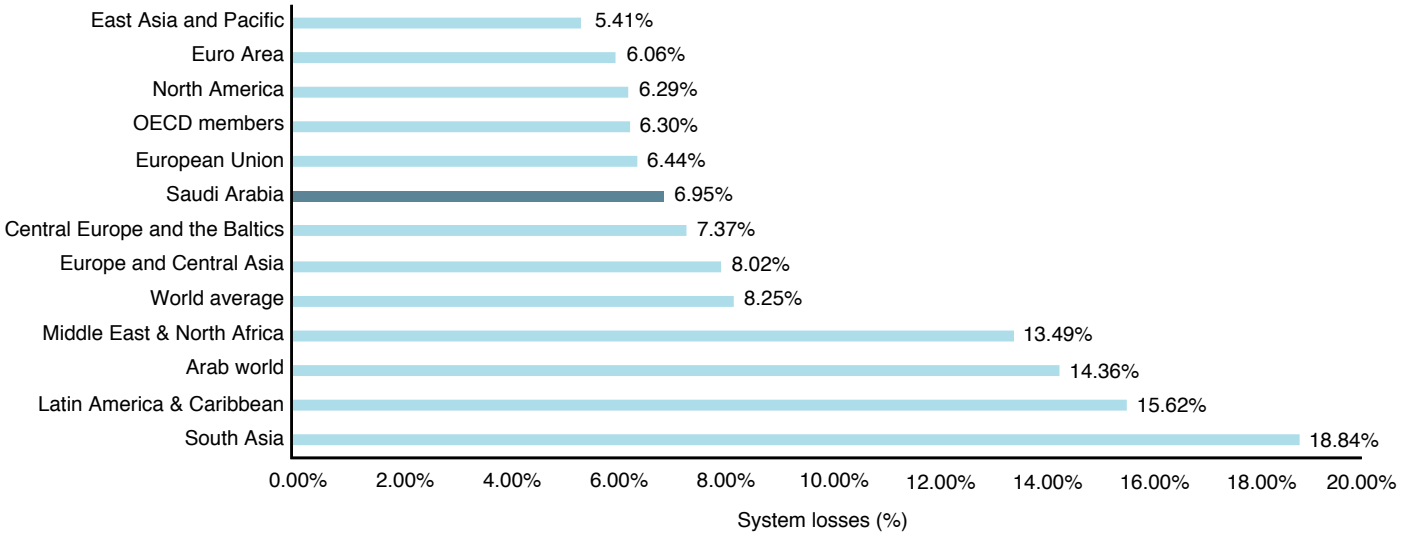
Source: ECRA annual reports (2008/2011/2014/2018).

Figure 17. Losses in Saudi Arabia's T&D networks.



Source: ECRA (2018).

Figure 18. Transmission and distribution losses by country groupings, 2014.



Sources: World Bank (2016) and ECRA.

Realizing the potential direct and indirect economic benefits of improving energy efficiency, network reliability, and power quality of the electricity grid through new technologies and innovations, ECRA developed its "Smart Metering and Smart Grids Strategy" (ECRA 2013) for Saudi Arabia in 2013.

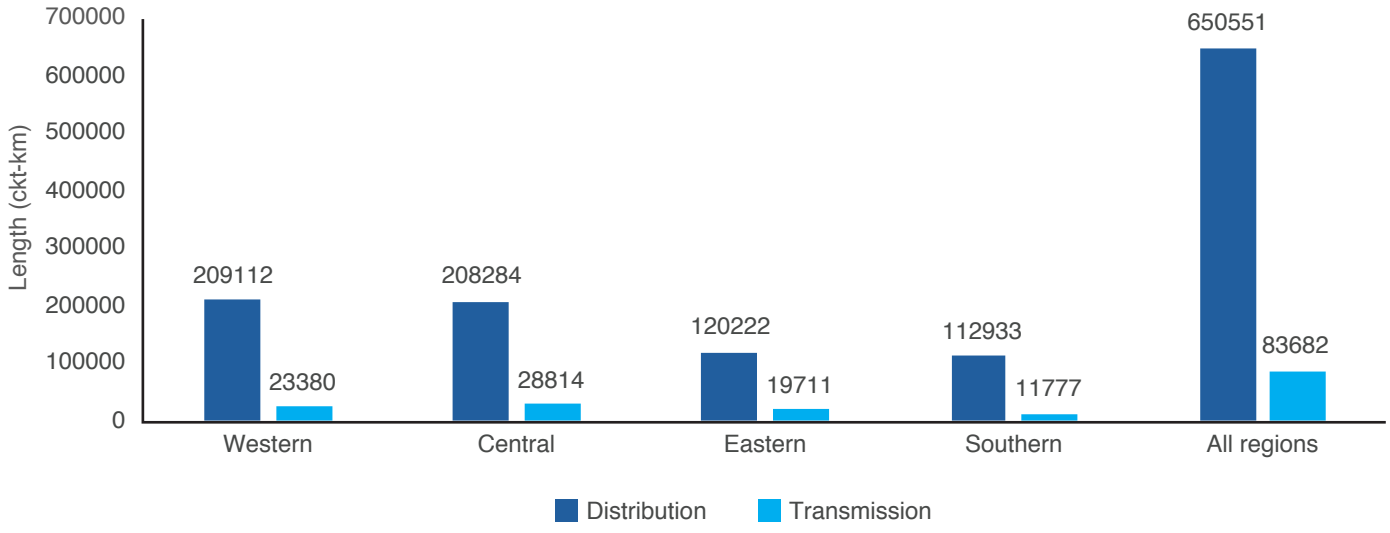
This report notes that the cost of implementing smart meters was estimated at 7.5 billion Saudi riyals (SAR) over 15 years. However, the direct benefits[6] from a massive rollout of smart meters were assessed to be 9.16 billion SAR. Aside from the direct benefits to the utility, an estimated

5% reduction in peak demand due to advanced metering could offer significant indirect benefits, including increased quantities of oil made available for export and reduced greenhouse gas emissions.

The SEC plans to accelerate its investments in the smart grid, including a significant smart meter rollout across the country. One component of the Kingdom's smart grid and energy efficiency program was put into place in 2010 when electricity tariffs for industrial and large commercial customers were increased, and variable tariffs were introduced to encourage conservation during peak demand hours. The SEC sees smart meters as an important enabler of the new tariff system, promoting energy conservation and demand-side management (SG 2018). The SEC's revised 2019 deployment strategy sets out its plans to install 10 million smart meters by mid-2020. Its Smart Metering Project is one of the single biggest digital transformation projects in the Kingdom (SEC 2019). Nearly one-third of the components used to build smart meters will be sourced locally (SEC 2019). Figure 19 provides the length of the T&D network by region. Figure 20 shows the distribution network by voltage level. The distribution system uses 13.8 kV, 33 kV, and 69 kV as standard nominal service voltages, alongside a low voltage distribution network. It also uses non-standard service voltages of 11 kV and 34.5 kV.

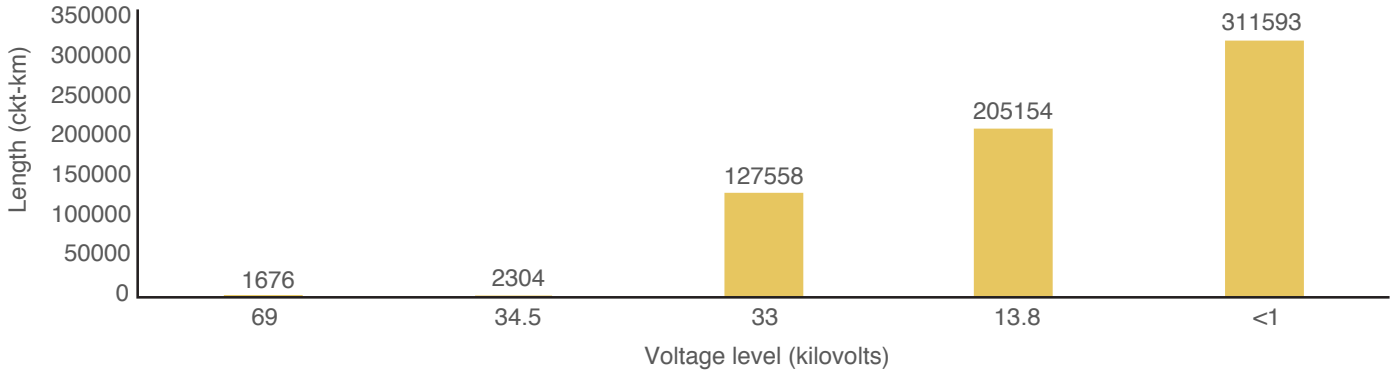
The SEC's development process of grid modernization has three strategic objectives: smart meter solution programs, smart grid programs, and grid efficiency. The expansion of the network and the number of consumers using it requires improvements in system accuracy and energy conservation through demand response programs. This can be achieved through the rollout of smart meters. The redesigned Smart Meter Project now aims an expeditious rollout of 10 million smart meters over the next 15 months. Furthermore, it plans to replace all existing meters in the Kingdom with smart meters over five years for residential, commercial, and industrial consumers.

Figure 19. T&D network by region.



Source: ECRA (2018).

Figure 20. Distribution network by voltage level.



Source: ECRA (2018).

Independent water and power producers (IWPPs): Selection, ownership and PPAs

The government has historically been responsible for all investments required by the power sector. However, significant stress on the state finances has forced the government to turn to the private sector. The process of engaging the private sector started with the preliminary work for the development of the US$2.5 billion Shuaibah independent water and power project in late 2002, the first IWPP to be developed in the Kingdom. The adoption of the Electricity Law by Royal Decree No. M/56, on 22 Nov. 2005 (20 Shawwal 1426), provided further impetus to the government's efforts to seek a greater role for the private sector in electricity (and water) production. The Electricity Law required the private sector to be allowed to earn a fair return to safeguard their business interests through clear, stable, and non-discriminatory regulatory frameworks for the electricity industry (ECRA 2005a). It also emphasized the importance of creating a suitable environment that encourages and supports legitimate competition in the electricity industry.

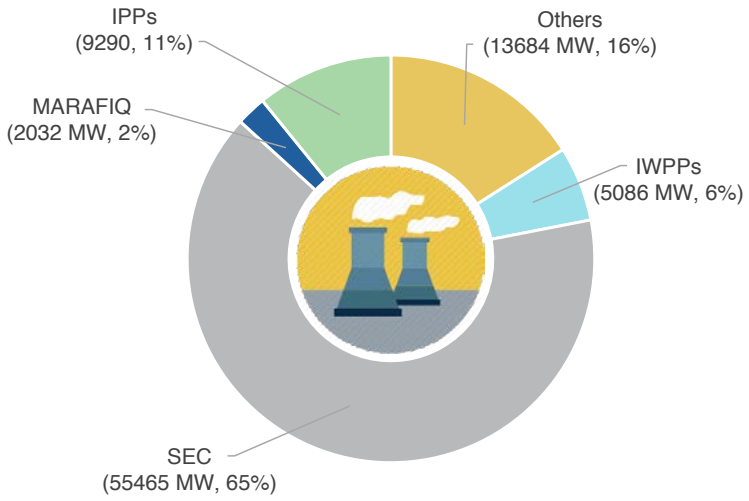
Since the Electricity Law was introduced, IPPs have been playing increasing roles in the Kingdom's power-generating sector. Non-SEC capacity now represents around 35% of the country's total power generation capacity (Figure 21). The participation of IPPs in power generation relieved the SEC of the pressure to mobilize the requisite financial resources (from local and external debt markets) needed to create additional generation capacity. The public-private partnership (PPP) model adopted by the Kingdom for the expeditious development of its generation infrastructure allowed the SEC to retain a majority stake in most IPP projects. It was still able to add requisite generation capacity without the need to pay the entire upfront cost.

The electricity sector offered a business environment very conducive to IPPs in the Kingdom. The SEC assumed most of the demand and payment risks by offering 20-25 years of 'take-or-pay' power purchase agreements (PPAs) at agreed strike prices. Furthermore, the risks to IPPs of fuel price fluctuations were mitigated through fuel supply agreements between the IPPs and the government through state-owned Saudi Aramco, the sole supplier of fuel to power producers in the country.

IPP projects are currently selected through a competitive tendering process. However, the competition exists only at the time companies enter into the market. Once IPP projects are commissioned and integrated with the grid, they are dispatched on the basis of IPP availability declarations and projected demand, among other technical constraints. The transmission service provider, NGSA, aims at overall cost minimization in scheduling and dispatching generation capacity.

The electricity generators are required to provide system services (i.e., ancillary services – frequency control, voltage control, system control, operating margin and black start) to the TSP in accordance with the Saudi Arabian Grid Code. While the code stipulates various technical requirements, the financial terms of the ancillary services are not clearly and adequately included in the PPAs. One of the reasons for this has been the vertical nature of the country's electricity industry: the SEC had a significant share in the power generation capacity and mostly provided the required system services from its own fleet of generation plants. The procurement of system services through directly contracting other generators was very limited.

Figure 21. Power generation capacity in Saudi Arabia by licensees.



Source: Annual Statistical Booklet 2018, ECRA.
Note: IWPPs include Jubail Water & Power Company, Shuaibah Water & Power Company and Shuqaiq Water & Power Company. IPPs include Hajr for Electricity Production Company, Durmah Electric Company, Rabigh Electric Company and Al-Mourjan for Electricity Production Company. Others include Saline Water Conversion Corporation, Tihama Power Generation Company, Saudi Aramco, Rabigh Arabian Water and Electricity Company, Power Cogeneration Plant Company, Jubail Energy Company, Saudi Cement Company, Tuwairqi Energy Company, Saudi Aramco Shell Refinery, Obeikan Paper Industries Company.

Regulation, price controls, and price reforms

ECRA (referred to as the 'Authority' in the Electricity Law) was established in 2001 as a government entity with administrative and financial autonomy for regulating Saudi Arabia's electricity and water desalination industries. The main objective of the Authority is to ensure that consumers obtain electricity supplies (including cogeneration and water desalination products) at reasonable prices. To enable ECRA to fulfill its objectives, the government gave it responsibilities covering four areas (ECRA 2005a, 2019):

Licensing, regulation and industry plans – On matters related to supply, ECRA is responsible for (i) issuing licenses for generation, transmission, distribution, retailing, and trading electricity and cogeneration services, and producing, trading, and transporting desalinated water; (ii) developing implementation regulations and procedures; (iii) monitoring licensees' compliance with the provisions of the Electricity Law, implementing the regulations and licensee requirements and conditions (ECRA 2007). ECRA is also responsible for developing the electricity and water desalination industry's long-term expansion plans in coordination with MEIM and other relevant entities. This entails working to ensure the most appropriate type and use of fuel resources to realize the best possible return for the national economy.

Pricing and tariffs – Determining the tariff and its structure for the supply of electricity, cogeneration, and water desalination services is an important function of the Authority. The tariff design encompasses three main objectives – it should be affordable to end users, easy to implement, and allow sufficient income for the service providers. Furthermore, the tariff and tariff structures are required to provide incentives for the continued improvement of technical efficiency, economic efficiency, and quality of services. ECRA undertakes a periodic review of tariffs as part of its mandate, and proposes new tariffs, when needed, to the government for final approval.

Competition – ECRA is also responsible, along with MEIM (now MoEn), for promoting competition in the electricity industry in a timely and organized manner, encouraging private sector investments, and ensuring consumer choice. It also has responsibility for overseeing any abuses of market dominance that may restrict competition in any part of the electricity industry.

Market reforms – ECRA has overall responsibility for electricity market reforms. It is required to continuously monitor the progress in implementing the electricity industry's restructuring plan, the amendments and updates to the plan, and to take necessary actions as it deems fit. However, the electricity industry restructuring plan is required to be consistent with development plans that may be prepared by the government (ECRA 2007). ECRA is also mandated to propose amendments to the Law and the Charter in coordination with MEIM (now MoEn) (ECRA 2007a). In developing a comprehensive program and a public relations campaign for the conservation of electricity, ECRA is required to cooperate with MEIM (now MoEn) and other relevant entities and organizations (ECRA 2007a).

It is evident from the above that ECRA as a regulator has been provided with a sufficiently clear mandate to regulate the electricity industry and develop it to the point where it becomes a fully competitive market.

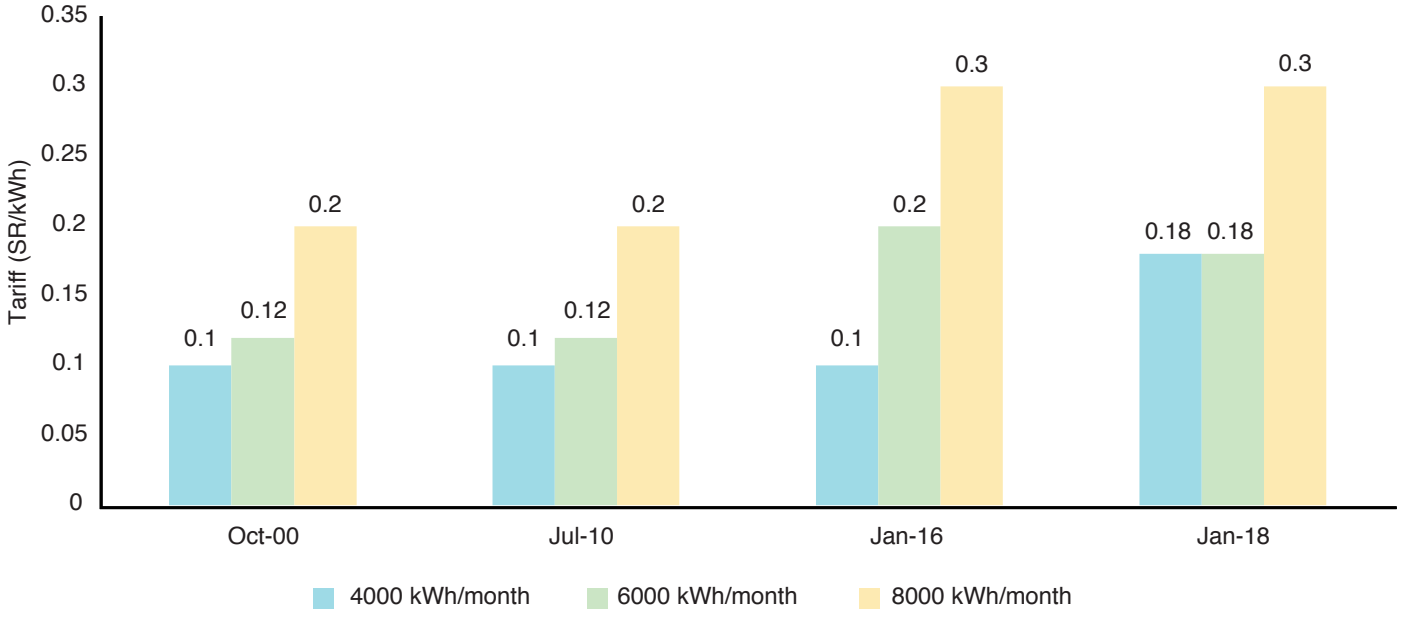
Fossil-fuel subsidies have, in the past, been the defining feature of energy price formation in the

Kingdom, as in many other Gulf countries. The Kingdom's retail electricity rates have been kept low for a long time. Figure 22 shows the tariff for residential consumers for consumption slabs of 4,000 kilowatt hours (kWh), 6,000 kWh, and 8,000 kWh per month.

The tariff for residential consumers in the 4,000 kWh per month consumption range remained unchanged from 2000 to 2015. The tariff for 6,000 kWh consumption was unchanged from 2000 to 2010. According to an assessment by ECRA, the unit cost of supply[7] in the Kingdom was about 0.149 SAR/kWh in 2011. This increased to 0.156 SAR/kWh in 2015, then to 0.204 SAR/kWh in 2017.

Compared with the unit cost of supply, the average price realized from consumers was 0.138 SAE/kWh in 2014, and 0.157 SAR/kWh in 2017. The unit cost of supply is based on the fuel prices paid by the SEC and other electricity generation entities, far below world market prices. Thus, in spite of the low fuel prices in the Kingdom during these years, the average per-unit revenue was below the unit cost of supply (Figure 24). If electricity producers were to pay a market-based price for procuring fuels, it was estimated that the unit cost of supply would be 0.80 SAR/kWh in 2014, more than five times the unit cost of supply with subsidized fuel for power generation. Table 1 compares fuel prices paid by electricity producers in the Kingdom with international prices (SEC 2016).

Figure 22. Electricity tariffs in Saudi Arabia for residential consumers for various consumption slabs.



Source: Collated from multiple sources including ECRA Activities Report 2011 and 2017.

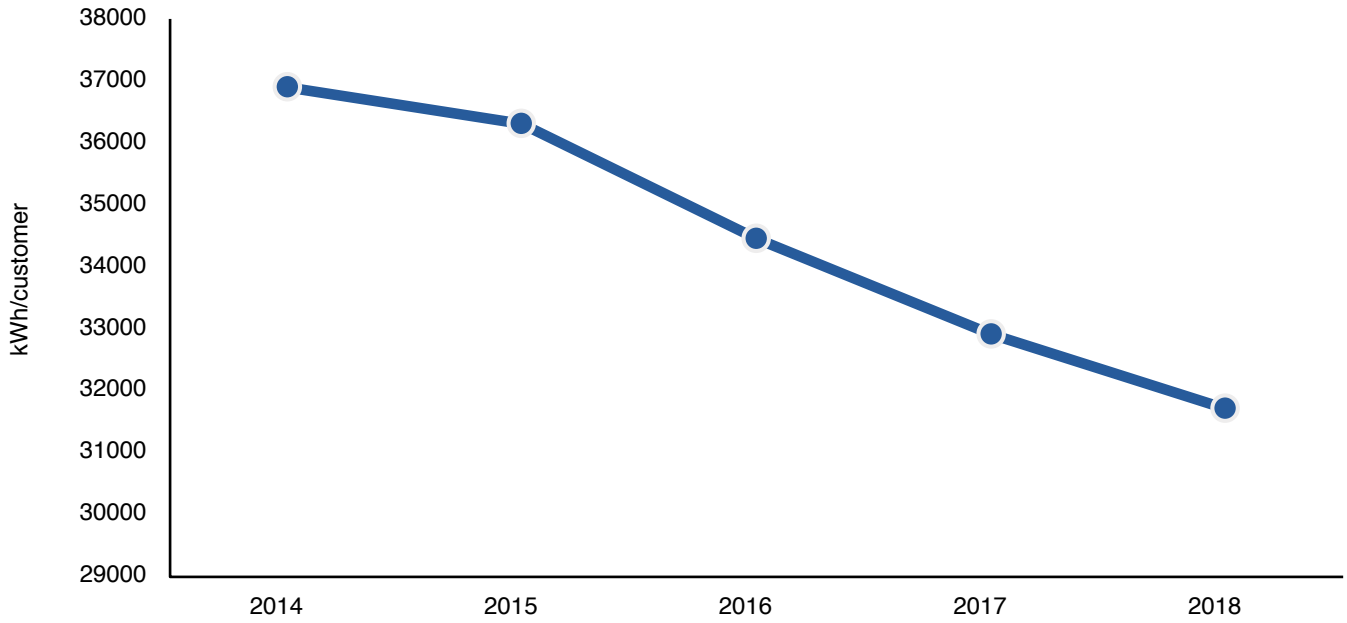
To contain the costs of its energy subsidies, the government introduced the first phase of its price reform measures in 2015. This also included a tariff hike for some electricity consumers, particularly residential and commercial. In late 2017, the government introduced the second round of tariff hikes, which became effective from January 1, 2018. Electricity consumption per customer has declined in the past few years (Figure 23). Although it is difficult to conclusively attribute this decline solely to tariff reforms initiated in 2015, nonetheless, the upward tariff revision for domestic customers is a possible reason for this decline.

Even after two successive rounds of tariff hikes, electricity rates for residential consumers remained low compared with other countries in the region. Figure 25 shows the historical distribution of the SEC's average energy costs.

Figure 26 compares the residential tariff applicable for the 4,000 kWh and 8,000 kWh per month consumption brackets. Saudi Arabia's tariff hikes from 2000 to 2018 were limited to 3.32% for 4,000 kWh/month consumption and 2.28% for the 4,000 and 6,000 kWh/month consumption brackets.

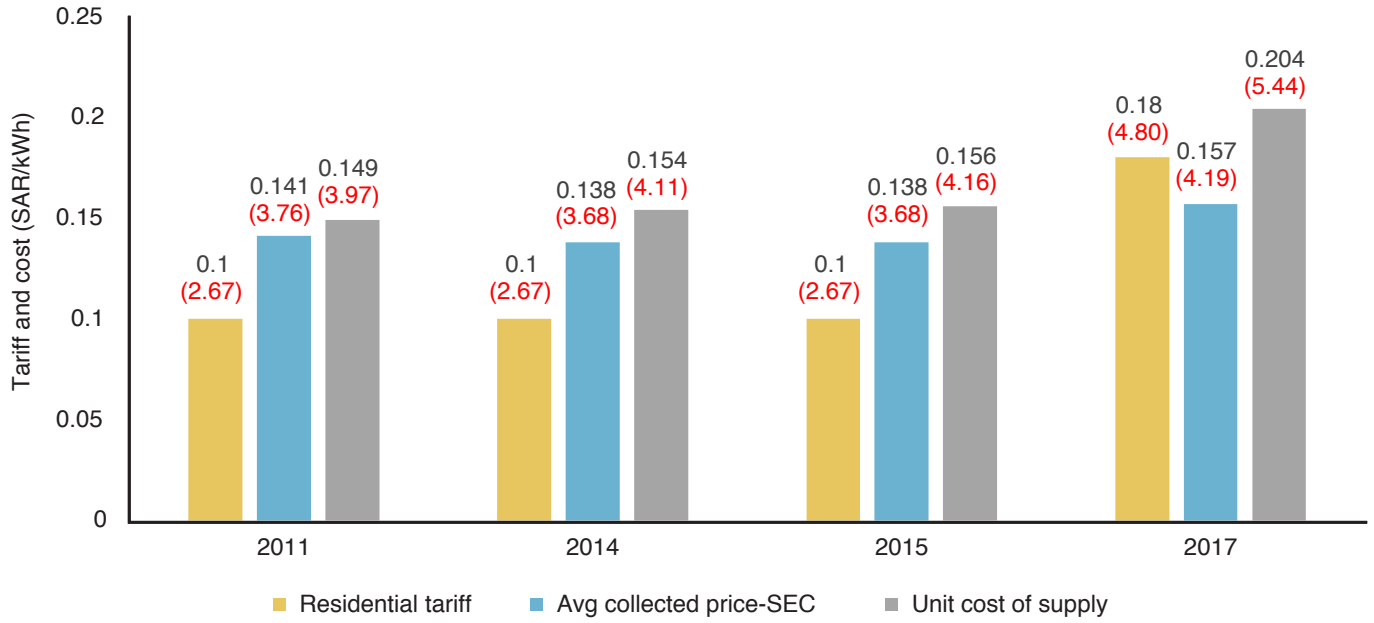
Subsidized electricity prices encourage higher consumption. Moreover, heavy dependence on subsidized fuel for electricity generation not only distorts the real cost of electricity but also poses a challenge for the integration of electricity markets. This is due to concerns of implicit wealth transfer through cross-border electricity trading.

Figure 23. The declining trend of electricity consumption per customer.



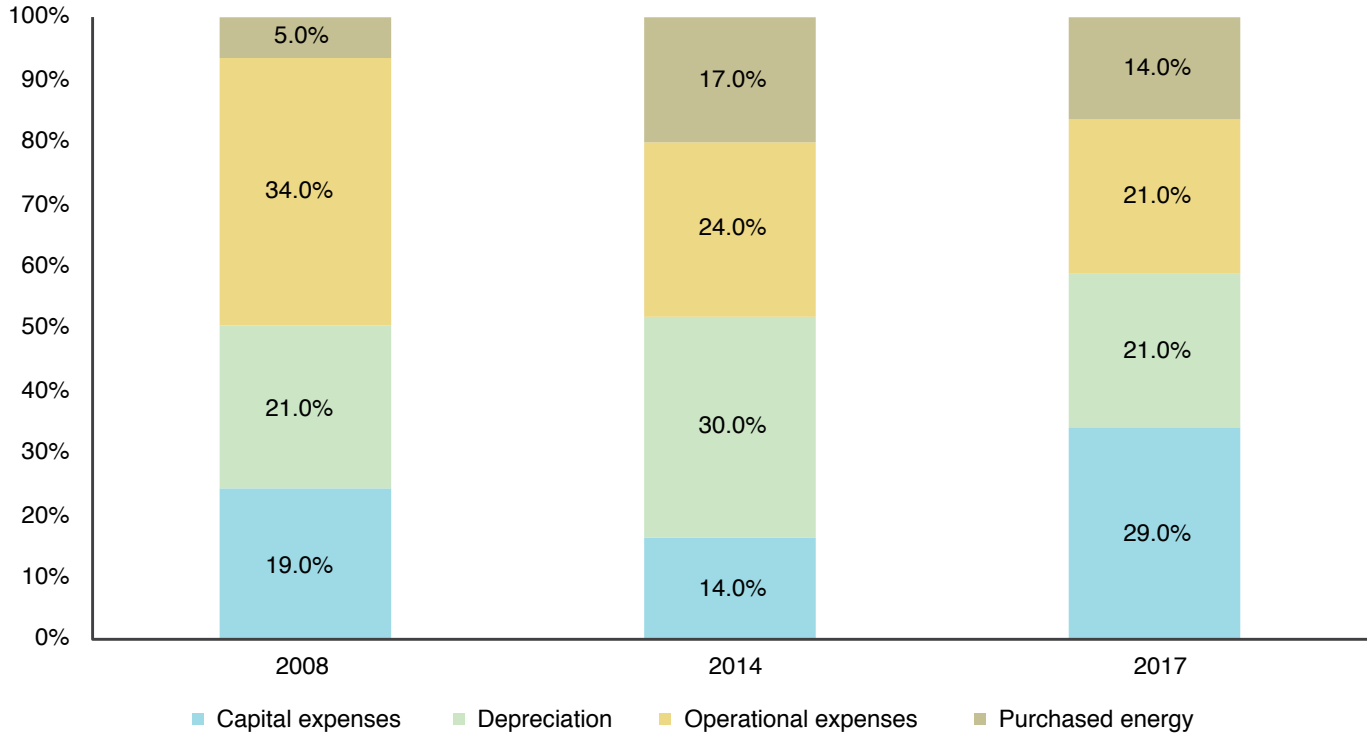
Source: ECRA National Electricity Registry.

Figure 24. Tariffs collected and the unit cost of supply.



Source: ECRA Activities Report 2011, 2014, 2015 and 2017.
Note: Figures in red are in equivalent U.S. cents/kWh.

Figure 25. Distribution of the SEC's average cost of supply.



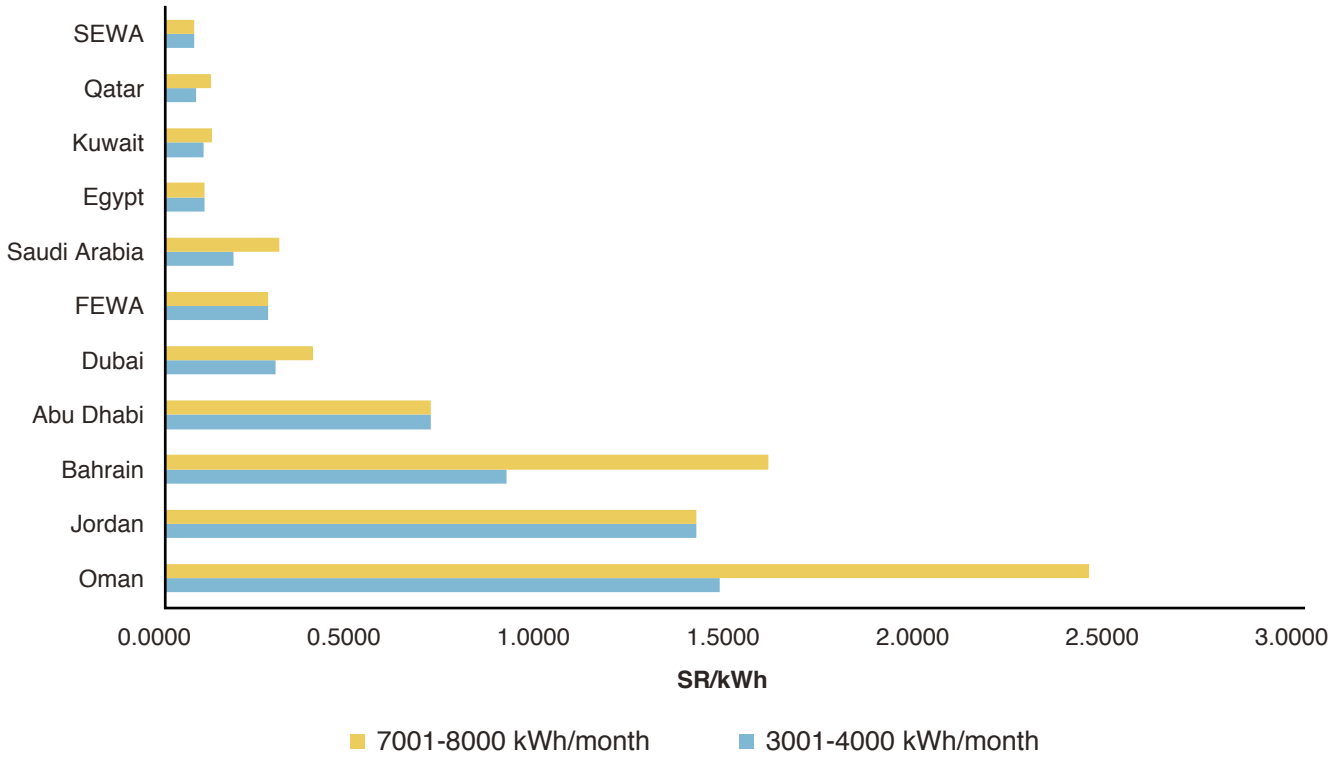
Source: ECRA Activities Report 2008, 2014 and 2017.

Table 1. Comparisons of fuel prices paid by the electricity producers in 2018.

Fuel type	Price (US$/MBtu)	
	Paid by producers in Saudi Arabia	International
Heavy fuel oil	0.64	15.43
Gas	1.25	3.15#
Diesel	2.42	21.83*
Crude oil	1.09	12.27**

Sources: APICORP 2018, COMSTAT Data Hub, Statista.com, GlobalPetrolPrices.com.
Annual average closing price of natural gas, Henry Hub Natural Gas Spot Price - Historical Annual Data
* Average diesel price in U.S.
** Average Brent crude oil price

Figure 26. Comparison of residential tariffs for different consumption slabs, 2019.



Source: KAPSARC analysis; collated from multiple sources.
Note: FEWA = Federal Electricity & Water Authority; DEWA = Dubai Electricity and Water Authority. The residential tariffs for Bahrain, Abu Dhabi, FEWA and SEWA are applicable to their local citizens. The electricity tariffs paid by expats are much higher for similar consumption slabs.

Open access to the transmission and distribution network

Providing non-discriminatory access to transmission networks is important to foster competition in the wholesale electricity market and to enhance market liquidity in an interconnected electricity market. Under the existing market design, access to and the use of the NGSA's transmission system are allowed, albeit with some restrictions. All generators of electricity are connected to the transmission grid and allowed to sell their electricity only to the PB. However, companies connected to the transmission grid, with their own captive generation facility and a license from ECRA, can use the grid to transport surplus electricity for use by their affiliates connected to the grid.

The Saudi Arabian Grid Code sets out the rules and regulations for accessing and using the transmission system of the NGSA. These rules define the obligations of the NGSA and other grid users, including generators, distribution entities, and directly connected customers, in accessing and using the grid. The Saudi Arabian Grid Code calls for open, transparent, non-discriminatory, and economic access and use of the grid while maintaining its safe, reliable, and efficient operation. Moreover, the transmission license conditions also require the transmission licensee (which in this case is the NGSA) not to unduly discriminate in respect of price or other terms between any users or classes of users of the transmission system, unless otherwise authorized by ECRA. The charges for connecting to and using the transmission system are proposed by the transmission licensee and approved by ECRA, in accordance with the Electricity Law and the implementation regulations.

Future View of a Competitive Electricity Market

Saudi Arabia is set to follow a building block approach to its electricity market reforms. The reform blueprint for the electricity sector that has been under discussion for some time has not yet been finalized. It is expected that the transition toward a competitive electricity market will take place in phases. Five notable features of the likely new market design, including the key challenges in successfully implementing it, and international experiences are briefly presented below:

Unbundling competitive and non-competitive business elements

The distinction between competitive and non-competitive activities differs from country to country according to country-specific characteristics (OECD 2001). However, in most cases, generating, retailing and trading electricity are considered potentially competitive activities, leaving transmission and local distribution (in some cases) to function as natural monopolies. In line with this thinking, Saudi Arabia's electricity sector restructuring plan envisions separating competitive and non-competitive activities by separating generation and distribution activities and maintaining the NGSA.

The reasons for and objectives of restructuring or deregulation also vary according to the local context. Reforms and restructuring initiatives in developing countries are largely driven by a desire to raise funds through private sector participation to add much-needed generation capacity. For example, in the late 1980s, Chile was the first country to comprehensively reform its government-owned and operated electricity industry. Its Electricity Act of 1982 was designed to provide a more competitive environment to attract private investors. The reform efforts focused on the vertical and horizontal unbundling of generation, transmission and distribution, and the industry's subsequent large-scale privatization.

As the United States (U.S.) already had many privately owned electricity companies, the focus of its reform efforts was on increasing competitiveness in the market through indirect regulatory oversight rather than privatization. Separating generation from transmission and distribution was considered important in the United Kingdom (U.K.) to put competitive pressure on generators to reduce costs. Accordingly, the reform of the electricity industry in the U.K. focused on unbundling and privatizing state-owned entities (the Central Electricity Generation Board responsible for generation and transmission, and 12 Area Boards responsible for distribution and supply).

The electricity reforms in Nordic countries were inspired by the reforms in the U.K. They believed that increased competition would benefit consumers through enhanced efficiency and increased productivity. Moreover, these countries also considered a market-based power system an important instrument for increasing the efficiency of their existing electricity systems.

Turkey's enactment of its Electricity Market Law (EML) in 2001 (amended several times in subsequent years) provided the foundations for initiating more comprehensive electricity market reforms. A core objective of the EML was to develop a financially sound and transparent electricity market operating in a competitive environment. Based on the lessons learned during the first phase of liberalization, the objectives of Turkey's

second phase of electricity reforms focused on improving the industry's economic efficiency and attracting private investment through market-based mechanisms. It has been observed that private sector participation through build-operate-transfer projects with take-or-pay guarantees has created contingent liabilities for public institutions while leaving the buyer with most of the market risks (IBRD 2015).

It is expected that implementing the proposed reorganization of Saudi Arabia's electricity sector and establishing a competitive wholesale electricity market in the country will benefit customers. It should also improve the government's fiscal position through privatization (wherever feasible), reduced subsidies and other fiscal incentives. To achieve the most positive reform outcomes will require developing a carefully drafted reform strategy to deal with the reorganization- and restructuring-related challenges. Some of these are briefly highlighted below:

Dealing with the stranded costs of the utilities – Important lessons can be learned from how electricity sectors have been restructured in other parts of the world. This section briefly reviews three cases of restructuring around the world and the mechanism used to deal with the stranded costs of the utilities.

Ontario, Canada - Ontario's electricity sector was restructured in 1999. Prior to this, artificially low electricity prices had left the vertically integrated utility (Ontario Hydro) with 38.1 billion Canadian dollars (C$) (106 billion SAR) in debt and other liabilities. At the time of the restructuring, the value of assets of the successor companies offset some of these liabilities. However, the government was left with 19.4 billion C$ (54 billion SAR) in unfunded liabilities, often referred to as stranded debt. The government introduced legislation to create the Electricity Financial Corporation, which manages the debt and liabilities of the successor companies. The legislation allows the government to recover the stranded debt from a number of sources, including:

1. Profits from successor companies.
2. Payments in lieu of corporate income and property taxes from successor companies.
3. A debt retirement charge from electricity consumers.

Electricity consumers in Ontario stopped paying the debt retirement charge as of March 2018, 20 years after the restructuring. The government continues to manage legacy debt and liabilities of C$19.6 billion inherited from the restructuring (OEFC 2018).

United States - In the 1990s, electric utilities in the U.S. convinced regulators that they should be compensated for any lost asset value as a result of restructuring. Most state restructuring schemes included a plan for the full recovery by utilities of any stranded generation investment. This was in place in case the market value of the generation asset in a competitive market was below the depreciated capital book value at the time of restructuring. The plan included the introduction of competition transition charges as surcharges on the bills of distribution companies.

The mechanism to pay back utilities for their stranded costs is called securitization and is operationalized through the establishment of an independent corporation to do the following:

1. Issue bonds.
2. Sell the bonds to investors.
3. Use the proceeds of the bond sales to buy out the utility's stranded assets.

4. Place charges on the electric bills of consumers for a limited transition period to repay the bond investors.

Securitization requires legislative changes to ensure corporations have the legal authority to collect and make payments to the parties involved (Borenstein 2015).

India - High levels of outstanding liabilities were one of the notable features of India's electricity industry prior to its structural and regulatory reforms that started in the mid-1990s. Its State Electricity Boards (SEBs)[8] were unable to generate sufficient financial resources to fund new investments in the sector and often relied on government support for capital funding and financial survival. The sector accumulated enormous debts to other federal government-owned power supply corporations, fuel suppliers, and other financiers. At the time of its unbundling, such inherited liabilities, including the debts of the vertically integrated utilities, were transferred to successor companies. State governments used a variety of instruments as part of their financial restructuring plans to soften the burden on successor entities. These included the following:

1. Partial waivers of outstanding liabilities.

2. Government takeover of 50% of the outstanding short-term liabilities.

3. Converting liabilities taken over by the government into bonds for sale to participating lenders.

4. Moratorium on repayment of interest and principal components of loans.

5. Debt recast to lower the financial burden.

6. Transitional finance mechanism (offered by the central government) for providing grants for liquidity support.

This approach differed when the electricity distribution sector was privatized and unbundled simultaneously. When the government of Delhi (capital of India) was drawing up its privatization strategy for the distribution sector, it thought its privatization efforts might not solicit the desired response if successor companies (in particular electricity distribution companies) were to inherit the liabilities and past losses of the vertically integrated utilities. Thus the government formed successor companies with clean opening balance sheets and funded these historical liabilities through government loans to the transmission company. These loans were to be repaid to the holding company by the generation company, transmission company, and the three distribution companies within 15 years. The government also provided a four-year moratorium on repayment and a waiver on interest payments as part of its reform and privatization package (Stamminger 2002). The transmission company used this loan to bridge the gap between its revenue requirement and bulk supply pricing during the transition period.

Competition and investment in generation

In Saudi Arabia, one or more companies (gencos) are likely to be established and partially privatized through a joint venture process. It is expected that the separation of generation (and supply) businesses from the core natural monopoly networks will allow gencos to operate as competitive suppliers. However, how best to introduce competition into the generation business will be a crucial restructuring and market design question.

The intensity of competition in the market will depend on the actions of the genco(s) and the existence of an open-access wholesale market, an important feature of the Kingdom's proposed electricity supply restructuring plan. Until such time, competition in the market will be limited to only merit order generator scheduling, constrained by the legacy PPAs with take-or-pay clauses. Developing an appropriate market mechanism that provides price signals for long-term investments in capacity and an efficient mix of generation technologies will be an important challenge in the proposed CEM.

Moving from the transmission system operator model to the independent system operator model

The NGSA as a TSP has a crucial role in operating, scheduling, and dispatching all generating units based on the least-cost operation. Asset ownership responsibilities also rest with the NGSA as the functionally unbundled transmission company. In its assessment of the unbundling requirements for transmission and distribution system operators in Europe, the Council of European Energy Regulators (CEER) observed that without the effective separation of networks from generation and supply activities, there is an "inherent risk of discrimination in the operation of the network and in the incentives for VIUs to invest adequately in their networks." (CEER 2016).

Similar concerns have also been raised in other electricity markets, including markets where successor entities of VIUs are placed under a common electricity holding company. The two most widely used unbundling models for system operation are – (i) a transmission system operator (TSO) and (ii) an independent system operator (ISO). The TSO model, with ownership unbundling, has been implemented in 70% of the cases throughout Europe as a whole, followed by the ISO model (12%). In some European member states, TSOs have a private ownership structure. However, in the majority of the participating member states, TSOs are owned and controlled by public entities (CEER 2016).

Unlike in Europe, wholesale electricity markets in the U.S. are run by ISOs. Regional transmission organizations (RTOs) perform the same functions as ISOs but over a larger geography. All these models have their merits and demerits depending on the industry structure, size, and a number of market players.

The current institutional arrangement in Saudi Arabia (i.e., the NGSA as a wholly owned company of the SEC) is more representative of an LTSO model, where both system operation and asset ownership responsibilities rest with the same company. However, to remove potential conflicts of interest, it has been proposed that an ISO be established in the Kingdom. The ISO would perform the generation scheduling and planning functions. After the transitional phase, the ISO would also be responsible for procuring new generation capacity. The expectation is that it will also be given the responsibility of managing the future spot market. In this context, the following questions merit attention:

- Can the NGSA (as it is currently structured) ensure the requisite independence of its grid operation to provide a level playing field?
- How can greater transparency of the grid operation be ensured (especially in matters relating to scheduling and dispatch)? And how can better information exchange be facilitated?

A ring-fenced[9] and independent PB

The SEC and its successor entities will remain the counterparties for existing PPAs. There is a plan to transfer such contractual agreements to the PB. All new PPAs with future generators (renewable and non-renewable), including those selected through ISO generation tenders in the CEM, will be with the PB. To ensure transparency, these contracts would be managed through a ring-fenced and independent PB. The PB is also expected to manage any financial support received from the government for maintaining the desired level of tariffs for a select group of consumers.

In the EIRP under discussion, the PB is being considered as a transitional arrangement in the run-up to the competitive spot market for wholesale electricity. The PB has been assigned to manage electricity procurement to ensure the security of supply to the industry and all related services. International experience suggests that an independent entity (often designated as a 'market operator') is needed for the spot market to function effectively. Given the closely aligned roles of a system operator and a market operator, much thought has to be given to how to transform the existing institutions (ISO or PB) to be able to have a functioning market operator. A market operator should have the following attributes:

- Clarity in its roles and objectives.
- A sufficient and desirable level of autonomy in governance.
- Transparency in operation, reporting, and decision-making processes.
- It should work in consultation with the industry to formulate market rules that are clear, fair, and cohere with the regulatory frameworks.
- An adequate mandate to administer the enforcement and compliance of market rules and regulations.

Several countries have established separate entities for managing their competitive electricity (or energy) markets. The two most commonly used institutional models for market operators and system operators in other competitive wholesale markets are ISOs/Regional transmission organizations (RTOs) and non-transmission system operators (TSOs). A brief overview of the institutional arrangement and functions of market operators in select electricity markets is presented below:

United States - The system operator model is widely practiced in the U.S., where seven ISOs/RTOs are engaged in overseeing the market operations that cater to nearly two-thirds of the country's population (FERC 2015). The Federal Energy Regulatory Commission (FERC) requires ISOs/RTOs to operate the competitive wholesale markets and make decisions independently of market participants. The essential functions performed by ISOs/RTOs include – (i) transmission system expansion planning, (ii) grid operation and monitoring, (iii) coordinating the maintenance of the generation and transmission system, and (iv) administration of the wholesale electricity markets. To ensure independent functioning and avoid any commercial interests, neither ISOs or RTOs are required to own any transmission or generation assets.

Europe - The role of a market operator in European member states is performed by the "Nominated Electricity Market Operator" (NEMO). Each member state has to designate one or more NEMO(s) in each pricing zone to undertake day-ahead and intra-day operations in the competitive wholesale markets. A

designated NEMO in one member state is allowed (with limited exceptions) to offer day-ahead and intraday trading services in another member state (EUETS 2019). Their key tasks as market operators include receiving orders from market participants, matching and allocating orders, publishing prices, and acting as counterparties for the clearing and settlement of trading activities (EUETS 2019). There are also third-party market operators/facilitators in some member states that are tasked with activities related to balancing electricity markets (Europex 2018). The responsibility for the safe operation of the grid in the European electricity market (including the development of grid infrastructure in many countries) remains with the TSOs (entso-e 2019).

Australia - After the liberalization of Australia's electricity industry, vertically integrated utilities were unbundled into separate businesses. These unbundled businesses were sold to the private sector in some states, while the government retained its ownership in other states. Australia developed its National Electricity Market (NEM) as a cross-state wholesale electricity market in 1998 by initially connecting the power systems of eastern and southern states and territories.

The National Electricity Market Management Company[10] (NEMMCO) was created to administer and manage the NEM as the market operator. Australia's National Electricity Law requires that NEMMCO recover its costs but should not make a profit. Accordingly, it operated on a break-even basis by recovering its operating costs through fees paid by market participants. The Energy Reform Implementation Group (ERIG) observed certain weaknesses in the governance arrangements for NEMMCO, given its current and possible future roles and functions (FVPL 2006). It was also noted that NEMMCO needed to play a major role in market development, transmission planning, and possibly transmission procurement. Suggestions to expand its current role to include some aspects of gas sector market operations were also discussed. However, gas industry participants expressed concerns about NEMMCO's governance model (FVPL 2006). The Australian Energy Market Operator (AEMO) was established in 2009 to carry out the market operation functions previously undertaken by NEMMCO, and planning responsibilities of the Electricity Supply Industry Planning Council of South Australia (AEMO 2010). Additionally, AEMO also assumed the retail and wholesale gas market responsibilities previously undertaken by other companies.[11]

As an independent grid and market operator, the primary responsibility of AEMO is to manage and maintain the country's energy system security (AEMO 2017). Some of its key responsibilities in the electricity market and system operation include the management of the NEM, grid operation, transmission planning (including preparation of the National Transmission Network Development Plan), facilitating retail competition, among others (AEMO 2018). The Australian Energy Market Commission (AEMC) is an energy policy advisor to the Australian government. It makes and revises the rules for the country's electricity and gas markets. The responsibility for the economic regulation of the electricity networks and gas pipelines rests with the Australian Energy Regulator (AER). In the wholesale market, the AER monitors the (i) compliance with the legislation and rules for the NEM and spot gas markets in southern and eastern Australia, and (ii) conduct of market participants and the effectiveness of competition.

Singapore - Since the start of Singapore's liberalization of its electricity industry in 1995, it has been structured to facilitate the development of competitive wholesale and retail electricity markets.

In the initial phases of its reform, the ownership of electricity and gas assets was transferred to Tamasek Holdings, a government investment arm. Within Tamasek Holdings, Singapore Power (SP) was created as another holding company for newly created successor companies, including generation (PowerSenko now Senko Energy), transmission (PowerGrid Limited now SP Power Assets) and supply (now SP Services). Tuas Power was also created as an independent new generation company directly under Tamasek Holdings. The Singapore Electricity Pool (SEP) was formed in 1998, providing a platform for generators and supply companies to trade electricity in the day-ahead market. Aside from owning the transmission assets, the transmission company was also the SEP's grid operator and administrator. As generation companies were not fully divested, companies that were competing in the SEP were almost exclusively government-owned (EMA 2010).

After a comprehensive review of the electricity industry, Singapore's government decided to progress its deregulation to obtain the benefits of full competition. As a result, the SEP was transformed into the National Electricity Market of Singapore (NEMS), which commenced trading operations in 2003.

The Energy Market Company (EMC), a public-private joint venture, was established as Singapore's wholesale market operator. It has three important mandates: setting market rules, monitoring market operations, enforcing market rules, and dispute resolution. The Rule Change Panel (RCP) of the EMC is responsible for proposing all modifications to the market rules, which are submitted to the Energy Market Authority (EMA), a Singapore government agency, after being reviewed by the EMC board.

The EMA is responsible for making the rules for the wholesale market and issuing licenses to electricity market participants. The EMA regulates the electricity and gas industries as well as district cooling services in designated areas. Its mandate is to promote competition and provide a level playing field to market players while protecting consumers' interests. The Power System Division within the EMA oversees the operation of the power and natural gas transmission systems (EMA 2019).

Malaysia - The electricity industry in Malaysia is undergoing structural transformations aimed at developing an efficient and competitive electricity market. The electricity industry is not fully unbundled into competitive and non-competitive activities. However, to further the reform initiatives, a principal buyer has been created within the vertically integrated industry. A number of IPPs have also been set up that share generation responsibilities with the Tenaga National Berhad (TNB). To ensure the principal buyer performs its functions in a fair and non-discriminatory manner, it is required to implement appropriate operational ring-fencing procedures to address potential conflicts of interest, competition reduction, or competitive advantages (ST 2018).

The main function of the principal buyer is to procure electricity and other related services from IPPs and TNB. In doing so, it follows the least cost dispatch scheduling methodology for preparing day-ahead, week-ahead, and three month-ahead dispatch schedules. The principal buyer makes payments to generators in accordance with the PPAs and other agreements for electricity from its ring-fenced accounts. Some of the PB's other responsibilities are to – (i) facilitate the security of supply, (ii) monitor the adequacy of the supply of fuels to generators, (iii) promote transparency, (iv) facilitate competition and promote confidence among industry stakeholders. It is also required to forecast demand and prepare a 10-year demand-supply report for submission to the Energy Commission.

The Grid System Operator (GSO), a separate ring-fenced entity, is primarily responsible for the day-to-day real-time operation of Malaysia's grid system. In addition, the GSO undertakes short- and medium-term transmission planning, including interconnections with Thailand and Singapore.

Enhancing competition through bilateral contracts

The implementation of a bilateral contract arrangement (BCA) in the Kingdom is also being explored to encourage the efficient utilization of existing facilities before establishing a competitive wholesale electricity market. It is estimated that nearly 2,500 MW of capacity is used for fewer than 100 hours in a year (Al-Shehri 2019). Under the BCA, eligible entities will be encouraged to optimize their assets by selling excess capacity to large industrial and other customers by paying the applicable transmission use of system tariffs. In a BCA, or similar arrangements adopted in other jurisdictions, losing the best-paying customers (often industrial customers) to captive generators (which are allowed to sell their surplus generation through open access and third-party sale provisions) has been the main concern of utilities when deciding whether to support such arrangements. Undoubtedly, such concerns can be addressed by making industrial tariffs more cost-reflective. However, if the progression of cost-reflective tariffs does not follow a similar trajectory for other consumers (e.g., residential), utilities may lose their ability to cross-subsidize these consumers.

Developing a competitive spot market

In order to further deepen the competition in the Kingdom's wholesale electricity market, there is a proposal for the introduction of a spot market, initially on a trial basis. During the trial phase, various market rules designed to govern the spot market will be tested for their efficacy. Further, to minimize the participants' exposure to the spot market, all the electricity would initially continue to be contracted as per the PPAs managed by the PB. All new generators will be paid on the basis of (i) capacity payments linked to the generating capacity made available by the generators, and (ii) energy payments linked to actual energy production. Gradually, generators and large customers could be allowed to trade electricity directly with each other. Traditionally, the key policy objective of capacity payments has been to ensure the system's reliability of supply. The challenge would be to set the capacity payments that are reflective of the long-term value of capacity and provide an appropriate price signal for investment.

Lessons for the Saudi power sector

Many countries, both developed and developing, have taken steps to reform their electricity sectors. While the micro-objectives of power sector reforms may differ from country to country, the overall goals have been to create financially stable industries, make conditions conducive for private sector participation, and improve the industries' efficiency, competitiveness, and sustainability. Thus, the Kingdom's decision to restructure its power sector to address its low efficiency and sustainability is not that different from the decisions taken by many other countries. Therefore, the electricity reforms of other countries could offer some useful lessons for Saudi Arabia:

- The electricity industry restructuring plan needs to articulate its objective clearly. Any reform strategy should ideally be aligned with the

sector's restructuring objectives and needs and be implemented in a time-bound manner. The intermediate stages on the path to a CEM should assess and resolve implementation issues and/or market design flaws in a timely manner.

- To establish a truly competitive market, the separation of potentially competitive generation and retail activities from the natural monopoly segments of transmission and distribution is desirable. It has often been pursued to facilitate competitive entry and mitigate concentrated market power. As discussed in the previous section, several models (LTSO/TSO/ISO) provide different degrees of structural separation of network operations from production and supply activities. Each model is expected to remove any conflict of interests between producers, suppliers and transmission system operators in varying degrees.

- The investment decisions of a vertically integrated transmission business are often distorted because legal and functional unbundling do not remove conflicts of interest within integrated companies. Decisions surrounding supply and production aim to maximize their sales and market share, while the network operator is obliged to offer non-discriminatory access to competitors. Removing such inherent conflicts to ensure the independence of the transmission operator within a vertically integrated company will be impossible to monitor without excessively burdensome and intrusive regulation. Therefore, the TSO model, with a full separation of ownership of the transmission business, would be more suitable for the Saudi power sector as it can ensure the independence of operations and investment decisions of the business and guarantee non-discriminatory access to the network.

- An ISO is independent of all market participants and can be a significant and powerful influence in ensuring fair play in the wholesale market. However, the governance of an ISO can be an issue. Additionally, an ISO is complex and requires maturity in information exchange and operational coordination between the SO and TO. Furthermore, the ISO model is often considered more suitable for regions with multiple transmission owners in order to ensure economies of scale and avoid the pancaking of transmission use of system charges.

- As the Kingdom embarks on restructuring its power sector, it will need to develop a plan to manage the potential stranded costs of SEC. Historically, the SEC has made large investments to service the needs of its customers and has accumulated large liabilities on its balance sheet. Many of its liabilities are due to the average selling price of electricity being well below the average cost of supply. For example, from 2011 to 2017, the average selling price of electricity was 0.141 SAR/kWh compared with the average cost of supply of 0.149 SAR/kWh in 2011. This gap further widened when the average cost of supply increased to 0.204 SAR/kWh in 2017, but the average selling price remained low at 0.157 SAR/kWh.

- Electricity tariffs and fuel prices should be reformed in parallel to restore the financial health of the electricity sector. Their misalignment or the prioritization of one over the other will continue to exacerbate the sector's current state of affairs. For example, in India, fuel for power producers was priced at the market value in most cases, but, even after more than two decades of price reforms and successive price increases, it has not been able to reverse electricity industry insolvencies in several states.

The main reason for the industry's continued financial crisis in India has been slower than expected retail electricity price reform. India's price reforms were expected to follow the core principles of economic regulation. However, regulatory priorities regarding tariff settings have often focused more on limiting tariff increases, controlling costs in the short term than developing an efficient and viable industry in the long term.

- In one of Saudi Arabia's neighboring countries, Egypt, there is growing support for cost-reflective tariffs and fuel prices to reduce the government's rising fiscal deficit. Comprehensive price reforms were introduced in 2014, which increased electricity prices. However, fuel subsidies did not fall significantly due to an increase in fuel prices for power generation during this period. The electricity sector continued to receive government subsidies, both for generation and retail (low consumption consumers), to keep consumer tariffs low.
- According to the literature, while the SB (represented as the "principal buyer" in Saudi Arabia) model may not be the best choice, it allows for a gradual transition to a fully competitive wholesale market. Many countries have adopted it for simplicity and ease of implementation. Some downsides of adopting a PB model include the fact that it weakens payment discipline and imposes contingent liabilities on the government through take-or-pay contracts. Issues that will require attention in the future include (i) signing future take-or-pay contracts in the wake of slow tariff reforms or limited counter-guarantee from the government, and (ii) the appropriate allocation of risk between IPPs and the SB (and/or the government).
- From regulatory oversight to making and revising the rules for the electricity industry, the role of a regulator is of critical importance. Regulatory agencies need to be strengthened, where necessary, to perform their roles and functions more effectively.

Summary and Insights

Although the importance of restructuring the electricity industry to avoid unsustainable outcomes was recognized in the mid-1990s, reform efforts had progressed slowly. The introduction of Saudi Vision 2030 in 2016, which aims to build a diversified and sustainable economy, has provided fresh impetus to accelerate the pace of reform. Future reform initiatives in the electricity sector are likely to be aligned with the objectives and implementation roadmap of Vision 2030.

The need for a coherent and integrated development of the electricity industry led to its nationalization in the mid-1970s and the formation of the SEC in 2002. Since then, the electricity industry in Saudi Arabia has functioned as a vertically integrated monopoly, but the aim is to transition it into a competitive electricity market. The key developments, reform features, and potential benefits of an interconnected regional market, and the challenges in implementing the reforms and market integration are briefly presented below:

Policy development and priorities

The following have been identified as strategic policy priorities in developing the Kingdom's energy sector: improving fuel utilization efficiency, enhancing competition, enabling a larger role for the private sector, and ensuring the diversification and sustainability of energy supplies. Natural gas and renewable energy will play an increasingly important role in the country's future energy mix, and nuclear energy will further complement resource diversity. To realize Saudi Arabia's plan to implement one of the largest renewable energy capacity expansion plans in the world, integration and other challenges need to be addressed. Vision 2030 also seeks to localize a significant portion of the renewable energy supply chain.

Regulation

ECRA regulates all licensed activities in the electricity sector, cogeneration, and water desalination services. One of its mandates is to set prices for the supply of electricity, cogeneration, and water desalination services. ECRA's tariff design is guided by three key objectives: affordability to end users, ease of implementation and sufficient cost recovery. In practice, finding the right balance between economically efficient tariff design and the practical realities of the electricity sector remains a formidable challenge for ECRA and regulators worldwide. Electricity rates have also been increased as part of the price reform measures introduced in 2015. However, the average collected price per unit of electricity is still below the average cost of supply.

Market design

As part of earlier reform efforts, a centralized purchasing agency in the form of a principal buyer and a separate transmission company (National Grid SA) was established. However, the current electricity market structure remains characterized by the presence of a state-owned vertically integrated company. The next round of liberalization initiatives is expected to gradually transform the electricity sector from a vertically integrated utility structure to a more competitive electricity sector in phases. The initiatives may include:

- A further unbundling of competitive and non-competitive business activities, including the creation of one or more generation companies and an additional distribution company to the NGSA.

- The principal buyer is to be a transitional arrangement in the run-up to a competitive spot wholesale electricity market. However, it is likely to be ring-fenced to ensure transparency in the management of commercial contracts.

- The government is considering instating an ISO and/or a market operator (MO) in the proposed wholesale spot market to enhance market transparency and level the playing field for market participants.

- In a step toward a competitive electricity market, large consumers with captive generation facilities are likely to be allowed to sell and purchase electricity directly through bilateral contracts.

- International experience suggests that to maximize positive reform outcomes, the approach to unbundling and liberalization should align with the reform's objectives. Important lessons can be learned from electricity sector restructuring and power pools in other countries. These include how to manage the potential stranded costs of the incumbent utility during the transition from the old to the new market structure.

- The effective separation of competitive and monopolistic activities to develop competition in electricity markets. Likewise, the need to separate ownership and system operation functions to prevent the possibilities of anticompetitive behavior in the market.

- Although the principal buyer model is easy to implement and removes most of the market risks for investors, it is also susceptible to risks. It is important to develop a mechanism to fairly compensate the principal buyer for the risk of retail rates being kept low and being unable to pay the agreed wholesale prices to generators.

- A slow pace of electricity price reform may delay the transition to a fully competitive and/or deregulated electricity market. It is important to develop an innovative approach to pricing new products and services so as to correctly assign values to electricity supply and use.

- Building greater institutional capacity and developing robust regulatory frameworks to support the market's development. A lack of clarity and uncertainty regarding regulatory rules and the tariff adjustment process may lead to an increased perception of risk.

- Developing robust market rules to encourage ancillary and balancing markets needed to address growing intermittency issues due to the emergence of non-centralized and distributed generation.

- Providing clarity on the roles and objectives of the MO, and assigning a requisite mandate to administer the enforcement and compliance of market rules and regulations.

- Periodic monitoring of reform performance to identify timely interventions, especially in situations where prices are well below the full cost of recovery.

Market integration

The development of an integrated regional electricity market has the potential to deliver higher economic efficiency, reliability, and environmental benefits, including export opportunities for renewable energy. Several studies have assessed the economic benefits of a regional electricity market in the Gulf region. The Gulf Cooperation Council Interconnection Authority estimated that gulf

countries would save some US$6 billion through avoided generation capacity investments, and US$ 27 billion through reducing fuel and operation and maintenance costs from 2014-2038 (Al-Shahrani 2016). This is equivalent to annual savings of US$ 1.32 billion. A similar study by KAPSARC estimates this figure to be US$ 1 billion annually (Wogan et al. 2018).

The existence of physical infrastructure is an important pre-requisite for cross-border electricity trade. Saudi Arabia has 3,450 MW of cross-border transmission capacity, representing nearly 6% of its peak demand. It is well connected with other Gulf countries except for Oman (1,200 MW Saudi Arabia-Kuwait, 600 MW Saudi Arabia-Bahrain, 750 MW Saudi Arabia-Qatar and 900 MW Saudi Arabia-UAE). However, the effective utilization of GCC interconnections has been very low (less than 5%).

However, despite the perceived economic benefits (and existing interconnection capacity), cooperation in electricity trading has not gained much traction. Low domestic fuel prices offered to electricity producers is cited as one of the key barriers to cross-border electricity trade.

Efforts are being made to connect the power systems of Egypt and Saudi Arabia, with a total designed capacity of 3,000 MW. This is expected to be fully commissioned by 2025. When operational, the Egypt-Saudi Arabia interconnector will play an important role in improving energy security in Egypt. Both countries will benefit from the increased diversity in demand and energy resources, and it could facilitate the development of a wider regional electricity market. The Jordan-Saudi Arabia proposed link is expected to boost the electricity import-export opportunities when it becomes operational in 2022. Saudi Arabia and Iraq are also exploring interconnectivity options to improve the availability of electricity in Iraq.

Endnotes

[1] The Gulf Cooperation Council (GCC) is a regional organisation comprising Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates.

[2] A monopsony is a market structure in which a principal buyer substantially controls the market as the major purchaser of goods and services offered by many sellers.

[3] The Royal Commission for Jubail and Yanbu was established as an autonomous organization with an independent budget by a Royal Decree issued on September 21, 1975. Its mission is to: "Plan, promote, develop and manage petrochemicals and energy intensive industrial cities through successful customer focus and partnerships with investors, employees, communities and other stakeholders."

[4] T&D losses include losses in the delivery of energy between sources of supply and consumption, including technical losses, energy pilferage and/or energy consumed but not paid for as a consequence of various factors such as non-registered consumers, un-metered electricity, inaccurate metering and billing.

[5] The term 'good power quality' is often used to describe a power supply that is always available, always within voltage and frequency tolerances, and has a pure noise-free sinusoidal wave shape (IEC 61000-4-30).

[6] Direct benefits considered in the business case analysis of smart metering deployment included – (i) reduced operating costs, (ii) improved network losses, (iii) improved billing accuracy, and (iv) the avoided replacement of traditional meters.

[7] This includes operational and capital costs, fuel, purchased energy, and depreciation costs along the entire value chain, i.e., production, transmission and distribution.

[8] State-owned enterprises responsible for generation, transmission and distribution of electricity in their respective states in India.

[9] Ring fencing is a regulatory rule requiring accounting separations so that different services provided by the same firm are treated as if they were separate companies.

[10] NEMMCO was a company limited by guarantee and incorporated under Australia's Corporations Act.

[11] Victorian Energy Networks Corporation (VENCorp), the Retail Energy Market Company (REMCO), the Gas Market Company (GMC) and the Gas Retail Market Operator (GRMO).

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About the Project

KAPSARC has initiated a regional electricity market integration research project to explore the potential opportunities that could be harnessed by developing a common electricity market in the GCC and wider MENA region. It examines a range of issues relating to electricity market integration, including the experiences of other power pools and their potential application for the MENA region. The project will focus on understanding and examining electricity market policy and legislation, market design, and structure, regulatory and system operations to identify best practices and to provide insights into policy and regulatory issues. The various outputs are intended to fill existing knowledge gaps and facilitate ongoing efforts toward regional electricity market integration.

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