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May 2020

Saudi Power Sector -
Challenges & Opportunities post Covid-19

Witnessing a period of stabilizing growth, clean energy, deregulation & market prices, and mega investments

Research Highlights:

Examining and analyzing the status of Saudi Power Sector highlighting the structural analysis, and demand and supply, existing and expected in future. The report also presents growth drivers, emerging new business models, investments required, financing sources and challenges that need to be addressed.

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Chapter 1

Executive Summary

The Saudi power consumption is around 282 Twh (terra watt hours), with residential consumers accounting for 48 % of the consumption. The Saudi power sector is facing stabilizing times as power consumption reduced in 2018 and is expected to show further decline or at the most remain flat in 2019, due to rationalization of power consumption mainly by residential and commercial consumers. The reduction in consumption is an effect of the government steps for increase in electricity prices steeply to bring them closer to prices commensurate with the real cost of power. Notwithstanding current stable conditions, the long-term outlook for Saudi power consumption is positive, though the growth rate for next 5 years may be lower than that of past two decades. At a macro level, Saudi Power consumption on per capita basis of about 9020 kwh was not very low compared to 12079 Kwh for a developed country like U.S. The higher power consumption of U.S. is due to its per capita income which is almost three times and since industrial progress of US is much higher than that of Saudi Arabia.

The power generation in the Kingdom is largely with Saudi Electricity Company (SEC) a state owned public listed company. Private sector participation in the power generation segment was allowed since 2002. Currently, over 99% of the transmission and distribution capacity is with SEC. The current power generating capacity in the Kingdom is about 76.9 GW, of which SEC accounts for 69.5%, IPPs and IWPPs[1] account for 17.7%, and Saline Water Conversion Company & Others for 12.8%. The country has 83,260 circuit kilometers (ckt.kms) of transmission network and 617,500 ckt.kms of distribution network. Public Private Partnerships (PPP) proved successful in the Saudi power sector over the last decade. The Government is likely to open the Transmission and Distribution also to private sector participation in the future, together with privatization of existing government assets in the sector.

Saudi Power sector has seen substantial reduction in crude oil for power generation by stepping up natural gas-based power generation capacity that is operationally efficient and is a cleaner fuel that aids Climate Control through much lower CO2 emissions. The Saudi government is also taking up steps to encourage and enhance solar and wind energy in a big way in the country's power generation sector. However, lower crude oil and gas prices after Covid-19 that are expected to continue atleast in the near term, the country's investments in renewables like solar and wind power might see a slowdown as the cost economics will be less favorable compared to what they were at higher crude prices. Saudi Arabia's plans also include setting up two nuclear power plants for which it is progressing with the required approval and agreements, though no substantial progress is reported.

[1] Independent Power Producers (IPP), Independent Water & Power Producers (IWPP)

The Kingdom has several bodies to regulate, develop and oversee the Power Sector. Electricity Services Regulatory Authority (ECRA) was formed to regulate the power sector and desalination industry. Water & Electricity Company was established by the SEC and SWCC to oversee the developments of IPPs and IWPPs in KSA. King Abdullah City for Atomic & Renewable Energy is mandated to contribute to the sustainable and alternative energy resources and their development in the Kingdom. King Abdulaziz City for Science & Technology is engaged in the areas of energy research.

The country's power consumption is estimated to grow in the coming years with an estimated 8.19 GW generating capacity to be added by 2024. This growth does not include impact of power demand that will grow if Electric Vehicles are introduced in the Kingdom, like in other parts of the world and as announced by UAE its GCC partner. Using long term historical growth rates, addition of 36,860 ckt.kms of transmission network and 307,650 ckt. Kms of distribution network will be required by 2024. These requirements will need investment of USD 48.6 billion during 2019-2024.

Not included in this investment estimate are the government's plan to create 43 GW of solar energy and 16 GW of wind power over next 10 years which will require mega investments to be made but cannot be accurately assessed at this point of time due to preparatory stage at which these plans lie at the moment as well as expected slowdown in progress until the comparative economics of renewables versus natural gas are reassessed in light of the post Covid 19 bearish outlook for crude oil and natural gas prices in the coming few years. Added to it, are the two nuclear plants that are proposed to be built, which are also not yet crystallized for implementation. If all these investments materialize, they are likely to make the Kingdom surplus in power generation in the coming years. Such capacity addition if implemented will enable the government to realize its plans for export of electricity within MENA countries at the initial juncture and to parts of Europe at a later stage, considering the country's comparative advantages in producing power at a lower cost compared to others. Saudi Arabia is part of the GCC Power Transmission grid that has been created. On the transmission side, the government is entering into agreements with Egypt and Jordan for establishing a transmission grid connecting Saudi Arabia to these countries. The government is also studying the opportunity of establishing grid connectivity with Europe. Such extension of the transmission network will be a prerequisite for the power exports plans of the Kingdom.

The funding for all the power sector investments that are on the anvil, poses a considerable challenge. The post Covid19 budgetary deficits being encountered by the Saudi government increases the need for financing the investments in power sector mainly through private sector projects. The government has taken and announced steps that will make the pricing commercially attractive in the power sector and suitable regulatory institutions to make the sector commercially attractive. Saudi government is also taking up several initiatives for attracting foreign investments. Also, the government's plans like increasing the investable resources of its Public Investment Fund (PIF) and investments expected from external sources like the Soft Bank (Saudi government invested USD 100 billion in the entity's fund) that are showing interest in large renewable energy investments, are potential sources of funding. It is thus crucial to attract private sector investments in the forthcoming period, local or foreign, and they will be forthcoming to invest in these projects, once the presence of a viable market potential in the local and export destinations is established.

Thus, Saudi Power Sector, having met the needs of the economy over the past few decades, is now poised to enter a new period that will require not only meeting its incremental consumption in the coming years, but to also address it's shift to cleaner modes of power generations that are being prioritized all across the world, install capacities for renewable sources of energy like solar and wind power for which it is endowed with natural resources, leverage its comparative advantage in power generation to generate non-oil export revenues, and attract foreign investments to make all this successful by becoming a more open global economy.

Chapter 2

Saudi Power Sector – Generation, Transmission & Distribution Status

Saudi power sector has grown many times over the past two decade. The three segments of the power sector namely, Generation, Transmission and Distribution are owned and operated mainly by Saudi Electricity Company (SEC), a public company listed on the Saudi Stock exchange. SEC was formed in 1998 followed by the reorganization of the energy sector in Saudi Arabia. Followed by that, all the electricity companies operating in the Kingdom under the state were merged to form this listed company. SEC enjoys the monopoly in the transmission and distribution sector of Saudi power industry. Government bodies like Saline Water Conversion Corporation (SWCC) and Saudi Aramco presently also own and generate power in the Kingdom. Share capital of SEC is predominantly held by the Saudi government institutions. Currently Power Generation is open for private sector participation as well, while transmission and distribution are held solely by SEC but are proposed to be opened for private sector participation. After the formation of SEC, Electricity Services Regulatory Authority (ECRA) was formed by the government in the September 2001. ECRA is responsible for major activities like electricity supply, project licenses, compliances, protection of rights and so on.

Power was one of the first sectors to be opened up by the government for private sector participation. The Saudi government, like its GCC neighbors, adopted the Independent Water and Power Project (IWPP) model to develop the power and water sectors. IPPs offer several distinct advantages[2] like, a competitive cost of power, predictable timing and often faster execution, and establishment of performance benchmarks. These advantages bring a phenomenal growth in IPPs. The successful implementation in 2009 of the SAR9 billion (USD2.4 billion) Shoaiba IWPP private sector project—the first of the four IWPPs—with a capacity of 1,191 MW was an inspiration for other IWPPs in Saudi Arabia. SABIC, the Saudi Arabian Oil Company (Saudi Aramco), and the Royal Commission for Jubail and Yanbu joined hands with private investors to set up a utility company, Marafeq, to expand water and power supply in the industrial cities of Jubail and Yanbu, having a capacity of over 2,000 MW. Independent Power Producers (IPPs) like Acwa Power set up capacity in the Kingdom. The formation of Marafiq in the industrial cities of Jubail and Yanbu and establishment of Water and Electricity Corporation (WEC) are considered as a major moves to privatize the regulated market of power in Saudi Arabia.

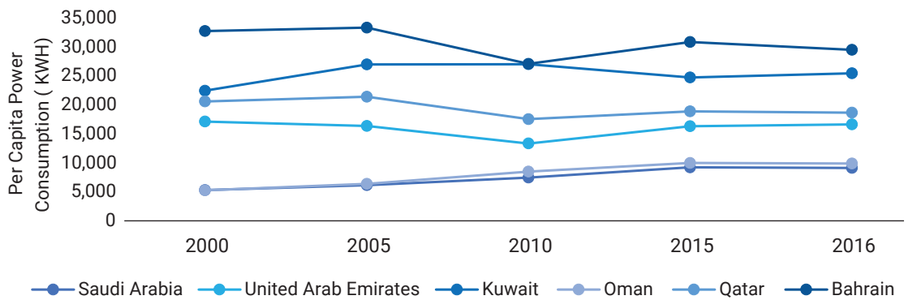
Power Consumption in the Kingdom and a Comparison with GCC Countries

The country's desert climate, like other GCC countries, makes use of power an essential need of residents for cooling and air-conditioning in summer and for heating during a part of the winter. Overall, electricity is mainly used for cooling, desalination, industrial, and domestic needs in Saudi Arabia. Natural gas, diesel oil, crude oil, and heavy fuel oil are used for electricity generation in the Kingdom. More than 70% of Saudi's electricity is consumed for air conditioning and cooling, and the summer demand is about twice the winter demand The per capita power consumption in Saudi is in the mid-range among the GCC countries and has shown signs of stabilization during the period 2010-2016 as seen from Figure 2.1.

The per capita power consumption was 9,020 KWH in 2016 compared to 12,079 KWH for United States, 29,470 KWH for Bahrain and 25,429 KWH for Kuwait. The higher per capita power consumption in the case of Bahrain may be due to its higher Manufacturing GDP (18.1% of total GDP) compared to that of Saudi Arabia (12.9% of GDP). The comparatively higher per capita power consumption of United Sates and Kuwait over Saudi Arabia maybe explained by their higher per capita income due to large proportion of locals in the population (USD 57,904 for US, USD 48,152 for Kuwait and USD 19,871 for Saudi Arabia). The good standard of living of the residents is translated into use of extensive lighting, several domestic appliances and electronic devices like TVs and Computers which consume good amount of power all-round the year.

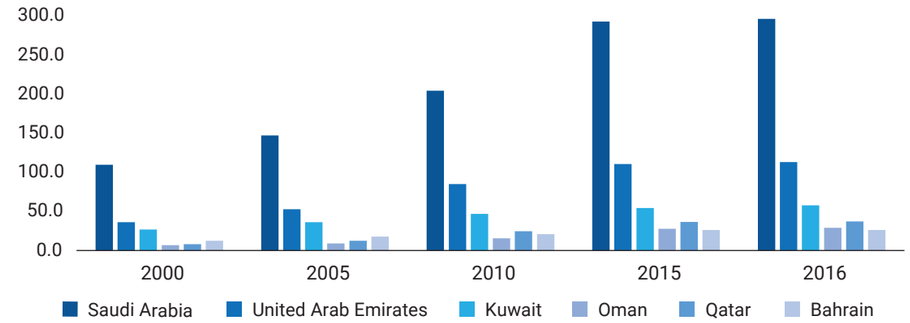
Residential power consumption is the major consumer of power currently in the Kingdom. Industrial and commercial progress has increased leading to greater power demand from these segments of the economy. This may see further rise in the coming years as the government is focusing its policies on job creation for the citizens through encouraging investments in leisure and tourism, real estate, non-oil industrial growth and service sector of the economy.

Figure 2.1: Per Capita Power Consumption in GCC Countries (KWH)



Source: Energy Information Administration, Marmore Analysis

Figure 2.2: Power Consumption in GCC Countries (Billion KWH)



Source: Energy Information Administration, World Bank, Marmore Analysis

[2] George Sarraf, Partner, Booz & Company, Capital Markets, Dec 2010.

Power Generation Capacity in the Kingdom

The electricity generating capacity in the Kingdom is 76.9 GW of which SEC 's capacity is 53.1 GW[3]. As of 2017, the licensed power generation capacity was 89 Giga Watts (GW – one GW is 1000 MW), the available capacity was 69 GW and the peak load was 62 GW. The number of customers was 9.06 million and the energy sales were 298 Twh (i.e. 298 billion Kwh)[4]. SEC accounts for the largest capacity in the Kingdom and it sees the growth of electricity demand in the Kingdom has been abating in recent years though it had increased previously many times over that in year 2000 when it was only 25.79 GW (SEC's capacity in year 2000 was only 22.1 GW).

The peak load, available capacity and number of customers by region of SEC in the Kingdom are given in Table 2.1:

Table 2.1: Peak Load, Available Capacity and Number of Customers of SEC by Region

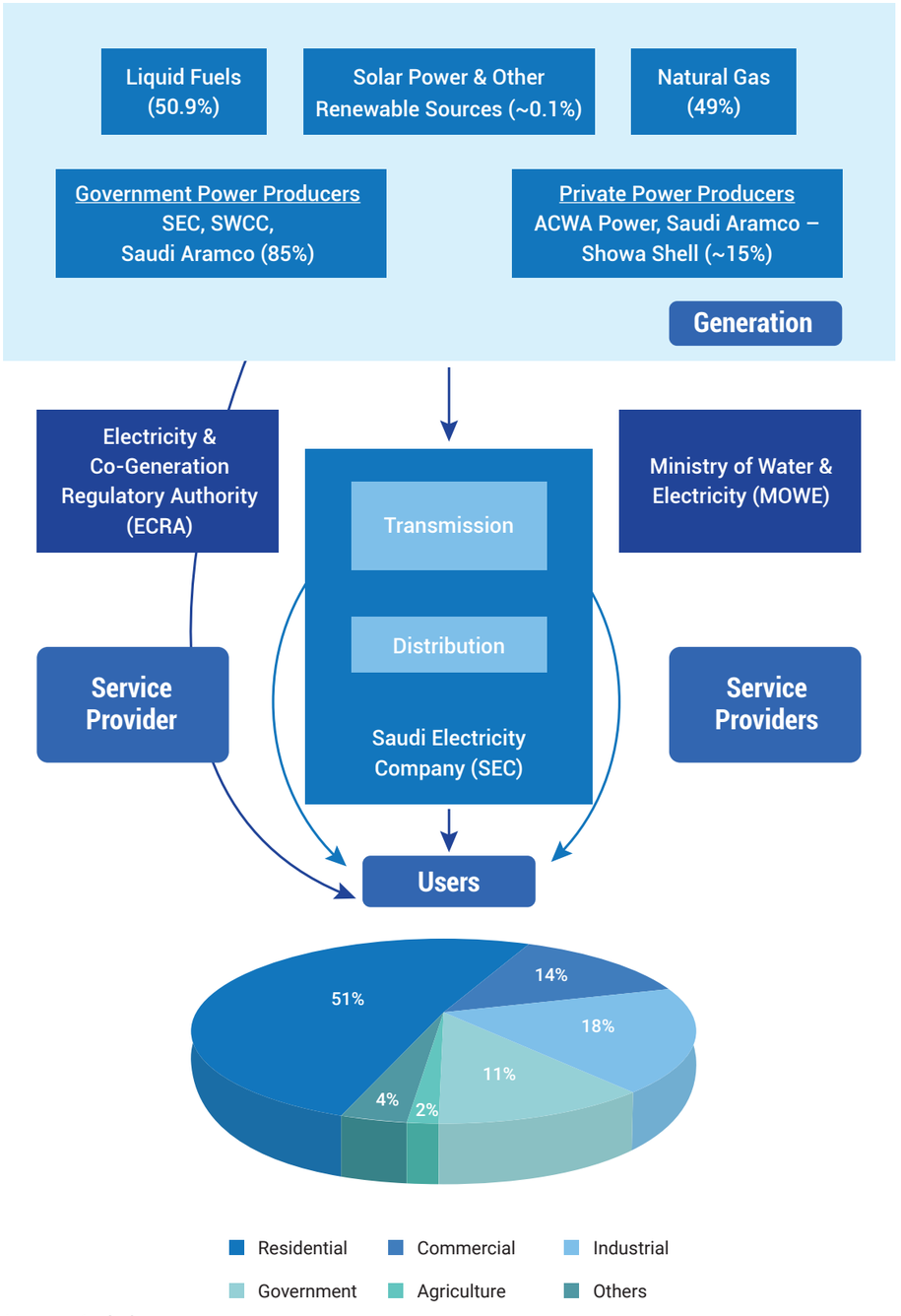
	Peak Load (GW)	Available Capacity (GW)	Number of Customers (Mn)
Central Region	20	23	2.92
Eastern Region	20	16	1.62
Western Region	19	21	3.23
Southern Region	6	4	1.30

Source: SEC Website

[3] Saudi Electricity Company, 2019H1 Investor Presentation
[4] ECRA Report 2018

Saudi Arabian Power Sector Stakeholders & Constituents

Figure 2.3: Saudi Arabian Power Sector a Structural Presentation



Source: ECRA, Marmore Analysis

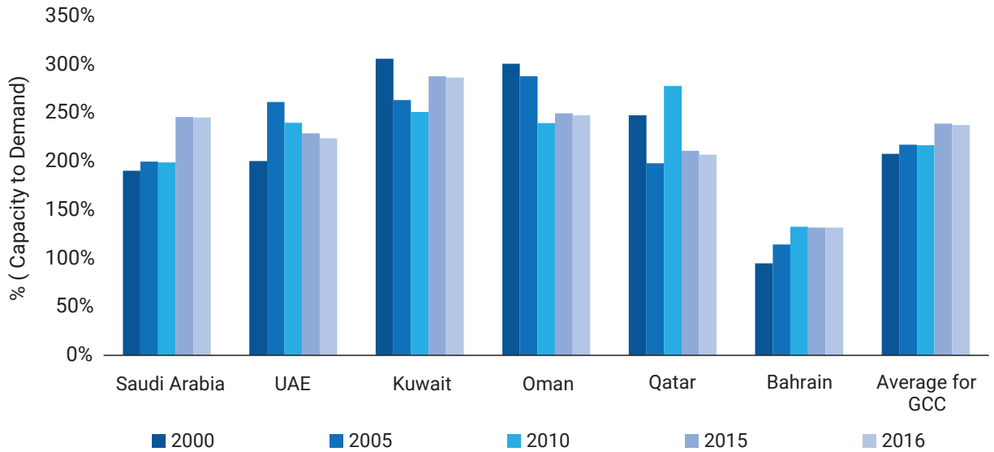
As mentioned earlier aside from SEC which is the principal supplier of power in the Kingdom, there are other government and private players. Principal among those is the Saline Water Conversion Corporation (SWCC) that started with the single purpose water plants, and gradually entered production of power along with desalinated water. SWCC is currently the second largest power producer in the Kingdom. ACWA Power International is a private developer, owner and operator of IWPPs structured on concession or utility outsourcing contract model in KSA. After announcement of privatization of desalination and power generation sector by Saudi government, ACWA Power Projects won tenders to build, own and operate five plants; Shuaibah IWPP (SWEC) and its expansion (SEPCO), Rabigh IWSP (RABEC), Shuqaiq IWPP (SqWEC), Marafiq Jubail IWPP (JWAP). Also, Bowarege was established as the owner and operator of two self-contained floating desalination plants and NOMAC was formed to provide operational and maintenance services to water and power generating facilities across the Kingdom.

Other players include, Saudi Aramco that has interests in the electricity sector also. Saudi Aramco-has a relationship with Showa Shell for solar power generation. Additionally, Saudi Aramco was one of the four major shareholders of the Marafiq (Power and Water Utility Company for Yanbu and Jubail) along with the Royal Commission (RC) for Yanbu and Jubail, Saudi Basic Industries Corporation (SABIC) and Public Investment Fund (PIF). Saudi Aramco with its tie up with Solar Frontier K.K., an affiliate of Showa Shell Sekiyu K.K. is into small scale solar power pilot projects.

Saudi Power Generation Capacity vs Power Consumption

It is worth noting that Saudi Arabia had power capacity equivalent to almost 2.5 times consumption in 2016 which shows adequate reserve capacity to meet fluctuations and peaking of load. The reserve capacity of Saudi Arabia is significant as it accounts for as much as 54.5% of the total GCC capacity. Other countries like Kuwait and Oman had slightly higher reserve capacity but they accounted for only 12.5% and 5.0% of the total GCC capacity. As mentioned earlier, Saudi Arabia is contemplating export of power in the future which will be enabled by the GCC Power Grid project completed few years ago and plans to have connectivity with Egypt, Jordan and in the long run Europe as well.

Figure 2.4: Ratio of Generation Capacity to Power Consumption in GCC Countries (KWH)



Source: Energy Information Administration, Markaz Research

Table 2.2: List of Licensed Power Capacities by Producer (As of 2017)

Name of the Power Producer	No.of Plants	Capacity in MW
Saudi Electricity Company (SEC)	40	58,224
Power & Water Utility Company for Jubail & Yanbu (MARAFIQ)	2	2,032
Jubail Water & Power Company	1	2,875
Shuaibah Water & Electricity Company	1	1,191
Shaqaiq Water & Electricity Company	1	1,020
Hajr for Electricity Production Company	1	4,098
Al-Mourjan for Electricty Production Company	1	2,116
Durmah Electric Company	1	1,756
Rabigh Electric Company	1	1,320
Saline Water Conversion Corporation (SWCC)	7	7,812
Saudi Aramco	8	2,097
Tihama Power Generation Company	4	1,643

Name of the Power Producer	No.of Plants	Capacity in MW
Rabigh Arabian Water and Electricity	1	840
Power Cogeneration Plant Company (PCPC)	3	879
Jubail Energy Company	1	250
Saudi Cement Company	2	227
Ma'aden Wa'ad Al-Shamal Phosphate (MWSPC)	1	163
Tuwairqi Energy Company	1	78
Saudi Aramco Shell Refinery	2	49
Obeikan Paper Industries Company	1	16
Total	80	88,685

Source: ECRA Report 2018

Saudi Power Generation Capacity by Type of Fuel and Carbon emissions

The power generation in the Kingdom is presently, based on crude oil, Heavy Fuel Oil (HFO), and natural gas as the primary fuel, that are available in abundance in the Kingdom. The non-fossils energy sources are just 0.04% of the total power produced. The Kingdom has a USD 300mn power plant for converting waste into electricity. In line with developments in the rest of the world, Saudi Power sector is planning to extend its source of energy to nuclear and renewables like Solar (in which the country is well endowed by nature) and Wind power that are at the initial stages currently. Saudi Aramco has collaboration with Showa Shell for solar power generation. Joint venture between Saudi Aramco and Showa Shell plans to establish projects to tap solar power. Also, Saudi Arabia's cabinet approved in March 2018 the national policy of the atomic energy program.

Further, Maher al-Odan,[5] the consultant at the King Abdullah City for Atomic and Renewable Energy (KACARE) announced that Saudi Arabia is planning to have 41,000 MW of solar capacity by 2032. Saudi Government also aimed at establishing 16 nuclear power plants by 2030. However, these plans are scaled down and it is said to be planning just two nuclear power plants of 1.4 GW each. The renewables target also is reduced to a modest 3.45 GW of renewables capacity by 2020 and 9.5 GW by 2023[6]. ACWA Power is one of the major players in the renewable energy generation sector in KSA[7].

[5] Saudi Arabia plans for USD 109bn boost for Solar Power, Bloomberg, May 11, 2012

[6] Center for energy Studies, January 2019

[7] ACWA Power projects Company Website; http://www.acwapower.com/index.php/our-investments.html

Exhibit 1: Institutions set-up to develop alternate sources of energy

King Abdulaziz City for Science & Technology (KACST)

King Abdulaziz City for Science & Technology is an independent scientific organization reporting to Prime Minister. In research related issues with energy and power, SEC is benefited from the work done by the KACST. As part of its energy research program, KACST has identified priority technology areas for development which are of foremost importance to the Kingdom.

Renewable Energy Generation

- Conventional Energy Generation
- Electricity Energy Distribution & Transferring
- Energy Conservation & Management
- Energy Storage
- Fuel Cell & Hydrogen
- Combustion

In January 2011, KACST with the collaboration of Ministry of Water & Electricity, SEC and SWCC announced its ambition to develop solar powered desalination plants. The project which is to be implemented in three phase aims at producing desalinated water in the initial phase and low-cost electricity in the final phases.

King Abdullah City for Atomic & Renewable Energy (KACARE)

King Abdullah City for Atomic & Renewable Energy is founded in 2010 with a mandate to contribute to the sustainable and alternative energy resources and its development in the Kingdom. Current focus is to capitalize on the high solar intensity the Kingdom receives. It also has plans to develop wind power and geothermal power resources. The most ambitious plan of KACARE is to establish 16 nuclear power plants with in 2030 and effectively make nuclear power as 20% contributor of the entire electricity demand of the Kingdom.

In the news report dated 1st June 2011*, KACARE announced the plan of 16 nuclear reactors to be set up in the Kingdom by 2030 with around USD 7bn per reactor. Recently, the Kingdom inked a pact with China for co-operation in development and use of nuclear energy for peaceful purposes. (However, these plans are scaled down and it is said to be planning just two nuclear power plants of 1.4 GW each).

The power capacity induced by the nuclear power plants will be a substitute for the primary energy resources required to produce that much electricity. Considering the opportunity cost of exporting the primary energy resources of hydrocarbons from Saudi Arabia and earning foreign currency, it is always better to think forward for setting up alternate power generation techniques like Nuclear reactors.

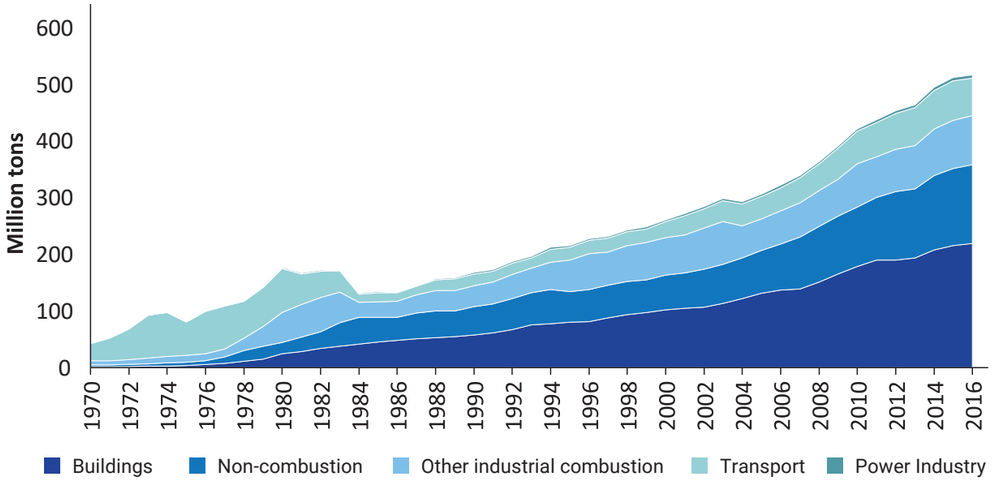
As per the KACARE, Saudi Arabia wishes to boost its solar power capacity to 41,000 MW by the end of 2032. The project of investment USD 109bn will be targeting to build 25,000 MW of solar power through mirrors to focus the sun's rays on heating fluids that turns a power turbine. The remaining 16,000 MW would come from Solar Photovoltaic (SPV) panels.

* As per Abdu Ghani bin Melaibari, the Coordinator of KACARE, Source: Arab News; Dated June 1st 2011

[1] Saudi Arabia plans for USD 109bn boost for Solar Power – Maher Al Odan, Consultant - KACARE, Source: Bloomberg, May 11, 2012

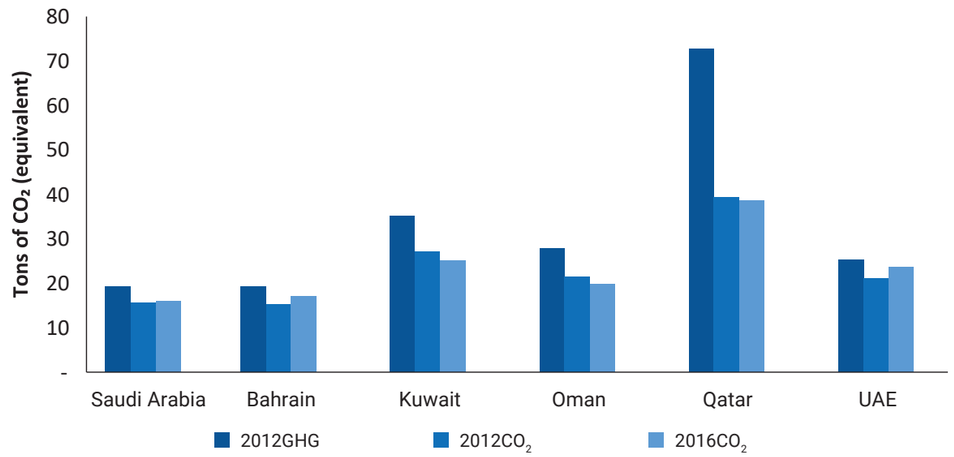
The country shift towards non-fossil fuels for power generation is also to reduce climate change impact, as the power sector is the largest contributor to the country's CO_2 emission, and this has been growing at a fast pace. As a participant in the UN climate talks and signatory of the Paris agreement of 2015, Saudi Arabia has issued a modest goal for in-kingdom GHG emissions reduction. The Saudi NDC calls for avoiding the release of up to 130 million tons of CO_2 equivalent by 2030. Data collected by EDGAR show the Saudi power generation sector alone produced roughly 250 Mt of carbon emissions in 2016 and the industrial sector produced another 86 Mt. Deregulation of fuel prices alone could reduce CO_2 emissions from the electricity sector from 160 million tons per year to as low as 72 million tons, if fuel prices and electricity prices were deregulated. Higher prices would encourage investments in energy efficiency as well as lower electricity demand by altering consumer behavior. In 2014, Saudi Aramco joined the Oil and Gas Climate Initiative, a group of 11 national and international oil companies pledging $100 million each for research into low-emissions technology for fossil fuels. Other climate control actions of the Kingdom include Saudi Aramco acquisition of Novomer, the U.S. chemistry development company, technology for converting waste CO2 into polyols and polyurethanes that can be used in finished products such as automobile seats and building insulation. The kingdom also plans strategic investments in maximizing the efficiency of the internal combustion engine, so that oil-fueled transportation remains cost-competitive with electric vehicles.

Figure 2.5: Saudi CO_2 emissions by sector since 1970



Source: EDGAR (2017), Center for Energy Studies

Figure 2.6: Per capita GHG and CO_2 emissions in GCC countries



Source: EDGAR (2017), Center for Energy Studies

Power Transmission Infrastructure in the Kingdom

SEC has a regulated monopoly position for the transmission of electric power throughout the Kingdom and its transmission network currently connects almost 99% of the Kingdom. The country as per SEC's Investor presentation of 2019H1 has a transmission network of 84,759 ckt.km(110-380KV)[8]. The Kingdom's four operating regions are almost fully interconnected through the transmission network and as at 2018 end interconnectivity of the transmission network was almost 99% with major grids in all four regions connected. SEC continues to add to its extra high voltage lines and transformers capacities. The company's extra high voltage (380KV) transforming substation capacity as of 2019H1 was 243,923 MVA. It has 213 substations and 583 substation transformers.

As of 2017, the country had transmission network of 78,000 circuit kilometers (ckt. Km) in different regions as shown in Table 2.3:

Table 2.3: Saudi Arabia's Electricity Transmission Network Size (2017)

	Transmission Network Size (Circuit kilometers)
Central Region	27,000
Western Region	21,000
Eastern Region Region	19,000
Southern Region	12,000

Source: Saudi Electricity Company

Out of the transmission network, about 50% is high voltage and 50% is of extra high voltage. During the last three and half years upto first half of 2019, SEC spent USD 16.9 billion on Transmission capex. The transmission

[8] Saudi Electricity Company 2019H1 Investor Presentation

network continues to grow though at a slower pace compared to the past when it grew many folds from only 29,631 ckt.km in the year 2000 to 84759 ckt.km in 2019H1.In 2019 the growth was only 1.66% compared to CAGR of 6.3% for the period 2000 to 2019.

Power Distribution Infrastructure in the Kingdom

SEC and government-controlled Marafiq are the two distributors of electricity in the Kingdom of Saudi Arabia. SEC accounts for 99.7% of energy sold and 99.8% of customers. SEC's distribution business is responsible for medium (13 KV) and low voltage (13.8 KV) powerlines, metering, billing, collection of payments and electrical service connections. As of 2019H1 end, SEC's total circuit length for its distribution networks stood at 660,892c. km, which comprises of medium-to-low voltage power distributions lines and low voltage lines of customers connections[9]. SEC is focusing its investment in improving the efficiency of the network by installing electronic meters and developing smart grids. The distribution transformers capacity is 273,548 MVA.

As of 2017, the total distribution network in the Kingdom of 617,000 ckt.km segregated by region was as shown in Table 2.4 :

Table 2.4: Saudi Arabia's Electricity Distribution Network Size (2017)

	Distribution Network Size (Ckt.km,)
Western Region	199,000
Central Region	198,000
Eastern Region	115,000
Southern Region	106,000

Source: Saudi Electricity Company

The country's distribution network growth in 2019 was 4.1% which is lower than the pace in previous years when it grew to its present size at a CAGR of 6.7% from size of 226,664 ckt.km in the year 2000.

SEC's distribution network currently covers 9.4 million customers compared to only 3.6 million customers in year 2000. SEC's distribution sales presently comprise of residential (41%), commercial (18%), government (22%), industrial (15%) and others (4%). During 2016-2019H1, SEC incurred capital expenditure of USD 9.2 billion for its distribution activity.

When coming to the efficiency of the transmission and distribution system prevailing in the Kingdom, good standards have been maintained throughout since inception of SEC. The current focus of KACST on research in the areas of electricity transmission and distribution can bring in more opportunities to improve the effciencies. Over the period 2000-2010, Saudi Arabia has kept average Transmission and Distribution loss at 8% of power generated and that transmitted through the grid. Average annual power loss during the period was 13.18 TWh of electricity. Transmission & distribution standards in Saudi Arabia compare well with that in developed countries.

[9] Saudi Electricity Company 2019H1 Investor Presentation

Electricity prices in Saudi Arabia vary by consumption segment and sector. The residential sector was charged flat fixed tariffs for all consumption classes until 1984. There were several price changes from 1984 onwards for different types of consumer. In 2016, four tariffs were introduced for the residential sector. The tariffs are as shown in the Table 2.5 below:

Table 2.5: Electricity Tariffs in Saudi Arabia (in 2016)

Consumption Band	Tariff Rate (Saudi Riyals per KWh)
1-2000 kwh	0.05
2,001-4,000 kwh	0.10
4,001-6,000 Kwh	0.20
>6,000 Kwh	0.30

Source: Data Insight, King Abdullah Petroleum Studies and Research Center (KAPSARC)

In pursuit of Vision 2030, Saudi Arabia launched new reforms effective January 2018. These include increasing the price of electricity substantially to rationalize its use. Electricity prices were raised for the residential, commercial and agricultural sectors in 2018, while prices for other sectors remained the same. In 2018, electricity prices rose for the low consumption brackets as a first step to improve energy efficiency and electricity conservation. The government also implemented a value-added tax (VAT) of 5% on goods and services, including water and all types of energy, such as electricity and gas. This was in line with the Unified VAT Agreement of the States of the Gulf Cooperation Council. About 48% of Saudi Arabian citizens receive full eligibility benefit from the country's Citizen's Account program, which saw 2.3 billion SAR allocated to more than 11 million beneficiaries by August 2018. The program is intended to cover some utility costs and to offset the impact of energy price increases[10].

According to the most recent fiscal plan, announced in December 2017, prices for residential, commercial and industrial electricity consumption will be 100 percent linked to international benchmark prices by 2025. In view of the large budgetary deficits due to steep fall in oil prices due to Covid-19, the measures to move electricity prices to market levels may be accelerated by the government. The power tariffs (US cents per Kwh) in the country effective January 1, 2018 are given in Table 2.6:

Table 2.6: Current Power Tariffs in Saudi Arabia

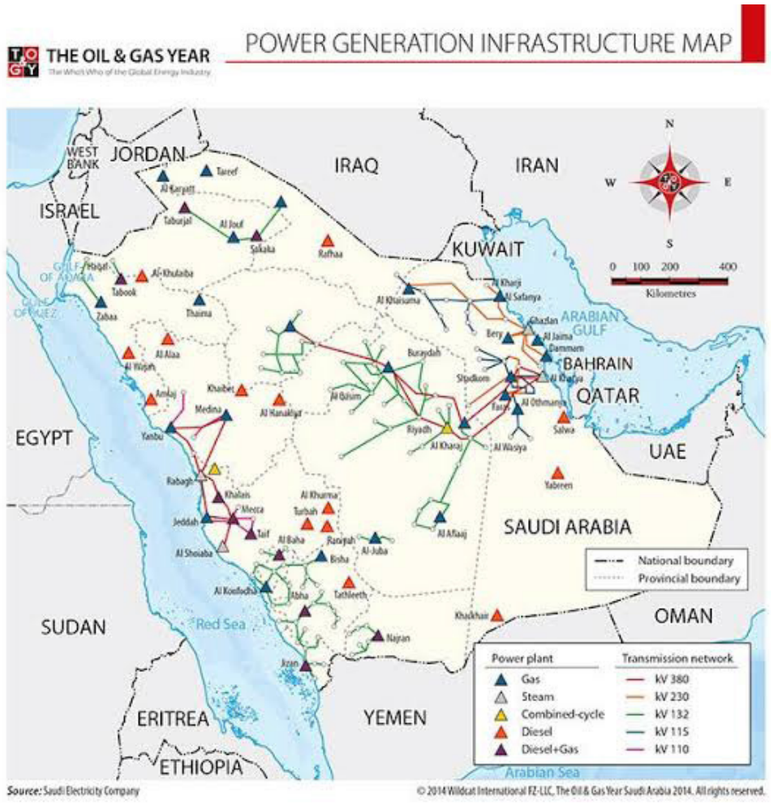
Consumption Category (Kwh)	Residential	Commercial	Agricultural & Charities	Government	Industrial	Private Education facilities	Private medical facilities
1-6000 Kwh	4.8	5.3	4.3	8.5	4.8	4.8	4.8
More than 6000 Kwh	8.0	8.0	5.3	8.5	4.8	4.8	4.8
Note: Assumed USD equal to 3.75 SAR							

Source: Saudi Electricity Company (SEC)

[10] Data Insight, King Abdullah Petroleum Studies and Research Center (KAPSARC), 2019

The country proposal to invest in solar energy in a big way will require innovative mechanisms for tariff that are to be paid to households who upload solar power produced by them to the grid. One suggestion for this is Feed- in -Tariff (FIT) Rate mechanism for solar energy that has been adopted successfully in USA and German where solar energy production is already practiced on a large scale.. KAPSARC's Data Insight suggest a FIT of SR 0.12 per KWH for the Kingdom based on the SEC tariff of SAR 0.18 /Kwh for residential customers.

Figure 2.7: Geographical locations of Power Generation and Transmission Stations



Source: Saudi Electricity Company (SEC)

Saudi Arabian Transmission and Distribution Code

The Saudi Arabian Grid Code[11] has been developed to define the rules and regulations for various participants to access and use the Transmission Grid of the Saudi Electricity Company. The objective is to establish the obligations of the Transmission Service Provider (TSP) and other Grid Users—Generators, Distribution Entities, and Directly-connected Customers—for accessing and using the Grid, specifically to:

Define obligations, responsibilities, and accountabilities of all the parties towards ensuring open, transparent, non-discriminatory, and economic access and use of the Grid while maintaining the safe, reliable, and efficient operation.

i. Define minimum technical requirements for the Participants.

ii. Set out the information exchange obligations of the participants.

The Distribution Code[12] is designed to describe the distribution structure of Saudi Arabian power structure, which comprises of mainly,

i. The Transmission Service Provider (TSP) owns and operates the Transmission System. The Transmission System transports the electricity, generated to the distribution system, through which most customers will be supplied. Some Generating Plant is connected directly to the distribution system and is referred to as embedded generation.

ii. The Distribution Service Provider (DSP(s)) is responsible for operating and maintaining secure, reliable and efficient electricity distribution system. The distribution system transports electricity from the transmission system or from embedded generating units to the final customer.

iii. Retailers supply electricity to customers. For this purpose, retailers will be entitled to use both the transmission system and the distribution system for the transport of electricity from generating units to customers.

iv. Traders supply electricity to other licensees and/ or eligible customers. For this purpose, traders will be entitled to use both the transmission system and the distribution system for the transport of electricity from generating units to those licensees or eligible customers.

v. Generators produce electricity which is fed onto the transmission or distribution systems. Generating units are classified according to their voltage, output power and whether or not they are subject to central dispatch by the TSP.

vi. Customers may purchase electricity from the DSP(s), traders or retailers. Some customers have their own generating plant for supplying all or part of their own needs. These are referred to as customers with CHP or Customers with auto-production.

vii. ECRA was established to regulate the new electricity industry.

Distribution code describes rules and provisions that are to be followed in case of any regular scenario, conflicts and other unforeseen incidents. The Distribution service provider license imposes a duty upon the DSPs to implement and enforce the distribution code. ECRA oversees various aspects of the distribution code and ensure all players follow the same. In case of any conflicts, ECRA's direction shall prevail.

[11] Saudi Arabian Grid code – Issue 01, May 2007, prepared by SEC and ECRA

[12] Saudi Arabian Distribution code – Issue 01, November 2008, prepared by SEC and ECRA

Chapter 3

Structural Analysis of Saudi Arabian Power Sector

A structural analysis of the power for the three principal segments of generation, transmission and distribution is presented in this section. The structural characteristics of power generation segment is analyzed in terms of composition of generation capacity by type of fuel and by type of generation as well as changes or shifts that are taking place in such characteristics that impact measures like generation cost and environmental impact. Other structural factors impacting the Saudi power generation sector is the shifts in size and age of plants that have implications for operating efficiencies and replacement horizons and ownership structure of the sector assets which will influence again efficiencies and ability to secure capital investments. In the case of transmission and distribution segment the composition of consumption by residential, commercial, industrial and government consumers and shifts occurring will influence the geographical concentration of consumers and hence impact the length of network and capacity as well as the peak load requirements.

Structural shifts in Power Generation by Type of Fuel and Type of Generation

Traditionally power was generated in the country using crude oil which is abundantly available in the country. However, given the technological and cost benefits accruing from use of natural gas for power generation and encouraged by the new discoveries of natural gas in the country, Saudi Power sector has moved away from liquid fuels like crude oil and fuel oil by substituting them with natural gas. In recent years, with increasing environmental concerns, Saudi Arabia as is the case globally, is accelerating the use of natural gas, which is a cleaner fuel, in power generation (Gas-driven power generation employs more efficient turbines and results in about half the carbon intensity of oil-based generation). Added to environmental concerns is the fear of non-availability of fossils fuel after some time due to their growing consumption for meeting many of mankind's needs. Therefore, globally the need for shifting to renewable energy sources like solar and wind power is well recognized and investment is being made in developing power generation from these sources, which due to technological progress, also have competitive generation costs vis-à-vis tradition fuel-based power plants. Saudi Arabia also, is following the global trend and is taking steps for large power generation from solar and wind-based power plants in the future. Saudi Arabia is well endowed naturally to generate solar power and has therefore set itself the task of focusing on a large growth of this sector. Located in the heart of the global sunbelt, the country has some of the highest solar exposures in the world; solar power plants in the region can expect 1,750 to 1,930 hours of full-load operation a year, compared to 940 hours in Germany, Next, nuclear power is an important energy source for power generation, though its growth is less globally, due to safety concerns. However, due to technological developments nuclear power plants for power generation, some countries are taking resort to this source of energy and Saudi Arabia has also announced plans to set up nuclear power plants in the Kingdom and is taking regulatory and other steps for implementation.

There are four types of power generators employed by Saudi power sector namely Steam Turbines, Gas Turbines, Combined Cycle Units, and Diesel Generators. In the Kingdom, combined cycle power plants usage is growing. A combined cycle power plant that uses gas or steam turbines or a mix of both operates a second stage since temperature of the steam or gas in the system is still high enough after completing the first stage and thereby extracts energy from the heat that the first cycle produced. By generating electricity from multiple stages, the overall net efficiency of the system may be increased by 50–60%. That is, from an overall efficiency of say 34% (simple or single cycle), to possibly an overall efficiency of 62% (combined cycle), versus a theoretical efficiency 84%. This can be done because single stage plants are only able to use a portion of the energy their fuel generates (usually less than 50%). Thus, combined cycle plants result in improved overall efficiency, reducing fuel costs. Many new gas power plants in North America and Europe are of the Combined Cycle Gas Turbine type.

Past Trends in Saudi Power Generation Capacity Mix by Type of Fuel

The data for the period 2013-2017 shows that natural gas as a primary fuel is increasingly being used for power generation in Saudi power sector. The number of natural gas-based power plants has increased at a CAGR of 4.0% (versus minus 1.7% for all types of fuels) during this period and the power generated by these power plants increased by a CAGR of 10.5% (versus +6.0% for total power generated). Natural gas as mentioned above is a clean fuel, provides better operational flexibility and has high efficiency of conversion of heat to electricity of 60% when combined with steam turbines. Natural gas-based generators increased from 239 to 280 during this period. Crude oil-based power generators fell from 275 to 260 and diesel generators fell sharply from 243 to 95 during this period. HFO based generators increased from 87 to 154.

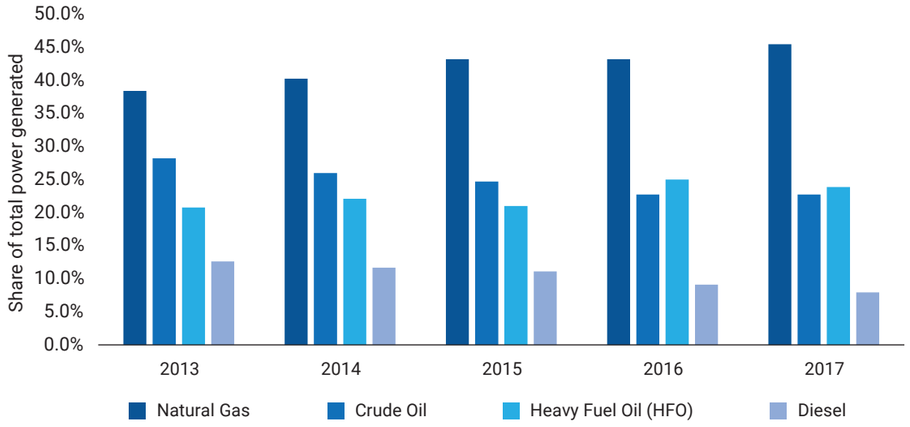
Share of natural gas-based power generation rose from 38.4% in 2013 to 45.5% in 2017. Crude oil which has higher emission of pollutants is accounting for smaller share with a decrease from 28.2% in 2013 to 22.7% in 2017 of total power produced. Diesel based power has decreased from 12.6% to 8.0%. Heavy Fuel Oil (HFO) share increased slightly from 20.8% 2013 to 23.9% in 2017 but was lower in 2017 compared to 25.0% in 2016 (See Table 3.1).

Table 3.1: Licensed Power Generation by Fuel Type – Saudi Arabia

				Giga Watts (GW)	
Year	2013	2014	2015	2016	2017
Natural Gas	27	31	35	38	40
Crude Oil	20	20	20	20	20
Heavy Fuel Oil (HFO)	15	17	17	22	21
Diesel	9	9	9	8	7
Total	70	77	81	88	88

Source: Saudi Electricity & Cogeneration Regulatory Authority (ECRA) Reports, Marmore

Figure 3.1: Change in Licensed Power Generation by Fuel types



Source: Saudi ECRA Reports, Marmore

Past Trend in Licensed Power Generation by Types of Power Generation

The licensed power generation by types of generators (Table 3.2) shows the type of power generating equipment that are being used by Saudi Power sector and changes if any of the preferred type of equipment. The data for the period 2013-2017 shows that Steam Turbines and Combined Cycle units showed steady increase during the period with a CAGR of 8.7% and 18.9% over the period respectively. Gas turbines did not show any change, while Diesel Generators showed negative CAGR of 15.7%.

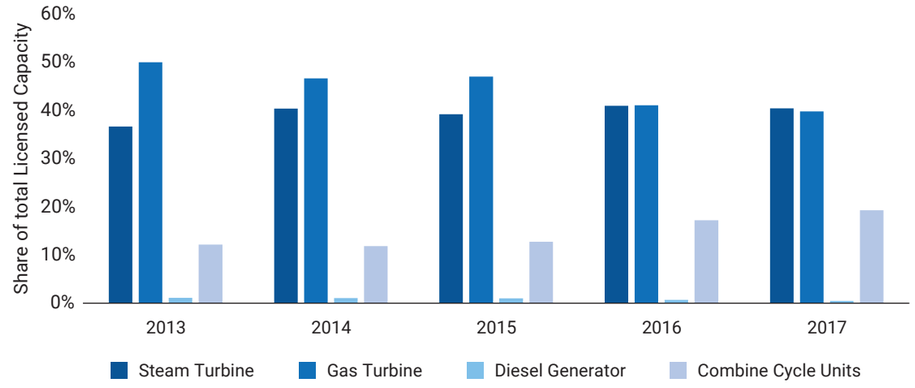
In numbers, the licensed steam turbine numbers decreased from 124 to 110, gas turbines from 585 to 507, Diesel Generators from 77 to 36. But combined cycle units increased from 72 to 122 units at a CAGR of 14.1% as compared to an overall reduction at a CAGR of minus 2.8%. The overall negative growth in number of units, while the capacity increased shows that the Capacity per unit showed an increase during the period meaning likely economies of scale. The average capacity of steam turbines increased from 209 MW to 328 MW, that of gas turbines from 59 MW to 70 MW, and combined cycle units from 119 MW to 141 MW.

Table 3.2: Licensed Power Generation by Type of Generating equipment in Giga watts- GW)

Year	2013	2014	2015	2016	2017
Steam Turbine	25.9	31.0	32.0	36.0	36.1
Gas Turbine	35.3	35.8	38.4	36.1	35.5
Diesel Generator	0.8	0.8	0.8	0.6	0.4
Combine Cycle Units	8.6	9.1	10.4	15.1	17.2
Total	70.6	76.7	81.6	87.8	89.2

Source: ECRA Reports, Marmore

Figure 3.2: Licensed Generation Capacity by Type of Generators



Source: ECRA Reports, Marmore

Saudi Power Generation Plants- Distribution by Size Classes

Size of power plants becomes important for achieving economies of scale in production and reducing the burden of fixed overhead costs or higher efficiencies in operating costs and emission control using expensive advanced process control equipment (PCE) justified only by the large sized plants. In Saudi Arabia, the situation might be that smaller plants that were economical in the past may not be commercially viable now with the current overheads like staff salaries at current wage levels that are much higher compared to that say 15-30 years back, and outdated PCE that have subpar efficiencies compared to PCE of current genre. One answer for this problem can be to dispose off the smaller generators, built in the past when wage levels were low to third world countries at their depreciated value. Investors in these countries can however find these old small capacity plants economically viable due to their lower wage levels, less stringent emission standards agreed for these countries by the global community in Kyoto Protocol and also since these countries can afford only small sized plants due to demand constraints or financing constraints or non-availability of small sized equipment by suppliers at an economical cost. With this perspective, the distribution of power generation capacity in the Kingdom by classes of capacity and by number of plants are presented Table 3.3.

Table 3.3: Saudi Power Capacity by Size Classes in 2017

Size Classes	By Number	By Capacity
< 26 MW	9%	1%
26-50MW	10%	4%
51-70 MW	30%	16%
71-100 MW	21%	15%
101-300 MW	23%	33%
> 300 MW	7%	31%
Total	100%	100%

Source: ECRA Reports, Marmore

It is observed from the table above that Saudi Power sector contains large proportion of the capacity in sizes lower than 70MW, i.e. 49% (665 total licensed plant) and 21% by capacity (total licensed capacity is 88 GW) as mentioned in the previous section. Therefore, there is good scope for taking out the small plants and replace them by large sized current generation plants, if a viable case exists based on operating economics and emission parameters of large sized new plants and existence of a viable market for the smaller size used plants in other countries.

Age Profile of the Licensed Power Generation Capacity in the Kingdom

The power generation capacity in the Kingdom, categorized by age groups has been examinedand also classified into the different types of generators like steam turbines, gas turbines, diesel generators and combined cycle plants.

The age wise generation capacity as of 2017 is given in Table 3.4:

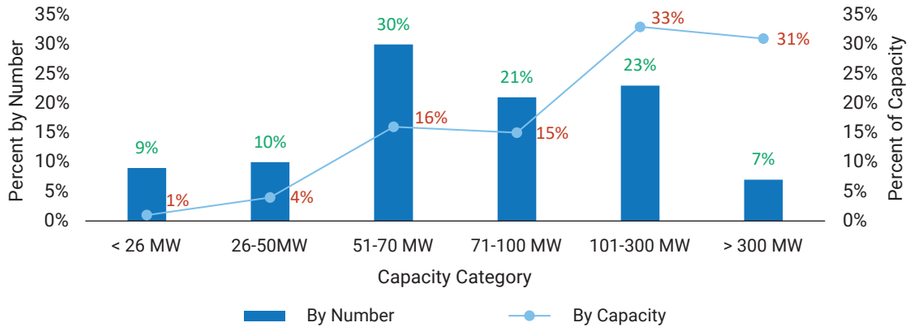
Table 3.4: Saudi Arabia's Generation Capacity by Age in 2017

Age Category (Years)	% of Capacity
Less than 5	38.0%
5-20	38.4%
21-30	6.9%
Greater than 30	16.7%

Source: ECRA Reports

Within the capacity older than 30 years given above that can be expected to have replacement requirement in the near future, SEC accounts for 74.7% while others account for 25.3% and of the capacity in 21-30 years age group 93.2% is with SEC.

Figure 3.3: Number of Generators and Generating Capacity by Capacity Buckets-2017



Source: Saudi ECRA Reports and Marmore

In 2017, the total number of power generators are 789 of which 201 (25.5%) are older than 30 years and 64 (9.6%) are between 21-30 years. 180 (22.8%) generators are less than 5-year-old. This shows that by number there are a large number of generators in the age of 30 years and above will be coming up for replacement in the future. Further, the Generating Capacity share of SEC and Others in each of the Age brackets shown in Table 3.5 reveals that Others have more of new capacity while SEC has greater share of old capacity

Table 3.5: Generating capacity by Age Categories in Saudi Power Sector 2017 (in Giga watts- GW)

Age Group	SEC (GW)	SEC (%)	Others (GW)	Others (%)	Total (GW)	Total (%)
0-5 Y	16.9	29.0%	16.6	54.6%	33.5	37.8%
6-10 Y	13.3	22.8%	6.2	20.4%	19.5	22.0%
11-20 Y	11.4	19.6%	3.4	11.2%	14.8	16.7%
21 -30 Y	5.5	9.4%	0.4	1.3%	5.9	6.7%
> 30 Y	11.2	19.2%	3.8	12.5%	15	16.9%
Total	58.3	100.0%	30.4	100.0%	88.7	100.0%

Source: ECRA Reports, Marmore

Regional Distribution of Saudi Power Sector Generating Capacity

The regional distribution of licensed power capacity presented below provides an understanding of regional differences in electricity consumption in the four regions of the Kingdom namely Western, Eastern, Central and Southern. The industrial consumption is highest in the Eastern and Western Regions that are home to major refineries and petrochemical plants that are the mainstay of the Saudi economy. The Eastern region is also the headquarters of Saudi Aramco and is close to several oil fields that are the lifeline of the Saudi economy. It also has an international airport that handles several business and leisure travelers and has an important seaport.

The Central region is the headquarters of Saudi Government and Defense Establishments and is also the home of a large urban population and number of commercial and office establishments in Riyadh the capital of the country. The Central Region also includes several prominent centers of higher education and a prominent international airport all located in Riyadh.

The religious centers of Makkah and Medina that host every year the annual Haj Pilgrimage for the entire world's Islamic population and host other pilgrimage tours during the rest of the year, are in Western Region. The Western region also includes the large urban population and trade and commercial establishments in the city of Jeddah that also use the Jeddah seaport for various import and export activities in addition to a major international airport. Yanbu Industrial City and King Abdullah Industrial City are also both in Western Region. The Southern Region which is known for its touristic destinations is also progressing on industrial and commercial fronts but its power demand is currently low.

Table 3.6: Saudi Licensed Power Generation Capacity by major Geographical Regions (GW)

Year	2013	2014	2015	2016	2017
Southern	5.2	5.2	5.3	4.9	4.1
Western	25.1	26.8	24.3	30.8	32.3
Eastern	24.3	28.7	31.3	33.5	33.4
Central	16.1	16.1	17.7	18.6	18.9
Total	70.7	76.8	78.6	87.8	88.7

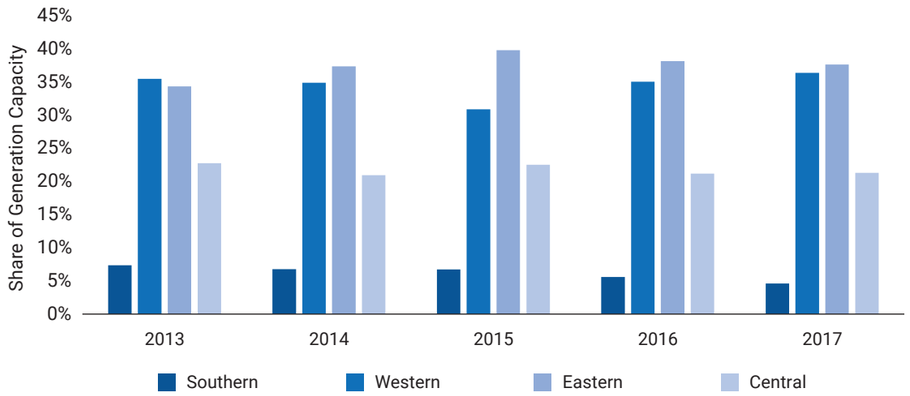
Source: ECRA Reports, Marmore

In 2017, Eastern and Western Regions accounted for the largest power generation capacity of 38% and 36% of total capacity respectively. These two regions showed a CAGR of 8.3% and 6.5% during 2013-2017 respectively. The higher growth can be due to the non-oil industrial growth taking place in the industrial cities located in these regions.

The Central region grew at a slower CAGR of 4.1% and accounted for a lower share of 21%. The comparatively slower growth in the Central Region, maybe due to slower growth of residential power demand on account of higher electricity tariffs introduced by the government in recent years, slowdown of income growth of residents dampened by government budget deficits and lower population growth in the urban areas of the region. The southern region accounted for only 7% of total capacity and showed negative CAGR of 5.7% during this period, possibly due to slower economic growth in the region caused geographical proximity to Yemen with which the Kingdom has been seeing altercations.

However, the percent shares of each region in the total power generation did not change much during 2013-2017.

Figure 3.4: Licensed Power Generation Capacity by Region during 2013-2017



Source: Saudi ECRA Reports, Marmore

Historical Trends in Saudi Power Transmission Sector

The transmission network in the country consists predominantly of overhead transmission lines having about 90.4% share in 2017 and a small share (9.6%) of undeground transmission lines. The share of overhead transmission network in 2017 was lower than that in 2013 when it was 91.8%. The total transmission network incresaed from 54,595 ckt.km in 2013 to 78,323 ckt.kms in 2017 at a CAGR of 9.4%. The growth in underground transmission lines during the period was higher at a CAGR of 13.7% and that of overhead transmission lines was slower at a CAGR of 9.0%.

The transmission network is predominantly used by SEC (57.1%) followed by SWCC (9.5%), and others (33.40%). The SEC utilization share of the network decreased during the period at a CAGR of 5.3%, while that of SWCC increased at a CAGR of 15.7% and that of others increased at a CAGR of 8.8%. Thus, it is seen that SEC is gradually becoming a smaller producer as other power generators like Independent Power Producers (IPPs) and IWPPs increase their share of the generation capacity, which is in line with the government policy of seeking greater participation of the private sector players in the Saudi Power sector. This diversity of players utilizing the transmission network also paves the way for allowing private players to operate part of the transmission network in future. The change in the utilization shares for the years 2013-2017 by producers, is given in Table 3.7:

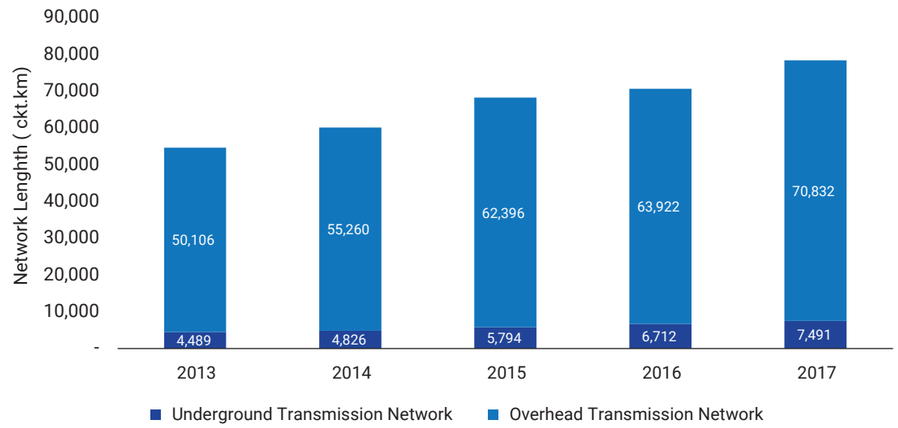
Table 3.7: Utilization of Transmission Network by Producers

Electricity Producer	2013	2014	2015	2016	2017
SEC	70.90%	69.50%	62.90%	59.80%	57.10%
SWCC	5.30%	4.50%	7.60%	9.10%	9.50%
Others	23.80%	26.00%	29.50%	31.10%	33.40%

Source: ECRA Reports 2018

The transmission losses which are dependent on the length of the network and the voltage at which electricity is sent increased from 7% in 2013 to 8% in 2015 and further to 9% in 2019.

Figure 3.5: Transmission Network Growth during 2013-2017



Source: ECRA Reports 2018

Historical Trends in Saudi Power Distribution Sector

As mentioned in the previous discussion about " Power Distribution Infrastructure in the Kingdom", SEC caters to 99.7% of energy distributed and 99.8% of electricity consumers in the Kingdom. Out of the total consumers of 9.07 million as of 2017, SEC accounted for 9.05 million and the remaining by Marafiq. Out of the total electricity supplied of 298.44 GWH, SEC accounted for 288.66 GWH (See Table 3.8).

Table 3.8: Energy Distribution- Consumers & Power Consumption 2017

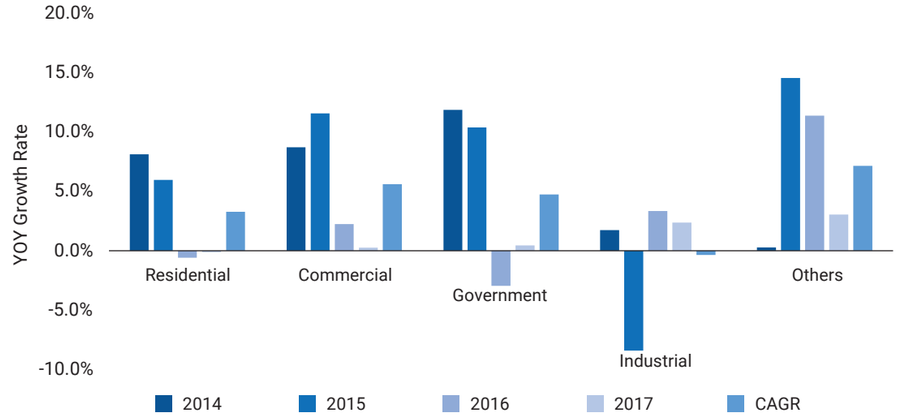
	Consumers	Power Consumption (PC) - GWH	PC per Consumer_ KWH-per year
Residential	7,103,515	143,473	20,197
Commercial	1,569,923	48,349	30,797
Government	272,713	38,666	141,783
Industrial	10,783	54,862	5,087,823
Others	112,579	13,089	116,265
Total	9,069,513	298,439	32,906

Source: ECRA Reports 2018

Growth in Power Consumption Consumers & Per Capita Consumption

Power Consumption slowed down gradually over the period 2013-2017, with annual growth rate falling from 7.0% (YOY) in 2014 to 4.8% (YOY) in 2015, 0.7% (YOY) in 2016 and 0.6% (YOY) in 2017. The sectoral growth rates are shown in Figure 2.3. The total power consumption increased by a CAGR of 3.2% during the period. However, it is observed that power consumption of Marafiq's customers increased from 6 GWH in 2013 to 9.8 GWH in 2017 at a CAGR of 13.0%. The main consumers of Marafiq are Industrial Consumers and they accounted for 78% of total industrial consumption. Marafiq accounts for 16.2% of total industrial consumption. However, industrial consumers of SEC showed negative consumption growth during the period. The number of residential consumers increased at a CAGR of 5.7% during 2013-2017, while total consumers increased at a CAGR of 6.1%. The growth of consumption was lower than growth of consumers. This shows that the consumption per consumer declined during this period and this was about 2.3% p.a. and about 4.7% p.a. during 2016 and 2017 respectively.

Figure 3.6: YOY Change in Power Consumption of Different Sectors



Source: ECRA Report 2019, Marmore analysis

Historical Trends in Saudi Power Distribution Network

Unlike the transmission network in the country, the distribution network consists almost equal proportion of underground transmission lines (having about 51.1% share) and of overhead transmission lines (having about 48.9%). The share of overhead transmission in 2017 was lower than that in 2013 when it was 50.9%. The total distribution network increased from 237,244 ckt.km in 2013 to 301,669 ckt.kms in 2017 at a CAGR of 6.2%. The growth in underground distribution lines during the period was higher at a CAGR of 7.3% and that of overhead transmission lines was slower at a CAGR of 8.4%.

Exhibit 2: Private Investments in Power Sector and Emergence of Public–Private Partnerships (PPPs) – Structural shift in Ownership structure

The Saudi as well as other GCC governments has been actively encouraging private participation in the infrastructure sector by liberalizing and privatizing major sectors like power, telecom, and so on.

In recent years, PPPs have emerged as an important alternative to outright privatization and combines the benefits of private management and government control. The popularity of PPPs has increased mainly due to the benefits of improved efficiency, higher quality, risk-sharing, and greater economies of scale offered by the private sector. Many projects in MENA as well as in the GCC region are currently being financed through PPPs.

Through long-term management contracts and operating concessions, PPPs allow private sector companies to participate in public infrastructure projects, designed to provide efficient services to the public. PPPs may be entered through the folllowing:

- Procurement of assets by the private sector;
- Formation of special purpose vehicles (SPVs) with state and private entities as shareholders;
- Service provider contracts;
- Leasing of state assets to private sectors; and
- Formation of joint ventures.

Private Participation in Infrastructure

Power was one of the first sectors to be opened up by Saudi government for development by the private sector. The successful implementation in 2009 of the SAR9 billion (USD2.4 billion) Shoaiba IWPP private sector project—the first of the four IWPPs—with a capacity of 1,191 MW was an inspiration for other IWPPs in Saudi Arabia. SABIC, the Saudi Arabian Oil Company (Saudi Aramco), and the Royal Commission for Jubail and Yanbu joined hands with private investors to set up a utility company, Marafeq, to expand water and power supply in the industrial cities of Jubail and Yanbu, currently having a capacity of over 1,000 MW.

IPPs—Advantages and Drawbacks of the chosen GCC Model

Up until the early 2000, power plants in the country were exclusively financed and developed by State Owned Enterprises. But since then there is a shift towards greater private sector participation.

IPPs offer several distinct advantages[1]: amortization of public expenditures, a competitive cost of power, predictable timing and often faster execution, the establishment of performance benchmarks, and the promotion of a favorable business environment. These advantages fuel the growth in IPPs. "Current expansion plans will more than double the region's IPP and IWPP capacity over the next five years, bringing the privately developed share of aggregate electricity generation to about 34%," said George Sarraf, Partner, Booz & Company.

The basic IPP model is consistent across the region: the amount of power to be sold is stipulated in a Power Purchase Agreement (PPA) at a fixed price; the PPA is guaranteed by a creditworthy off taker backed by the government, and the price of fuel is fixed by contract. The model eliminates market and fuel risk for the IPP developer, and the remaining risk consists of difficulties the developer might encounter with financing, construction, and operation. "This modest risk profile permits IPP developers to use limited-recourse, high leverage project financing schemes, with debt ratios averaging 75% and reaching as high as 85%. Consequently, IPPs have been exposed to the global credit crunch; although there have been recent adjustments to financing terms, they have not fundamentally stopped IPP growth," said Walid Fayad, Partner, Booz & Company.

One drawback of this financing model is that governments accumulate liabilities. Also, current IPPs are biased toward baseload power generation, as opposed to mid and peak load plants. While efficiency, brought about by IPPs in baseload power is around 3%, it is estimated that it could be as high as 30% for mid and peak loads because of the stop and start nature of operations. Hence, a substantial proportion of the economic gains of IPPs are being foregone.

The third risk of IPP dependence is that it can prevent much needed future liberalization. If IPP investment increases, GCC nations may find themselves with power generation assets that are locked down in long-term PPA contracts. To mitigate this rigidity, Booz recommends that governments could include buyout mechanisms in the contracts. GCC authorities could also encourage IPPs to secure contracts with additional buyers, such as long-term industrial customers. Diversifying a plant's end-users could reduce the magnitude of governmental obligations to IPPs. Governments should empower IPPs to sell excess electricity not just to the network but to other industrial users.

We thus come to the multiple-supplier model mentioned earlier (latest structural change— distribution) for consumers. This would also help to make power production and distribution more efficient for industrial users, making it economically beneficial for all stakeholders.

[1] George Sarraf, Partner, Booz & Company, Capital Markets, Dec 2010.

Power Sector Business Models – Generation-Transmission-Retailing

Electricity supply is an essential requirement for retail consumers, industrial users and commercial establishments. The usage and availability of power supply therefore increases directly with economic growth of an economy or a country. Advances in energy efficiency reduce energy costs and contribute to improved competitiveness. The electric supply or power supply that reaches the users' end has to pass through three important steps namely (i) Generation (production), (ii) Transmission (transportation of electricity from the source of generation to many central points close to the geographical locations of the users) and finally (ii) Distribution (or retailing) to the end users premises in a form that the end user requires to make productive of the power i.e. electricity.

Traditionally electric utilities which were government owned in most countries handled all the three steps of electric supply namely Generation, Transmission and Distribution through a single public corporation. Such public corporations provided electricity to the end users i.e. both retail, commercial and industrial consumers at government determined rates that were not necessarily commercially viable prices. While this worked well in initial years, soon as the economies grew in size and the public bodies became monolithic, it resulted in subpar performance whether it was in operational parameters like plant load factors in power generation, distribution losses in transmission of power or billing and collection or meeting supply targets in terms of investing in new capacities, reaching all corners of their geographical boundaries, or providing quality and reliable supply during all parts of the day. These inefficiencies directly affected the bottom line or profit requirements of these corporations leading to all round stagnation of growth and development posing difficulties to the economic growth of the countries as power is a crucial determinant of economic prosperity.

Here we address the emerging business models for the power sector. Business models focus on ways of diversifying risk, improving operating efficiencies and overcoming financial barriers to investing in power sector. It was realized in many economies that the success factors, staffing and business models governing each step i.e. Generation, Transmission and Distribution were different and required different business models to make them succeed. Therefore, the logical move was that all three activities were separated into independent corporations or companies, though still being predominantly in the government fold. The changes moved further in this direction as in the last few decades all round consensus emerged in all sectors, including in power sector, that private enterprises brought in greater innovation, productivity and managerial competence as compared to government enterprises bound by bureaucratic procedures and practices. This led to the advent of greater private sector role in the power sector globally.

Business models are ownership models, which focus on financing and risk mitigation concerns; or service models, which focus on providing specified services and highlight different methods of operation and maintenance. The most appropriate business model for a given project will depend on local conditions, the

financial and regulatory environment, and the institutional framework and support mechanisms in place. The choice of the appropriate business model will thus depend on (i) product or service considerations, (ii) the scale of the project, (iii) the consumer, and (iv) the regulatory environment.

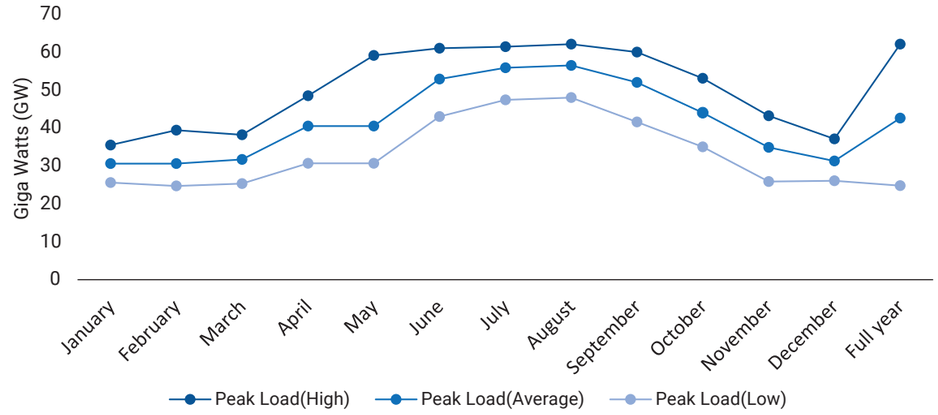
GCC power sector, including Saudi Arabian power sector is not very old like that in some of the older nations, but it had similar beginnings and evolution like the rest of the world as it passed through Government owned power utilities that combined generation, transmission and distribution. Also, all were initially government owned. But in the recent years GCC governments including that of Saudi Arabia are transitioning towards the global model of separating the three stages of electricity supply. In addition, governments are reducing their role in ownership of these investments and seeking greater participation of private sector in partnership or totally. The implications of these shifts in ownership and services of Saudi power Sector on the business models for the players is expected to be as follows.

Business Model Architecture in Power Generation

The goals of power generation companies are to provide reliable, continuous, and priced electricity to its customers serviced through the transmission and distribution network companies. The business models now focus on ways of spreading risk and overcoming financial barriers to investing in renewable energy and energy efficiency projects, and secondly in the provision of services to facilitate such investment

Power demand is generally not uniform throughout the day as well as throughout all seasons of the year (see Figure 4.1: High, Average and Low Peak Load by Month – National Transmission Grid). For the full year 2017 the high was 62.1 GW and the low was 24.8 GW. Therefore, if its output is not managed well it will lead to swings in demand that will impact the production efficiency of the power plants and makes it difficult to keep the production cost low. This makes Demand Management a very important component of the Power Generation Business Model. Some of the solutions can be to create power storages through power banks or use of gas turbines over steam turbine plants that can be managed with higher turndown ratios. Diesel generators that can be started and shut down easier than coal-based steam generators can help manage swings in power demand but are not clean and efficient. So also, is the case with hydroelectric power generation that facilitates flexibility in varying the output but is not relevant in the Kingdom. In modern society when daytime power requirements in offices offset part of the higher residential demand at nights there is some reprieve for demand management in power generation. If electric vehicle population that is expected to show sizeable increase in the coming years can be equipped to permit spare batteries that are charged during day light, then that will offer a good solution to equalize power demand during daytime and nighttime. Solar power generation that generates power during daytime and supplies power at nighttime can be another means of solving the demand imbalance. Thus, so long as retail or some of the industrial demand is more at night than day, power demand management will be a challenge, but the bright side is that technology may provide solutions to this problem in the future.

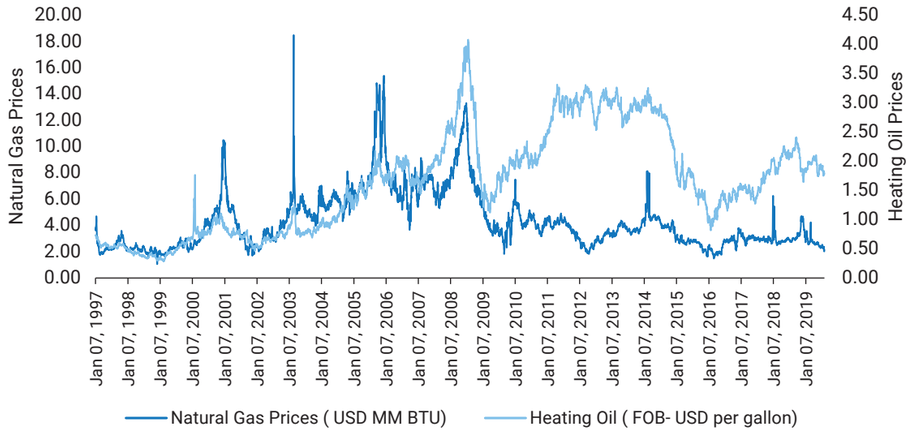
Figure 4.1: High, Average and Low Peak Load by Month – National Transmission Grid (2017)



Source: ECRA Report 2018, Marmore

Gas, Crude Oil, Fuel Oil are the main fuels used by the Power Generation plants in Saudi Arabia. These commodities undergo frequent fluctuation in prices while the cost of power supplied is generally fixed for a period, exposing the Power Generators to variations in profit margin beyond their control (Refer to Figure 4.2: Fluctuations in Prices of Natural Gas and Heating Oil). As a result, Commodity Price Management is an important component of their Business Model. Generation Companies therefore need to manage this risk optimally to deliver profits and ensure their operations are viable. One approach to the problem is to negotiate long term contracts with the fuel suppliers at a fixed price that matches in duration with their Power Purchase Agreement with the buyers of electricity. Using such arrangement and corresponding price agreement with their customers, the variations in profit margin can be managed. However, such an arrangement with suppliers may always not be feasible. Therefore, power suppliers need to have alternative approaches to handling price mismatch risks, like arming in-house management with skills to enter into and manage forward contracts for fuel purchases, or alternatively negotiating fuel price linked power prices with customers. While this is in existence in developed countries, GCC power generators are restricted by Sharia restrictions on trading of derivative contracts, absence of derivative markets and consequently lack of adequate local managerial talent to manage these complexities.

Figure 4.2: Fluctuations in Prices of Natural Gas and Heating Oil



Source: US Energy information Administration

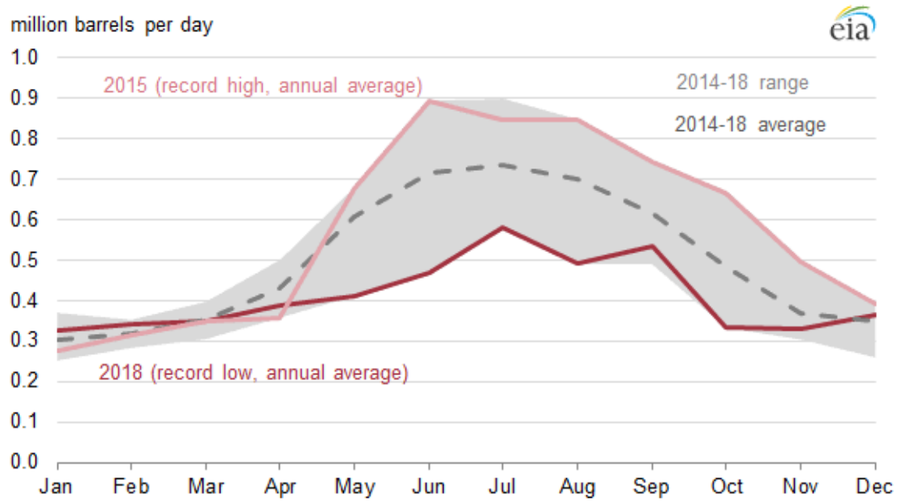
The third important component of the Business Model of Power Generators is managing the cost of Capital Goods (say Turbines) required for power generation. This equipment is expensive and account for a large share of capital investment required. Further, as the equipment has a long life their cost can be recovered only over a long time period. Attracting debt capital for investing in such assets for a long period becomes difficult and exposes the investor to interest rate risks. To manage this risk, Power Generators can explore long term lease of the equipment say gas turbines (as is being done in leasing of aircrafts by airlines leasing in modern times) from the manufacturers which will reduce the burden of excessively large investment and the need for long term debt financing of the assets.

The fourth important component of the Business Model of Power Generators is managing the Climate Control regulations on account of emissions in power generation. GCC countries have ratified the Kyoto Protocol in early 2005, except for Bahrain, which ratified the Protocol in January 2006.The world is moving towards bettering Kyoto Protocol through a similar Paris Agreement to which many countries have given their commitment. As a result of the Climate Control regulations, world over, there is concerted effort to reduce carbon emissions. Though the GCC nations emit only around 3% of the world's carbon, on a per capita (pc) basis, they are all in the biggest 15 countries. Qatar is the highest pc emitter at 6.7 tons. The US emits 5.6 tons (pc) of carbon dioxide. Saudi Arabia, Kuwait, and Bahrain all emit around four tons (pc) of carbon. A mitigant is the Saudi Aramco recent announcement that it has developed converge polyols technology that takes the greenhouse gas Co2 and combines it with abundant hydrocarbon feedstocks, to create high performing polyols for use in everyday applications: coatings for household appliances, consumer and industrial adhesives, automotive and medical applications, food packaging, and more[13].

[13] Zawaya, August 25, 2019- Saudi Aramco to reuse CO2 emissions.

Addressing climate control objectives, generators are however, increasingly moving towards higher proportion of power generation using cleaner fuels to begin with by converting to gas based power plants and in the long run to shift towards greater percent of electricity generation to come from renewables like solar, wind and hydroelectric and nuclear fuels as well. Saudi Arabia has reduced its use of crude oil in power generation (see Figure 4.3: Saudi Arabia direct use of crude oil for power generation) and is shifting towards greater use of natural gas. It is also taking up projects based on nuclear power and usage of renewable power sources like Solar and Wind power. In the previous discussion on "Past Trends in Saudi Power Generation Capacity Mix by Type of Fuel" relevant statistics pertaining to shifts in composition of fuel types for power generation in Saudi Arabia were presented.

Figure 4.3: Saudi Arabia direct use of crude oil for power generation (2014-2018)



Source: U.S. Energy Information Administration, based on the Joint Organizations Data Initative

Business Model Architecture in Power Transmission

Transmission is a critical element of the electricity value chain. A well-developed transmission network helps in efficient evacuation of electricity from generating stations for transmission to the demand centres.

In current times, the Transmission Business Model that was serving a single power producer has instead to provide for shared utilization of the Transmission Network. With privatization of power producers in Saudi Arabia, there are several power producers other than the state-owned power producing companies in the country. Earlier, transmission activity was primarily catering to a single power producer, but with the multiple power producers currently it has become necessary for Power Transmission businesses in the Kingdom to provide shared services for power evacuation and transmission. The Business Model for Power Transmission therefore requires more sophisticated Distribution Management to address the needs of multiple power producers acting independently of each other. The Distribution has now to be done in an efficient and seamless

manner, meeting the differing loads at different times and measuring output to determine the transmission charges for each of the power producers. Also, the transmission tariffs need to be managed to factor swings if any in power evacuation needs, in case the Transmission company desires to provide tariffs that are linked to changes in network dependence and usage parameters.

Presently power transmission is still controlled by state owned companies in Saudi Arabia. The Kingdom plans to privatize some or all the state-owned generation assets. A proposal to break up state-owned utilities firm Saudi Electricity Company into four independent power-generation units and an independent transmission company is under review since 2016. Therefore, if power transmission is privatized it will entail change in Transmission Business Model to make it commercially attractive. Like power transmission, power transmission assets also have long life above 35 years, compared to conventional industrial assets that generally last for 10-15 years. The Business Model for private players therefore must seek alternative supplemental revenue streams like real estate and advertisement revenues where feasible along the transmission network for which the concession is granted to them, to improve their viability. The private businesses also need to source long term finance at a low cost which may require negotiating a long concession period and credit guarantees or tax concessions to subsidize the higher financing costs demanded for commercial borrowings. Also, negotiation of concession terms needs to include inflation linked transmission tariffs to ensure commercial viability for private players.

Business Model Architecture in Power Retailing

Electricity distribution and retailing is also still with the state-owned enterprises in Saudi Arabia and other GCC countries. The electricity tariffs were highly subsidized for decades. However, as mentioned above these conditions may change as the government is moving towards economic pricing of electricity in the interest of long-term sustainability of the sector and for attracting capital investment to the sector, which requires the investment to justify commercial viability criterion. The government, as mentioned earlier, has allowed private sector ownership in power generation. With the reforms taking place, private sector distribution is likely in future. Given these conditions we delve briefly on the implications of private sector participation on the business models for distribution (retailing) of electricity.

In developed countries also electricity distribution did not change much for many decades. Then, in 1990, deregulation came into force in many developed countries. The nature of electricity retailing thus changed from an administrative function within an integrated utility to become sales and marketing function as well as a risk management function within a competitive electricity market.

This new market in these countries has taken many forms. The list below highlights the latest reform in the distribution in developed countries, as Saudi Arabia is likely to adopt a similar pattern for its power distribution sector.

a. The producers sell their production in bulk to several independent retailers (who become the suppliers to customers, households, or businesses);

b. Users can switch suppliers (and even encouraged to do so) in the interest of competition;

c. The role of the retailers is to provide fixed price to their customers while managing the price risk by purchasing electricity at variable prices through a bulk contract, on the spot market, or even by speculating on derivatives, that is, futures;

d. Customers have the choice of different rates (e.g., lower nighttime tariffs during off-peak hours since a higher proportion of power consumption is used by industries during the day in industrialized countries) to help alleviate the problem of usage at peak times;

e. Customers can also choose to pay a higher price for their electricity if it is “green,” that is, sourced from renewable energy;

f. With microgeneration (home production from solar panels and wind turbines, for example), a household can sell surplus electricity (usually in summer).

The GCC countries including Saudi Arabia aim to reach the same level of reforms as the industrialized countries in retailing. Reform in the power sector means different things to different countries. There is no unique model to fit all countries, even within the GCC. Regardless of the model chosen, it implies, to varying degrees, separation of generation, transmission, and distribution (vertical unbundling), privatization or increasing private participation as well as the establishing of an independent regulatory body.

Distribution is the ultimate part of reforms in the sector. Reduction of the large subsidies, to bring the end user prices closer to production costs is the first step, though this is socially and politically unpopular. Saudi Arabia increased electricity prices to consumers in July 2010 and again in recent years. The electricity sector reform for Saudi Arabia envisages three stages: the need for unbundling and competition in power generation, wholesale competition in purchase and sale of electricity, and retail competition in marketing electricity to consumers.

Chapter 5

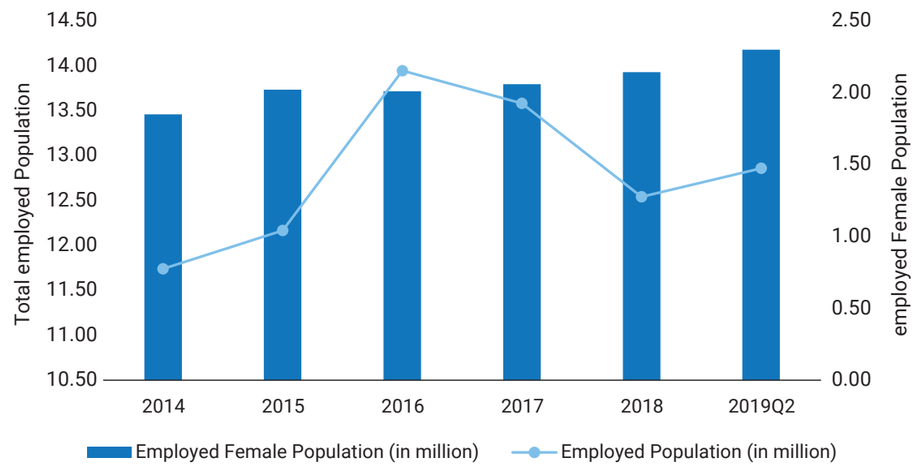
Factors Influencing Growth of the Power Sector in Saudi Arabia

Power sector as mentioned earlier is essential for economic progress of any country and power consumption is a barometer of economic development. With the industrial revolution of 1800s electricity replaced gross human labor with power driven equipment, brought a sharp rise in human productivity and standard of living and reduced working hours and improved the working conditions of the population at large. Electricity today powers many appliances that meet needs of the population in their quest for knowledge, prosperity and comfort. GCC including Saudi Arabia, which are nascent countries have leapfrogged many stages of development compared to many developed and developing countries and boast of world class infrastructure of which their Power Sector is one. Saudi Arabia's per capita power generation compares well with other countries and is poised to grow further as the economy transcends to higher levels.

Power Consumption to be led by Nuclear Families, Digital Age and High-Income Expatriates

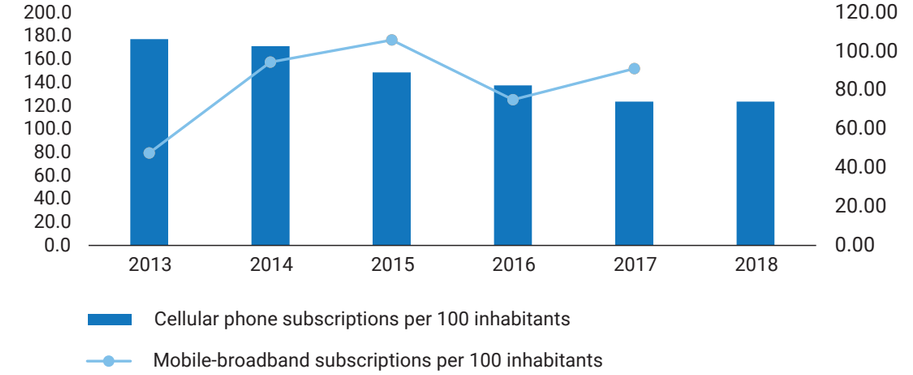
In Saudi Arabia residential power consumption is the largest power use segment so far. The growth in this segment is driven by population growth, increase in households due to urbanization, and widespread use of home devices and appliances like TV, Audio devices, Air conditioners, Heating appliances, Vacuum cleaners and Internet & Mobile phones. The devices used and their usage are growing, aided by improvement in household incomes, educational progress and most importantly government subsidized power tariffs. While subsidized power tariffs that will disappear fully soon will be a dampener to growth, other enabling factors may continue to prevail. These include population growth and increasing households due to nuclear families, though both may now be at a comparatively slower rate. Other enablers that will continue are household income growth due to educational progress, economic progress and the recent steps for encouraging higher female employment opportunities, continuing increase in youth population segment which has propensity for greater use of applications requiring electricity. For instance, the working female population has increased by over 1.84 million over 2005-2015 and it grew at 9.4% in 2015 as against CAGR of only 4.2% for 2005-2015 (see Figure 5.1: Employed Population Growth in Saudi Arabia).

Figure 5.1: Employed Population Growth in Saudi Arabia



Source: Saudi General Authority of Statistics, Marmore

Figure 5.2: Per Capita Mobile Broadband Internet & Mobile Users in Saudi Arabia



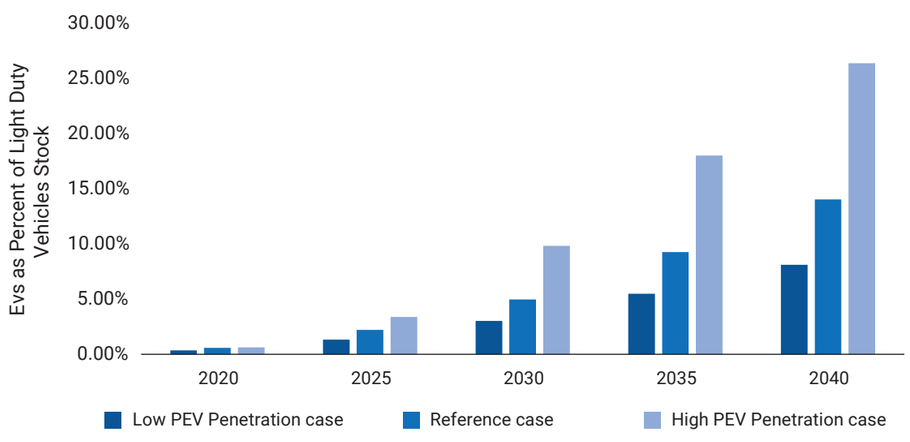
Source: Saudi General Authority of Statistics, Marmore

Mobile phone users per 100 inhabitants in Saudi Arabia has however decreased to 124 in 2018(See Figure 5.2) as per Communications and Information Technology Commission (CITC). Greater use of Smart Phones, though they require small power consumption individually, can add a sizeable incremental future power consumption in the country due to large numbers of devices in total. The intensity of smart phone usage is increasing led by extensive use of applications like E-commerce and digital entertainment and expected future use of IoT devices that will be enabled by introduction of 5G services. (See Figure 5.2: Growing population, Internet & Mobile Users in Saudi Arabia). It is worth noting that globally, direct internet electricity use is stated to account

for 10% of world electricity consumption[14]. Of all the different network components the ones that consume the most electricity are end user devices. The second largest power users are the data centers. Per unit, the end user devices, don't use much power, desktops and notebooks run on 200 and 70 kWh/year respectively and mobiles and tablets use 2 kwh/year and 12kwh/year respectively. But the numbers worldwide are 1.6 billion connected PCs and notebooks and 6 billion mobile devices. No doubt, the energy efficiency of computing has doubled every 1.5 years for more than six decades[15]. However, this is expected to be more than offset by higher intensity of usage and simultaneous usage of two or more devices per person. More usage of IT Infrastructure and IT based services and commerce can be expected as a fall out of the Covid-19 and the social distancing and lock-down experienced by the society and businesses at large all over tvvhe globe.

Finally, a steep rise in power consumption can be expected with advent of electric vehicles that are being encouraged by the Governments as a solution to use green energy. There is expected to be a worldwide shift towards electric vehicles in large numbers, which can be expected to happen in Saudi Arabia as well. (Refer Figure 5.3: worldwide Plug-in Electric Vehicles (EVs) as % of Light Duty Vehicle Stock).

Figure 5.3: Worldwide Plug-in Electric Vehicles (EVS) as % of Light Duty Vehicle Stock



Source: US Energy Information Administration

Next, the Saudi government's policy to attract high income expatriates to join the company's economy will also have a positive impact as their per capita power consumption will be much higher than that of some of the expatriate segments who have left due to refusal of resident permits and Saudization of jobs in the country by the government. Noteworthy observation is that most of the uses of power in the future, discussed above, will require increase in connected load (generation capacity required to meet peak load) much more than the increase in power consumption as the requirements will be more intermittent than continuous all parts of the day.

[14] www.elektormagazine.com, Jon Koomey and Eric Masanet at Google's 'How green is the Internet?' summit, June 2013

[15] www.elektormagazine.com, Jon Koomey and Eric Masanet at Google's 'How green is the Internet?' summit, June 2013

Economic Diversification & Private Sector Industrial Growth to drive Saudi Power Sector

Saudi Arabia a predominantly oil exporting economy is charting new directions of growth to become a well-diversified economy by enhancing production of value added petroleum derivative products for exports, increase in mining activities given its rich mineral resources, increased manufacturing and production of building materials sector fueled by steps to increase home ownership and boost to construction activities as it builds new cities to develop domestic tourism. For example, with a total area of 26,500 square kilometers, NEOM an industrial city to cost USD 500 billion in north west, will focus on industries including energy and water, biotechnology, food, advanced manufacturing and entertainment. The country had USD 112 billion of non-food imports in 2017 notwithstanding USD 57 billion (in 2010 prices) non-oil manufacturing GDP in 2017. This shows the additional potential for future non-oil industrial growth through import substitution-oriented manufacturing in the country. All these economic activities require electricity in their execution and production and will therefore drive the growth of the power sector going forward.

The oil sector that is presently in government fold to a large extent is also expected to witness growth as the governments intends to increase production of refined products to replace crude oil exports, to achieve higher value-added exports. Refining capacity that will be set up will add to the additional power needs of the country in the coming years.

Also, the digital applications growth can be expected to foster growth of power demand as the requirement of servers in data centers that have high electricity consumptions can be expected to add to power demand particularly as the use of internet based applications grow with greater use of E-commerce, e-entertainment, e-banking, I-cloud, blockchain technology etc. and as the government may demand local data storage from a security and strategic perspective as is being seen in some other countries.

Commercial and Infrastructure Power Demand in Saudi to Grow in the Future

The Saudi government priority to increase leisure and tourism within the country is resulting in many entertainment avenues like multiplexes and building of entertainment theme parks across the country and this can be expected to add to the country's power demand in the coming years. More offices being built and expected increase in employments opportunities being planned for the growing youth population as well as for greater induction of female population in the labor force, will mean greater power consumption for needs like office air-conditioning, and greater transportation needs for the office going population. Also, the continuing growth of shopping places and increasing footfalls at these destinations can be expected to continue due to the additions to the population and increase in the number of households.

The construction of new transportation infrastructure for the urban population like the new metro rail network in urban areas driven by electric power can be expected to lead to a greater share of the population using this mode of transportation adding to the electricity demand in the future. Other infrastructure segments like Railways that are seeing large investments for expansion in the country both for passenger and goods transportation will add to the growth in power needs of the country.

As a result of the above, the commercial and infrastructure power demand can be expected to see increases in the future, though Covid-19 has raised concerns about possible slowdown of growth of commercial real estate and tourism demand at least in the short term. There will be more clarity on this once the mankind's efforts to develop a vaccine for this virus is successful.

Increase in Government Power Demand to Add to Growth in the Future

The digital applications influence just not the individuals and private industries and establishments but also the various wings of the government in areas like governance and defense. Therefore, with increasing digital application in uses like e-governance, civil security and defense the power demand of the government for operating data centers and computer centers can be expected to see an increase in future and will therefore contribute to growth of the country's power sector. This is expected to accelerate and increase in view of the government's experience consequent to Covid-19.

Plans to Export Power to MENA countries may also drive Saudi Power sector

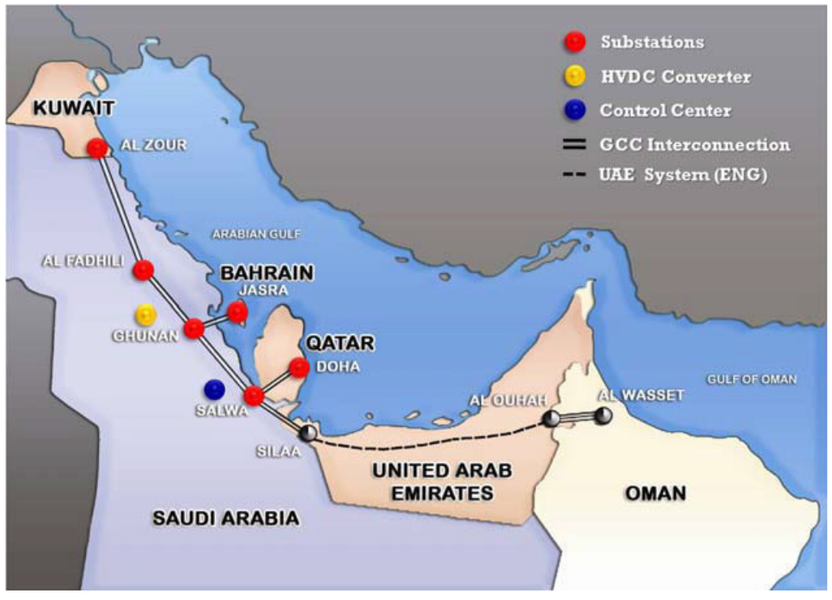
The GCC countries have implemented a power grid project, linking all the power grids of all six member states. The GCC countries look to harness the surplus power-generating capacity in each Gulf state and create an adequate and reliable power supply system for the region through the formation of the power grid. Considered a fundamental step toward the liberalization of a regional power market, the new power grid would enable GCC states to export or import electricity during seasonal fluctuations. Energy trading in the GCC Power Grid is further regulated through the Power Exchange & Trading Agreement (PETA). GCCIA board will oversee the work of Regulatory Advisory Committee (RAC) which will function as the regulatory body for the power exchanges and trading in the GCC Power grid area. The GCC grid is expected to save participating countries more than US$5 billion in electricity costs over the next decade (Refer Table-5.1 for GCC Power Grid Investment, Figure 5.4 GCCIA Project Map and Figure 5.5: GCCIA Power Grid electrical Map).

Table 5.1: GCC power grid Investment

Consumers	Nominal value invested (US$ mn)	Holding (%)
Saudi Arabia	347.6	31.6
Kuwait	293.7	26.7
UAE	169.4	15.4
Qatar	128.7	11.7
Bahrain	99.0	9.0
Oman	61.6	5.6
Total	**1,100**	**100**

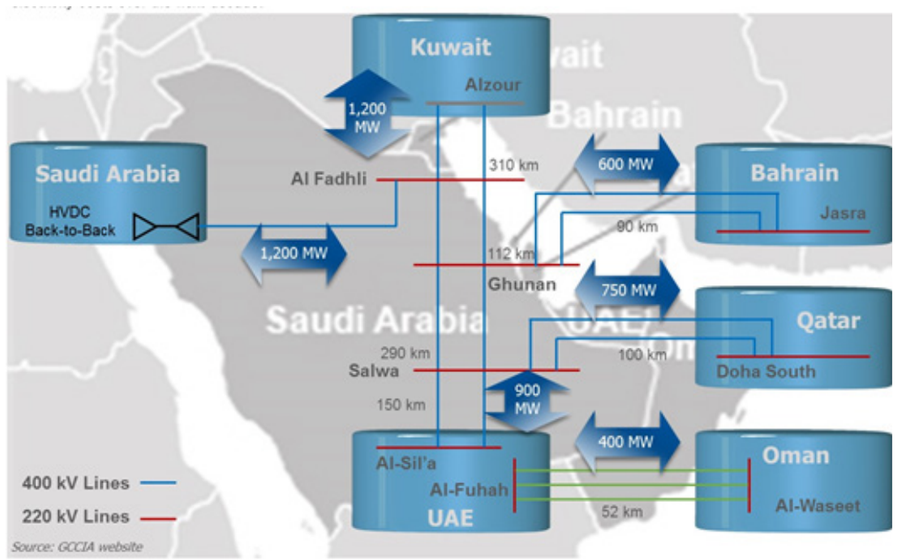
Source: GCCIA

Figure 5.4: GCCIA Project Map



Source: GCCIA Website

Figure 5.5: GCCIA Power Grid Electrical Map

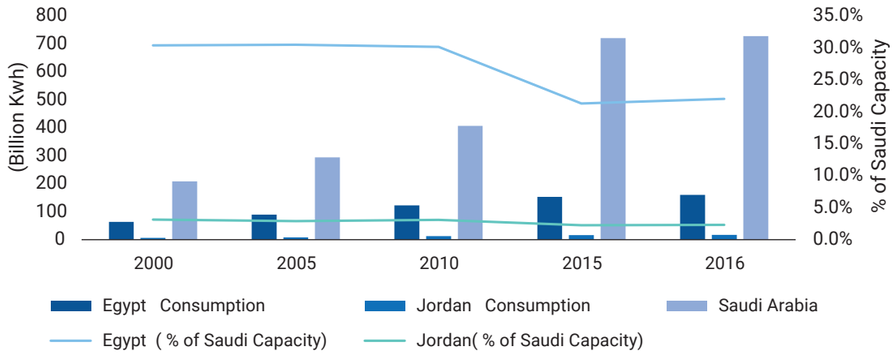


Source: GCCIA Website

In addition, Saudi Arabia and Egypt are planning a project to link the electricity grids of both countries. It would have a capacity of 3 gigawatts. The project would cost around $1.6 billion as per a report in early 2018. Egypt would contribute about $600 million to the project. The 1,300-kilometer, 500 kV DC transmission line will start at Badr in Egypt, pass through the Northwestern Saudi town of Tabuk and end at the Western Medina city. Also, Jordan and Saudi Arabia propose to connect both countries' electric grids.

Figure 5.6 shows that Egypt's power consumption constitutes less than 25% of Saudi generation capacity, making sourcing part of its power from Saudi a workable proposition, thereby saving it resources that can be deployed for other productive investments. Moreover, the Arab League is studying the possibility of connecting the grid to the North Africa region whereas Saudi Arabia with the World Bank is studying the prospect of connecting the grid to Europe. These agreements when implemented can drive additional demand for export of Saudi power as Saudi is advantageously placed to produce power given its natural benefits of low-cost production of oil, gas and solar energy.

Figure 5.6: Power Consumption in Egypt and Jordan versus Saudi Generation Capacity



Source: World Bank Statistics, Marmore Analysis

In addition, newly formed regulations that allow private players to come and invest in Saudi Arabia in power sector can catalyze power exports from the Kingdom. The existence of the power grid which is backbone will help the Independent Power Projects (IPPs) and Integrated Independent Water & Power Projects (IWPPs) to select the strategic geographical locations close to the primary source of energy. Thus, extension of the Saudi power grid can enable the country to export the surplus power to the Maghreb countries, and at a later stage to European Grid.

Chapter 6

Expected Growth of the Power Sector in Saudi Arabia

The Saudi power consumption was characterized by consumption at a CAGR of 5.8% and a generation capacity CAGR of 6.9% to meet the growth in consumption over the last two decades. However, electricity consumers have been confronted during past few years with a new environment of steeply higher electricity prices consequent to the government policies oriented towards pricing electricity at rates that will provide for economically feasible returns to the generators, and providers of transmission and distribution services. The extremely low power prices in the Kingdom in the past might have contributed to an environment of profligate power consumption by households and low priority accorded to ensuring efficiencies in commercial and industrial consumption of electricity. It was common during this period to hear of extravagant use of electricity for uses like lighting and cooling even when residents were outside their residences. All this is expected to have changed with the new power tariffs announced by the government and 2018 was a year of rationalization of electricity consumption by households[16] and commercial establishments resulting in lower electricity consumption per consumer with possibly curbing of wasteful and unwarranted consumption. Despite these changes, electricity growth drivers for Saudi Power sector discussed in the previous sections like the growth in population, reducing household size due to factors like urbanization, higher standards of living, increased use of digital devices like smart phones, tablets and notebooks, increasing female labor force, economic diversification leading to commercial and industrial growth all hold good overall in the long term. Also, the transmission and distribution sectors however continues to grow as they are focused on the long term needs to support the infrastructure for meeting power demand in the country.

Power Consumption Outlook over the period 2017-2024

There five important segments of power consumption in the Kingdom namely Residential, Commercial, Government, Industrial and Others (includes agriculture). It is expected that the power consumption that decreased in 2018, will show further degrowth in 2019, flatten in 2020 and thereafter return to growth path. This outlook does not take into consideration impacts of factors like widespread growth of electric vehicles in the country and the Kingdom's proposal to export power to MENA countries (See Table 6.1)

The important driver of consumption, namely number of consumers continues to show growth through 2018 to 2020 and expected to maintain the trajectory during the future years, aided by further decrease in household size, and increasing number of commercial, government, industrial and other consumers. The overall increase in number of consumers over the period is estimated at a CAGR of 5.0%, comprising 4.3% CAGR of residential consumers, 8.0% CAGR of commercial customers, 3.6% CAGR of Government consumers, 5.7% CAGR of industrial consumers and 8.0% CAGR of other consumers.

[16] Saudi Electricity Company, Investor Presentation 2019

Table 6.1: Number of Electricity Consumers by Segments (in million)

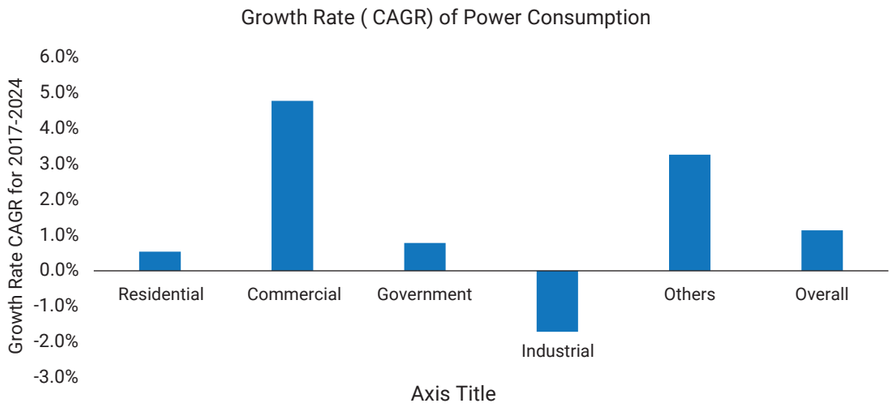
Year	2017	2018	2019	2020	2021	2022	2023	2024
Residential	7.10	7.44	7.78	8.12	8.47	8.82	9.17	9.54
Commercial	1.57	1.70	1.83	1.98	2.14	2.31	2.50	2.70
Government	0.27	0.28	0.30	0.31	0.32	0.33	0.34	0.35
Industrial	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02
Others	0.11	0.12	0.13	0.13	0.14	0.15	0.15	0.16
Total	9.07	9.55	10.04	10.55	11.08	11.62	12.18	12.76

Source: ECRA Reports, Marmore Analysis

The power consumption per consumer that has reduced by 6.9% on average in 2018 is assumed to continue to reduce though at a slower rate. On this basis it is expected that consumption per user for residential consumers will reduce at a CAR (-) 3.3%, for commercial consumers at a CAGR of (-) 2.7%, CAGR of (-) 2.4% for Government, (-) 8.9% for Industrial and (-) 1.7% for Others.

The overall power consumption is expected to decrease from 288.7 Twh in 2017 to 282.6 Twh in 2020 but increase thereafter to 304.7 Twh in 2023 and further to 312.4 Twh in 2024.The biggest growth in the five years 2018-2023 is expected to occur in commercial consumption (13.9 Gwh), followed by residential consumption (7.6 Gwh), Others (2.5 Gwh) and Government (1.5 Gwh). Industrial segment is however expected to see a reduction (-3.8HWh) assuming past trend. (refer to Figure 6.1 : Growth rate of Power Consumption by Segment and Table 6.2 : Power Consumption Outlook (in Gwh per year).

Figure 6.1: Growth Rate (CAGR) of Power Consumption by Segment



Source: ECRA Reports, Marmore Analysis

Table 6.2: Power Consumption Outlook (in Gwh per year)

Year	2017	2018	2019	2020	2021	2022	2023	2024
Residential	143,055	137,995	137,336	136,552	139,606	142,608	145,571	148,516
Commercial	48,252	48,963	50,631	52,344	55,666	59,184	62,907	66,847
Government	38,422	38,118	37,570	36,710	38,206	39,218	39,619	40,572
Industrial	47,230	46,422	45,629	44,848	44,082	43,328	42,587	41,859
Others	11,698	11,551	11,866	12,153	12,775	13,396	14,018	14,639
Total	288,657	283,049	283,031	282,608	290,335	297,734	304,702	312,432

Source: ECRA Reports, Marmore Analysis

Expected Power Load and Transmission/ distribution Infrastructure: 2017-2024

Using the power consumption outlook presented in the previous section and using the historical ratios of power load to consumption (average, peak and low value) ratios the power load expectations over the period 2017-2024 were prepared. Also taking the historical long-term trend in growth in power transmission and power distribution network to be applicable to the future, the estimated growth in these networks is estimated. SEC has reported that it continues with expansion of the transmission and distribution networks. It is a fair assumption that the network expansion will occur continuously, considering that these networks need to build continuously to meet the additions of consumers spread over widely spread locations in the Kingdom as well as distributed over several points within a given distribution network. The results of the analysis are presented in the Table 6.3 below:

Table 6.3: Growth in Power Load, Generation Capacity, and Transmission & Distribution Network

Year	2017	2018	2019	2020	2021	2022	2023	2024
Total Average Load	42.60	41.77	41.77	41.71	42.85	43.94	44.97	46.11
(GW)								
Peak Load	**62.10**	**60.89**	**60.89**	**60.80**	**62.46**	**64.05**	**65.55**	**67.21**
(GW)								
Low load	**24.80**	**24.32**	**24.32**	**24.28**	**24.94**	**25.58**	**26.18**	**26.84**
(GW)								
Estimated Generation Capacity Required	**80.5**	**78.94**	**78.93**	**78.81**	**80.97**	**83.03**	**84.97**	**87.13**
(GW)								

Year	2017	2018	2019	2020	2021	2022	2023	2024
Transmission Network Length	78.32	83.26	88.50	94.08	100.01	106.31	113.00	120.12
(ckt. '000 Kms)								
Distribution Network Length	617.50	658.25	701.70	748.01	797.38	850.00	906.10	965.91
(ckt. '000 Kms)								

Source: ECRA Reports, Marmore Analysis

The above estimates assume CAGR of 6.3% in Transmission Network and 6.6% in Distribution Network, which have been the case over the period 2000 to 2018 in the Kingdom. It also shows that the new additions to generation capacity is not expected to be sizeable over next 6 years. However, the expected growth in Transmission and Distribution network is expected to be large, as they are infrastructural in nature and need to be created ahead of demand increase that may occur in future.

Investment Requirement of the Power Sector in Saudi Arabia

As stated earlier, capacity additions required for power generation, transmission and distribution that were estimated in the previous section, do not include the capacity to meet future power demand from factors like possible entry of Electric Vehicles (EVs) in sizeable volumes in the country. Also not included are planned power exports to Egypt and Jordan planned by the Kingdom for which agreements have been reached between Saudi Arabia and these countries. Also, planned exports to Europe in the long term were not included.

The incremental capacity requirements of different assets for power supply for the period 2019-2024, are presented in Table 7.1:

Table 7.1: Increase in Capacity for Assets required for Power Supply

Power Capacities Required	2019	2024	2019-2024	% Increase over 2018
Power Generation (GW)	78.94	87.13	8.19	10.4%
Transmission Network Length	83.26	120.12	36.86	44.3%
(ckt. '000 Kms)				
Distribution Network Length	658.25	965.91	307.65	46.7%
(ckt. '000 Kms.)				

Source: ECRA Reports & SEC for historical data, Marmore Analysis

The increase in power generation of 8.19 GW expected over the period 2019-2024 is smaller than that created over the previous period 2013-2018 of 9.2 GW. However, the expected addition to Transmission network of 36,860 ckt. Kms during 2019-24, is higher the addition of 28,954 ckt.kms for the network during the previous period 2013-2018.Similarly the expected increase in Distribution network of 307,650 ckt.km during 2019-2024 is higher than the addition of 192,750 ckt.km to the network during the previous period.

Based on the incremental capacity requirement over the period 2019-2024, and the average historical cost per unit capacity derived from the 2018 Annual Report of Saudi Electricity Company (SEC), the estimated capital investment required to be incurred by the Saudi Power sector over this period is expected to be as given in Table 7.2:

Table 7.2: Investment in Power Supply Assets in Saudi Arabia (2019-2024)

Power Supply Assets	Addition to Capacity	Assumed cost (USD million) per Unit	Estimated Investment (USD million)
Power Generation (GW)	8.19	831.43	8.19
Transmission Network Length	36.86	699.17	36.86
(ckt. '000 Kms)			
Distribution Network Length	307.65	52.09	307.65
(ckt. '000 Kms.)			
Total Investment (2019-2024)			**48,612**

Source: ECRA Reports for data, Marmore Analysis

Thus, the investment that is expected to be required over the period 2019-2024 is USD 48.6 billion which might be smaller than the investment incurred by SEC alone of USD 79.8 billion over the period 2013-2018. The smaller investment estimate for the next five years is derived by assuming lowering of power consumption will persist further and will remain flat during 2018-2020. This, as mentioned previously was due to rationalization of power consumption by consumers due to the hefty increase in power tariffs introduced by the Saudi government in recent years to bring the power tariff structure in the country to commercially economic prices as compared to heavily subsidized prices in the past. To understand the financing structure of Power Sector investments, it may be noted that highly leveraged power projects in the region continue to be largely financed based on non-recourse or limited recourse structure, with debt-equity ratios in the 60:40 to 80:20 range, even 85:15 for lower risk profile projects backed by strong government payment guarantee

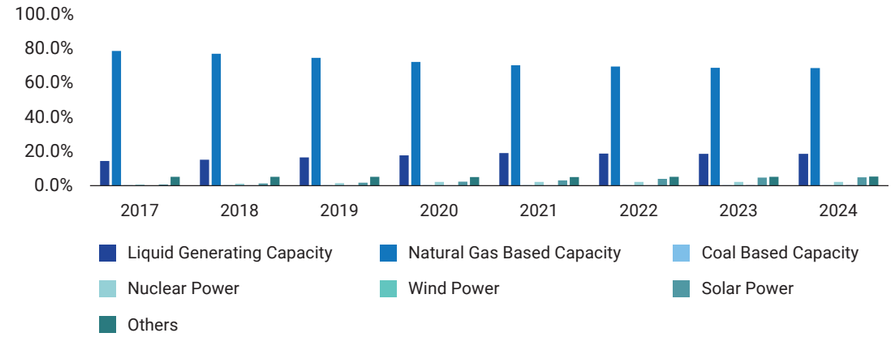
An alternative forecast of power generating capacity for Saudi Arabia based on the power generating capacity growth in Middle East, published by EIA, is presented below. The estimates given in Table 7.2 and 7.3 for Saudi Arabia are close, giving conviction in the estimates presented in Table 7.3.

Table 7.3: Alternative Forecast of Power Generating Capacity (2017-2024)

								GW
Year	2017	2018	2019	2020	2021	2022	2023	2024
Total Installed Generating Capacity in Middle East	309.2	319.8	327.2	336	342.9	344.2	345.4	343.9
(Estimated Saudi Arabian Share)	**80.50**	**83.26**	**85.19**	**87.48**	**89.27**	**89.61**	**89.92**	**89.53**
Estimates for Middle East								
Liquid Generating Capacity	44.5	48.5	53.9	59.6	65	64.5	64.1	63.7
Natural Gas Based Capacity	243.2	246	244.3	242.6	240.9	239.2	237.5	235.9
Coal Based Capacity	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Nuclear Power	2.3	3.6	4.9	7.3	7.3	7.3	7.3	7.3
Wind Power	0.5	0.7	0.8	1	1.1	1.1	1.2	1.3
Solar Power	2.1	3.9	5.8	7.6	10.5	13.5	16.4	16.6
Others	15.8	16.3	16.7	17.1	17.3	17.8	18.1	18.3

Source: Energy Information Administration (EIA), Marmore Analysis

Figure 7.1: Forecasted Power Generation Capacity by Fuel for Middle East



Source: EIA, Marmore

As mentioned earlier, the Kingdom has set itself ambitious plans for development of electricity from non-renewable sources, after adding which the capacity will go beyond its power consumption growth. If these plans are met, it is expected that solar energy primarily supplemented by wind energy will meet bulk of its power consumption leaving surplus capacity for meeting its strategy to emerge as an exporter of power to neighboring and other MENA countries and to Europe in the long term (*Refer to Exhibit 3: Saudi Arabia Opens Bids for Kingdom's First Utility-Scale Wind Farm (July 26th, 2018) and Exhibit 4 : Saudi Energy Minister Khalid al-Falih speaks during a news conference in Riyadh, Saudi Arabia January 9, 2019 on Saudi Renewable Energy Investments*).

Exhibit 3: Saudi Arabia Opens Bids for Kingdom's First Utility-Scale Wind Farm (July 26th, 2018)

Saudi Arabia has received four bids for the first utility-scale wind farm to be built in the kingdom. The $500m Dumat Al Jandal wind farm, located in the northern Al Jouf region, will generate enough power to supply up to 70,000 Saudi households and forms part of the country's wider industrial diversification strategy. The Renewable Energy Project Development Office (REPDO) at the Ministry of Energy, Industry and Mineral Resources (MEIM) in Saudi Arabia hosted the bid opening ceremony. The Dumat Al Jandal project is the second tender issued by MEIM as part of the National Renewable Energy Programme (NREP) under the auspices of the King Salman Renewable Energy Initiative.

"The Kingdom's first utility-scale wind project opens a new chapter in our journey towards a diversified energy mix. The development of a wind energy industry in Saudi Arabia is an important component of our wider industrial diversification strategy," said His Excellency Khalid Al Falih, Minister of Energy, Industry and Mineral Resources. Four bids were submitted by pre-qualified consortiums ACWA Power, EDF Energies Nouvelles, Enel Green Power S.p.A. and International Power SA, Dubai branch (ENGIE). REPDO will now evaluate the proposals, with the project set to be awarded on December 18, backed by a 20-year power purchase agreement with the Saudi Power Procurement Company (SPPC). The bid opening was live streamed through a webinar that saw over 350 participants. Dumat Al Jandal was chosen for the project site following studies that showed a strong mixture of Class II and Class III wind capabilities on the site. Average annual generation from the wind plant is expected to be around 1.4 TWh. The initiative forms part of Saudi's Vision 2030 and National Transition Programme to shift the country away from reliance on oil. As part of this transition the goal is for renewable energy to provide four percent of the Kingdom's total energy production by 2020 and 10 percent by 2023 - roughly 9.5 GW. Total investment in the projects is expected to reach $16bn.

Exhibit 4: Saudi Energy Minister Khalid al-Falih speaks during a news conference in Riyadh, Saudi Arabia January 9, 2019 on Saudi Renewable Energy Investments

Khalid al-Falih also told an energy industry event in Abu Dhabi that Saudi Arabia planned to issue tenders for at least 12 renewable energy projects this year, as part of a push by the world's biggest oil exporter to diversify its energy mix. He did not give details of the tenders but said they would "stimulate investor, manufacturing and developer activity across the entire value chain.". The desert kingdom aims to develop about 60 gigawatts (GW) of renewable energy capacity in the next 10 years, including 40 GW of photovoltaic solar power, three GW of concentrated solar power and 16 GW of wind power the minister said. Saudi Arabia, which has said it is implementing a deal with Japan's Softbank to develop solar power, wants to boost its power generation from renewables and cleaner gas-fired plants. "Since reforms were put in place, we have noticed a growing public interest in energy efficiency, and a clear change in behavior," Falih said, adding gasoline demand fell 8 percent in 2018 compared to 2017 and electricity demand also dropped. "Over the coming decade, liquids burning in our utilities will be virtually eliminated, while the share of gas capacity will grow from around 50 percent currently to nearly 70 percent, which will be the highest among the G20," the minister said. The Energy Ministry would work with the kingdom's sovereign wealth fund, the Public Investment Fund (PIF), in its push to develop renewable power capacity, Falih said. "The PIF and its selected partners will develop 70 percent of the total renewable energy capacity with the objective of accelerating the localization of our manufacturing capability," he said, adding the ministry would tender for 30 percent. State-run Saudi Aramco had identified more gas resources in the kingdom and would be working to develop unconventional gas reserves found in the east of the Ghawar field, Falih said. Unconventional gas refers to reserves requiring advanced extraction methods, such as those used in the shale gas industry. Saudi Arabia aims to export gas by 2030, industry sources say.

Chapter 8

Key Challenges to the Kingdom's Power Capacity Expansion Drive

The country's plans for the power sector no doubt is in the direction of putting itself in the lead for progressive steps for honoring global commitments for climate control through reduced CO2 emission from power generation as it is the largest contributor to CO2 emissions. However, given its large reserves of gas and oil which are a very economical fuel source for the country, it remains to be seen how the Kingdom can shift its power generation away from oil and gas and towards non-fossil fuels.

Saudi Arabia is well endowed with natural advantages for generating power through solar energy for which it has announced ambitious plans to set up huge solar capacity. However, the growth in country's electricity demand has slowed in past few years and additional solar capacity of large magnitude to be viable will require a large demand increase which can be realized only by acceleration of the economy to a high growth trajectory, establishing export markets in neighboring countries for new capacities planned to be set up in the country. Further, in the current post Covid-19 environment where the near-term price outlook for crude oil and natural gas is bearish, the generation of solar and wind power is less economical as compared to power from existing fossil fuels. No doubt, the shift to renewables is strategic and must be viewed from the perspective of greater objectives of climate control.

Thirdly, Saudi Arabia requires large resources for its various mega infrastructure and tourism projects that are being implemented for diversification of its economy from excessive dependence on oil exports. With large financial resources being allocated to these projects, the solar and nuclear power projects of large scale being planned in the country may find it challenging to attract sufficient financial resources unless they offer strategic or financial returns in excess of what the current mega projects offer.

Thus the key challenge are ways to attract sponsors to take up these mega sized investments, meeting climate control initiatives, attracting the required financial, human and managerial resources required with ease and next, if all of this capacity comes online, finding export markets to utilize the added capacity as the expanded capacity is expected to exceed its consumption.

Chapter 9

Conclusion

The Kingdom has set itself goals of stepping up the power generation capacity in a big way over the next decade by setting up additional gas based generation capacity to replace liquid fuels and attract large investments in solar and wind power generation supplemented with planned capacity addition through nuclear power generation.

The government has been preparing the country particularly over the past few years to realize its big push to investments in all forms whether for industrial and economic diversification, or for real estate growth to step up housing ownership among its citizens or for infrastructural investments like power.

In the power sector the government has taken up several reforms by encouraging private investment in generation capacity through Public Private Partnership (PPP) initiatives as well as attracting completely private owned producers. It has also set up the necessary institutions to regulate and oversee its commercialization and expansion of the Power sector. It has taken bold steps like the revision of electricity tariffs to do away with subsidies and bring electricity prices to economically realistic levels, an essential ingredient for success of its privatization drive in the power sector.

The Kingdom has seen creation of large local multinational private sector players like Acwa Power in the past decade, who have successfully taken up mega projects for power generation within and outside the Kingdom and have raised independently the required financial and human resources to set up and operate such investments. The state-owned Saudi electricity Company (SEC) has also exhibited creditable performance in the PPP power projects in which it has been participating since the power sector was opened to private sector in the Kingdom. The resources, capabilities and operating efficiencies of SEC in its power assets are also of standards comparable to international levels, making the expected shift to private ownership resulting from the privatization plans being made by the government seamless and successful.

The GCC grid as well as the proposed extension of its transmission network to Egypt and Jordan in the medium term and the long term proposition of connectivity with Europe, can be expected to facilitate tapping these markets to market its surplus power generation capacity resulting from big expansion drive into renewable energy generation. In addition, the economic diversification of the Kingdom by stepping up non-oil industrial production and increase in power demand that can be expected from introduction of electric vehicles can make the large generation capacity increase a viable initiative.

No doubt, the government's freeing up of investable resources of its sovereign funds like Public Investment Fund (which for instance has recently divested its stake in SABIC), and more investable resources that have been raised from the IPO of Saudi Aramco, should provide the required resources for investments required by power and other sectors needing investments. The government's strategic move of investing in Soft Bank which has evinced interest in investing mega resources in private sector renewable energy sector (solar particularly) also bodes good for realizing the government's ambitions for the power sector. In conclusion, the Kingdom's stepping up renewable energy sector in a big way may prove right, given its abundant access for tapping solar energy and can be expected to be fruitful in the long term. However, there is likely to be a review of the comparative economics of solar and wind power projects before proceeding with them, at least until a clearer picture emerges from the currently highly bearish outlook for prices of crude oil and natural gas post Covid-19.

Appendix

Appendix 1: Saudi Power Projects under Execution

S.No.	Project Details	Project Phase	Contract Type	Completion Date	Owner
1	Saudi Aabia SWCC - Al Shuaibah 380 kV Substation	Bid Submission	DB - Design, Build	5/17/2023	SWCC
2	SEC - Al Urqair A&B 115/13.8 kV Substations	Execution	EPC - Engineering, Procurement, Construction	6/21/2020	SEC
3	Saudi Arabia MOH - Khamis Mushait 132/13.8 kV Substation and 132 kV Double Circuit Overhead Transmission Lines	Bid Submission	Construction	4/12/2022	Government
4	Saudi Arabia SEC - Hail South 132 kV Overhead Transmission Line	Execution	Construction	11/22/2020	SEC
5	SEC - Riyadh 132/33 kV and 132/13.8 kV Substation - No. 8719	Execution	EPC - Engineering, Procurement, Construction	5/13/2020	SEC
6	Saudi Arabia SEC - Najran and Abha 380 kV Substation	Execution	Construction	10/8/2020	SEC
7	Soft Bank Corporation - Riyadh 200 GW Solar Power Plant	Planning	EPC - Engineering, Procurement, Construction	11/14/2030	Soft Bank Corporation
8	Saudi Arabia MODA - Rehabilitation of Jubail Air Force Power Network	Bid Submission	Construction	10/13/2021	Government
9	SEC - Interconnection of PP 13 BSP Phase 2	Execution	EPC - Engineering, Procurement, Construction	10/7/2021	SEC
10	Saudi Arabia MOD - Asad Shooting Range Electricity Network	Bid Submission	Construction	2/21/2019	Government

S.No.	Project Details	Project Phase	Contract Type	Completion Date	Owner
11	SEC - Interconnection of PP 14 BSP Phase 2	Execution	EPC - Engineering, Procurement, Construction	10/7/2021	SEC
12	SEC- Riyadh PP13 - Electromechanical installation	Execution	Supply & Installation	8/23/2022	SEC
13	SEC - Reinforcement of PP 7 380/132/13.8 kV BSP Stage 2	Execution	EPC - Engineering, Procurement, Construction	10/18/2022	SEC
14	SEC - Riyadh 132/13.8 kV Substation - No. 8210	Execution	EPC - Engineering, Procurement, Construction	5/13/2020	SEC
15	Holy Makkah Municipality - Makkah Entrances Lighting Development and Upgrade	Bid Submission	Construction	12/15/2021	Government
16	Saudi Arabia MOH - Jeddah 380/110/13.8 kV Substation	Bid Submission	Construction	12/8/2021	Government
17	Saudi Arabia SEC - HVDC Interconnection between Western Operating Area and Southern Operating Area - Stations 1	Execution	Construction	10/3/2021	SEC
18	SEC - Riyadh 132/13.8 kV Substation - No. 8308	Execution	EPC - Engineering, Procurement, Construction	5/13/2020	SEC
19	Saudi Arabia MOEWA - Al Ahsa Agricultural Center Power Network	Awarded	EPC - Engineering, Procurement, Construction	6/25/2021	Government
20	Saudi Arabia MOH - Arar Hospital Electric Network Expansion and Construction of a Boiler Room	Bid Submission	Construction	1/13/2021	Government

S.No.	Project Details	Project Phase	Contract Type	Completion Date	Owner
21	Saudi Arabia NWC - Manfuhah 30 MVA Power Production Plant	Bid Submission	Construction	6/10/2020	National Water Company
22	Saudi Arabia SEC - Abqaiq 380 kV Substation	Tendering & Bidding	EPC - Engineering, Procurement, Construction	1/22/2020	SEC
23	Saudi Arabia SEC - Al Mubarraz 380 kV Substation	Execution	EPC - Engineering, Procurement, Construction	1/22/2020	SEC
24	Saudi Arabia MODA - Al Mashaaer Al Mugaddassah Low Current Transmission Line - Site A and J	Bid Submission	Construction	1/9/2020	Government
25	SEC - New Jeddah University 380/110/13.8kV BSP	Execution	EPC - Engineering, Procurement, Construction	8/11/2020	SEC
26	Saudi Arabia MEIM - The National Renewable Energy Program	Bid Evaluation		2/8/2023	Government
27	Saudi Arabia MEIM - The National Renewable Energy Program - Round 2	Bid Evaluation		2/21/2020	Government
28	Saudi Arabia SEC - Al Wasam 110/13.8 kV Substation	Execution	EPC - Engineering, Procurement, Construction	1/16/2020	SEC
29	Saudi Electricity Company - Jazan Baysh Hydroelectric Pumped Storage Power Plant	Planning	Construction	11/12/2020	SEC
30	Saudi Arabia SEC - Al Quwayiyah 132 kV Substation No. 8514	Execution	EPC - Engineering, Procurement, Construction	1/10/2020	SEC

S.No.	Project Details	Project Phase	Contract Type	Completion Date	Owner
31	SEC - Al Kharj New AL TAWDIHIYA-2 S/S 8725 Three DC 132KV OHT Lines	Execution	EPC - Engineering, Procurement, Construction	2/20/2020	SEC
32	SEC - Qassim 2/Medina East Bulk Supply Point Substations Double Circuit Overhead Transmission Line	Execution	EPC - Engineering, Procurement, Construction	3/15/2020	SEC
33	SEC - Rafha 132/13.8 kV Substation	Execution	EPC - Engineering, Procurement, Construction	5/13/2020	SEC
34	SEC - Rabweh 132/13.8 kV Substation No. 8251	Execution	EPC - Engineering, Procurement, Construction	5/13/2020	SEC
35	SEC - Al Azim 132/33 kV Substation No. 8938	Execution	EPC - Engineering, Procurement, Construction	5/13/2020	SEC
36	Saudi Arabia MEIM - The National Renewable Energy Program - Round 1	Bid Evaluation		1/22/2020	Government
37	SEC - Al Ghazalah 132/33 kV Substation No. 8936	Execution	EPC - Engineering, Procurement, Construction	5/13/2020	SEC
38	SEC - New Jubail 380/230/115 KV BSP	Execution	EPC - Engineering, Procurement, Construction	12/22/2019	SEC
39	SEC - Nariyah 115/13.8 KV Overhead Transmission Line	Bid Evaluation	EPC - Engineering, Procurement, Construction	3/21/2022	SEC
40	SEC - Al Raies BSP Interconnection Stage 2	Planning	EPC - Engineering, Procurement, Construction	9/21/2022	SEC
41	SEC - Wadi Al Dawasir to Layla Interconnection Transmission Line	Tendering & Bidding	EPC - Engineering, Procurement, Construction	7/31/2019	SEC

S.No.	Project Details	Project Phase	Contract Type	Completion Date	Owner
42	SEC - Tabouk to Al Madinah HVDC Transmission Line	Bid Submission	EPC - Engineering, Procurement, Construction	7/31/2018	SEC
43	SEC - Tabouk/Medina Power Interconnection	Planning	Construction	7/6/2018	SEC
44	SEC - Ras Abu Qames Power Plant	Planning		7/1/2023	SEC
45	RCJY - Ras Al Khair Electrical GIS Substation and Construction 380 kV OHTL Double Circuit RIC S/S	Execution	EPC - Engineering, Procurement, Construction	2/20/2020	Royal Commission for Jubail and Yanbu
46	SEC - Ras Abu Qames 115/380 kV BSP Stage 2	Planning	Construction	5/24/2023	SEC
47	SEC - Ras Abu Qames 115/380 kV BSP	Planning	Construction	12/9/2021	SEC
48	SEC - Al Raies 2 PP	Planning	EPC - Engineering, Procurement, Construction	10/31/2025	SEC
49	SEC - Ras Al Zour PP	Planning	Construction	10/31/2018	SEC
50	SEC - Al Khafji Solar Power Plant	Planning		10/31/2017	SEC
51	SEC - Al Raies 1 PP	Planning	EPC - Engineering, Procurement, Construction	5/31/2022	SEC
52	SEC - Al Raies BSP Interconnection Stage 1	Planning	EPC - Engineering, Procurement, Construction	9/20/2022	SEC
53	SEC - Eastern Operating Area and Central Operating Area Seventh Interconnection Transmission Line	Planning	EPC - Engineering, Procurement, Construction	9/26/2020	SEC
54	K.A.CARE - K.A.CARE Geothermal Program	Planning	EPC - Engineering, Procurement, Construction	2/15/2032	KACARE

S.No.	Project Details	Project Phase	Contract Type	Completion Date	Owner
55	K.A.CARE - K.A.CARE Solar Program	Planning	EPC - Engineering, Procurement, Construction	2/15/2032	KACARE
56	K.A.CARE - K.A.CARE Wind Energy Program	Planning	EPC - Engineering, Procurement, Construction	2/11/2032	KACARE
57	K.A.CARE - K.A.CARE Solar Thermal Program	Planning	EPC - Engineering, Procurement, Construction	2/10/2032	KACARE
58	K.A.CARE - K.A.CARE Solar Thermal Program - Phase 1	Planning	EPC - Engineering, Procurement, Construction	2/10/2032	KACARE
59	K.A.CARE - K.A.CARE Solar Thermal Program - Phase 2	Planning	EPC - Engineering, Procurement, Construction	2/10/2032	KACARE
60	K.A.CARE - K.A.CARE Waste to Energy - Phase 2	Planning	EPC - Engineering, Procurement, Construction	2/10/2032	KACARE
62	K.A.CARE - K.A.CARE Waste to Energy Program	Planning	EPC - Engineering, Procurement, Construction	2/10/2032	KACARE
63	K.A.CARE - K.A.CARE Wind Program - Phase 1	Planning	EPC - Engineering, Procurement, Construction	1/28/2032	KACARE
64	K.A.CARE - K.A.CARE Geothermal Program - Phase 1	Planning	EPC - Engineering, Procurement, Construction	1/15/2032	KACARE
65	K.A.CARE - K.A.CARE Wind Program - Phase 2	Planning	EPC - Engineering, Procurement, Construction	1/15/2032	KACARE
66	K.A.CARE - K.A.CARE Solar Program - Phase 2	Planning	EPC - Engineering, Procurement, Construction	2/10/2032	KACARE
67	K.A.CARE - K.A.CARE Renewable Energy Program	Planning	EPC - Engineering, Procurement, Construction	2/1/2032	KACARE
68	K.A.CARE - K.A.CARE Solar Program - Phase 1	Planning	EPC - Engineering, Procurement, Construction	2/10/2032	KACARE
69	K.A.CARE - K.A.CARE Waste to Energy - Phase 1	Planning	EPC - Engineering, Procurement, Construction	2/10/2032	KACARE
70	Holy Makkah Municipality - New Taif City - Oasis of Technology - New Taif Solar Energy Plant	Execution		2/16/2020	Holy Makkah Municipality
71	SEC - PP13	Execution	EPC - Engineering, Procurement, Construction	12/29/2020	SEC
72	SEC - Dammam Replacement of 69 kV Underground Cable	Planning	Supply & Installation	9/9/2020	SEC
73	K.A.CARE - Saudi Arabia 2.8 GW Nuclear Reactor - Kashm Umm Huwayd Nuclear Reactor	Tendering & Bidding	EPC - Engineering, Procurement, Construction	3/15/2030	KACARE
74	K.A.CARE - Saudi Arabia 2.8 GW Nuclear Reactor	Tendering & Bidding	EPC - Engineering, Procurement, Construction	12/25/2030	KACARE
75	SEC - Yanbu/Dhuba Power Overhead Transmission Line	Bid Evaluation	EPC - Engineering, Procurement, Construction	12/28/2021	SEC
76	SWCC - Yanbu Power and Desalination Plant Phase 3 - Power Package	Execution	EPC - Engineering, Procurement, Construction	1/9/2023	SWCC
77	Jazan Economic City - Jazan Power Plant	Planning	Construction	11/19/2020	Jazan Economic City Jazan Economic City Company

Appendix 2: Illustrations of some major PPP Power Projects in Saudi Arabia

Appendix 2.1: Marafiq IWPP (Capacity: 2,700 MW)

OVERVIEW (MARAFIQ IWPP)

Marafiq IWPP is the world's largest power and desalination plant, consisting of 16 units of gas fired GE turbines with a net capacity of c.2,700 MW and 27 desalination units manufactured by SIDEM, producing 800,000 m3/day of desalinated water.

The plant is split into 4 operational blocks of two different designs. Three of the four blocks are power and desalination blocks, each of which comprises 3 gas turbines operating in a combined cycle with a single backpressure steam turbine. Steam from the turbine exhaust is used to feed the desalination process. The fourth block is a 'power only' block and comprises three gas turbines operating in combined cycle with a reheat condensing steam turbine.

KEY FACTS

LOCATION	Jubail, North Eastern Saudi Arabia
OFFTAKER	Tawreed (a subsidiary of Marafiq)
FUEL	Natural Gas
PROJECT COST	USD 3,359 Mn
COMMERCIAL OPERATIONAL DATE	Q4 2010
ACWA POWER SHARE	20.0%
OFFTAKE CONTRACT	PWPA-BOOT 20 years
O&M	JOML (Joint venture of Engie and NOMAC)
OTHER INVESTORS	Power & Water Utility Co for Jubail and Yanbu, PIF, SEC and consortium of Suez, GIC and ACWA Power
EPC	GE, HHI, SIDEM Consortium

Source: Acwa Power Website, Marmore

Appendix 2.2: Qurrayyah IPP (Capacity: 3,927 MW MW)

OVERVIEW (QURAYYAH IPP)

Qurayyah IPP, a greenfield project, that is developed on a BOO (build, own, operate) basis located on the eastern coast of Saudi Arabia with a net generation capacity of 3,927 MW. The design production capacity will make it, one of the largest IPP combined cycle gas-fired power plants in the world.

KEY FACTS

LOCATION	Eastern Province, Saudi Arabia
OFFTAKER	Saudi Electricity Company
FUEL	Natural Gas
PROJECT COST	USD 2,717 Mn
COMMERCIAL OPERATIONAL DATE	Q1 2015
ACWA POWER SHARE	18%
OFFTAKE CONTRACT	PPA-BOO 20 years
O&M	NOMAC (Nominated Subcontractor: Siemens LTSA)
OTHER INVESTORS	SEC, Samsung C&T, MENA Infrastructure
EPC	Samsung C&T

Source: Acwa Power Website, Marmore

Appendix 2.3: Rabigh 2 IPP (Capacity: 2,060 MW)

OVERVIEW (RABIGH 2)

Rabigh 2 is a greenfield BOO (build, own, operate) project located in Rabigh, on the western coast of Saudi Arabia, 130 Km north of Jeddah adjacent to the Rabigh IPP. The Project, the fourth in SEC's IPP program and this will be the first IPP to utilize combined cycle power plant with a gross thermal efficiency of c.58.8 % at reference site conditions at Rabigh.

Samsung C&T will be the EPC contractor and NOMAC will be the operator and maintenance contractor of the project. The project will deliver gross 2,060 MW of electricity to SEC under the PPA which has a term of 20 years from the scheduled commercial operations date of June 2017.

KEY FACTS

LOCATION	Rabigh, Western Saudi Arabia
OFFTAKER	Saudi Electricity Company
FUEL	Natural Gas
PROJECT COST	USD 1,559 Mn
COMMERCIAL OPERATIONAL DATE	Q1 2018
ACWA POWER SHARE	37.50%
OFFTAKE CONTRACT	PPA-BOO 20 years
O&M	NOMAC
OTHER INVESTORS	SCT (12.5%), SEC (50%)
EPC	Samsung C&T Corporation

Source: Acwa Power Website, Marmore

Appendix 2.4: Rabigh IWSPP

OVERVIEW (RABIGH IWSPP)

Rabigh IWSPP is owned and operated by the Rabigh Arabian Water and Electricity Company (RAWEC), a joint venture between ACWA Power, Marubeni Corp, JGC Corporation, and Petro Rabigh.

Phase II Expansion Project

Phase II involves an expansion of the existing captive plant supplying power, steam and water with HFO-based steam turbines that desalinated water in an RO plant. While Phase II is being developed as a standalone project, it will be integrated with Phase I once Phase II PCOD is achieved.

KEY FACTS

LOCATION	Rabigh, Western Saudi Arabia
OFFTAKER	Petro-Rabigh Petrochemical Complex
FUEL	Heavy Fuel
PROJECT COST	USD 984 million
COMMERCIAL OPERATIONAL DATE	Q1 2018
ACWA POWER SHARE	74%
OFFTAKE CONTRACT	WECA BOO 25 Years
O&M	Rabigh Project Company (NOMAC)
OTHER INVESTORS	Marubeni, JGC Corporation, ITOCHU Corp, Petro Rabigh
EPC	MHI

Source: Acwa Power Website, Marmore

Appendix 2.5: Rabigh IPP

OVERVIEW (RABIGH IPP)

The Rabigh IPP project is a n important project in the Middle East based on Chinese technology and an reflection of strategic and economic relationship between Saudi Arabia and China. It is also the first IPP in Saudi Arabia without a guarantee from the Ministry of Finance.

KEY FACTS

LOCATION	Rabigh, Western Saudi Arabia
OFFTAKER	Saudi Electricity Company
FUEL	Heavy Fuel Oil
PROJECT COST	USD 2,506 million
COMMERCIAL OPERATIONAL DATE	Q2 2013
ACWA POWER SHARE	40%
OFFTAKE CONTRACT	PPA – BOO 20 years
O&M	ROMCO (Joint Venture of KWEPCO & NOMAC)
OTHER INVESTORS	KEPCO, SEC
EPC	SEPCO III + Dongfang Consortium

Source: Acwa Power Website, Marmore

Appendix 2.6: Shuaibah IWPP

OVERVIEW (SHUAIBAH IWPP)

The Shuaibah IWPP was the first IWPP developed following the Saudi government's decision to open the market to private investment. The facility delivers water and electricity to a wide region including the cities of Makkah, Jeddah, Taif and Al-Baha.

KEY FACTS

LOCATION	120 km south of Jeddah, Western Saudi Arabia
OFFTAKER	Water & Electricity Company
FUEL	Arabian Light Crude
PROJECT COST	USD 2,450 Mn
COMMERCIAL OPERATIONAL DATE	Q1 2010
ACWA POWER SHARE	30%
OFFTAKE CONTRACT	PWPA-BOO 20 years
O&M	NOMAC
OTHER INVESTORS	PIF, SEC, Khazanah, TNB, Malakoff
EPC	Siemens (Power), Doosan Heavy (Desalinated Water)

Source: Acwa Power Website, Marmore

Appendix 2.7: Shuqaiq IWPP

OVERVIEW (SHUQAIQ IWPP)

Shuqaiq Water and Electricity Co. (SqWEC) owns and operates the Shuqaiq IWPP. It is the second phase of the Shuqaiq complex that produces water and power for the Assir region and city of Jizan. This green field project included the design, construction and commissioning of three 340MW oil fired power units combined with Reverse Osmosis desalination. Shuqaiq IWPP provides a net electrical output of 850 MW in combination with a total capacity of 212,000 m3/day of desalinated water.

KEY FACTS

LOCATION	140 km north of Jizan, Southern Saudi Arabia
OFFTAKER	Water & Electricity Company
FUEL	Arabian Heavy Crude Oil
PROJECT COST	USD 1,831 Mn
COMMERCIAL OPERATIONAL DATE	Q2 2011
ACWA POWER SHARE	32%
OFFTAKE CONTRACT	PWPA-BOO 20 years
O&M	NOMAC
OTHER INVESTORS	SEC, PIF, Gulf Invest Corp (GIC), Mitsubishi Corp
EPC	MHI

Source: Acwa Power Website, Marmore

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