



آفاق الطاقة في دولة الكويت
Kuwait Energy Outlook

2020

Kuwait Energy Outlook

Current Policies and
Necessity of Reform



Energy and Building Research Center
Kuwait Institute for Scientific Research

Foreword

The Kuwait Institute for Scientific Research (KISR) has played a critical role in meeting the needs of the State of Kuwait and the Gulf region. As the applied research institute of the nation, through the years, KISR has expanded its mandate to meet these needs. Since KISR's most recent transformation in 2013, the Energy and Building Research Center (EBRC) was established to meet the needs of the energy sector, the main driver of Kuwait's economy. The Kuwait Energy Outlook produced by the Center is one critical attempt to meet the country's needs to move towards a sustainable energy future and achieve 'New Kuwait' Vision 2035.

The first edition of this report, the Kuwait Energy Outlook (KEO), was published in 2019 (KEO-2019) and was supported by the General Secretariat of the Supreme Council of Planning and Development (GSSCPD) through the United Nations Development Program. Their support, most notably that of Dr. Khaled Mahdi, the Secretary General of the GSSCPD, was critical in establishing the KISR energy policy team, which composes the KEO publications.

In the previous edition of KEO-2019, an evaluation of Kuwait's current energy situation and the evolution of Kuwait's energy supply and demand over the next two decades were described. In this edition of Kuwait Energy Outlook 2020 (KEO-2020), updates to the KEO-2019 analysis with current developments in Kuwait's energy sector are presented, and policy recommendations are provided to enable meeting Kuwait's energy targets for 2035. The KEO publications continue to provide thorough updates on Kuwait's energy sector based on the Kuwait Energy Model used for analysis published in KEO-2019. We hope that Kuwait will take the necessary steps in the coming years to move Kuwait towards a more sustainable energy future.

Samira A.S. Omar

Director-General

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This Kuwait Energy Outlook 2020 (KEO-2020), KEO-2020 Special Report, was prepared by the Energy Policy Team of the Energy Efficiency Technologies (EET) Program in the Energy and Building Research Center at Kuwait Institute for Scientific Research. The work was directed by **Yousef Mohammad Al-Abdullah**, Associate Research Scientist in the EET Program, and supervised by **Fotouh Al-Ragom**, Program Manager of the EET Program, and **Osamah Alsayegh**, Executive Director of the Energy and Building Research Center. **Krishnan Nair Sreekanth**, Associate Research Scientist in the EET Program, was a key contributor. **Charlie Heaps** from Stockholm Environment Institute, US designed the Kuwait Energy Model using the Long-range Energy Alternatives Planning software. **Manal Shehabi** from the Oxford Institute for Energy Studies provided economic analysis and context to the importance of the Kuwait energy sector to the economy and co-authored this Special Report.

The editorial committee of the Kuwait Energy Outlook provided valuable insights and feedback. **Samira A.S. Omar**, Director General of Kuwait Institute for Scientific Research, chaired the committee, and **Khaled Mahdi** was the Vice-Chair. Other members included: **Salem Al-Hajraf**, Deputy Director-General, Kuwait Foundation for the Advancement of Sciences; **Abdullah Ahmad Al-Hamoud Al-Sabah**, Director General, Environment Public Authority; **Nimer Al-Sabah**, Undersecretary, Ministry of Oil; **Mutlaq Mubarak Al-Sanei**, General Manager, Kuwait Authority for Partnership Projects; **Wafaa Al-Zaabi**, Managing Director (Planning and Finance), Kuwait Petroleum Corporation; Undersecretary, Ministry of Electricity and Water. Many KISR research associates assisted in the production of this report. They include Eissa Al-Nasrallah, Mahdi Al-Saffar, Ahmed Bennakhi, Naser Hussain, Mohammad Al-Jassam, Nourah Al-Safi, Sarah Al-Osaimi, and Aisha Ismael.

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Executive Summary

- The energy sector dominates Kuwait's economy and is highly dependent upon oil exports for government revenue. The State of Kuwait, an arid country, has proven reserves of 101.5 billion barrels of crude oil and 1,784 billion cubic meters natural gas, as well as ample solar resources with one of the highest levels of solar power potential globally.
- The purpose of this Kuwait Energy Outlook 2020 (KEO-2020) Special Report is to characterize the progress made in Kuwait's energy sector in 2019; to outline the energy and economic outlook until 2035 in light of current economic and energy policies; and identify the necessity of reform necessary to move towards achieving the State's Vision 2035 'New Kuwait' (Vision 2035).
- Major projects to develop the country's energy sector have been undertaken by several government entities, led by Kuwait Petroleum Corporation (KPC) and its subsidiaries (known as K-companies).
- Kuwait continues to develop its natural gas supply. To meet local power generation demand, KPC seeks to increase non-associated gas supplies. The total production of natural gas in Kuwait, associated and non-associated, reached around 1.8 billion standard cubic feet per day in 2018. In recent years, the country has relied on imported liquefied natural gas (LNG) to meet shortages in gas supply for the power sector.
- To date, in Kuwait there are two refineries operating at Mina Al-Ahmadi and Mina Abdullah. Both refineries contribute to a total processing capacity of 736,000 barrels per day (bpd). A significant project is that of Al-Zour refinery (known as the fourth refinery project), which is expected to be completed in 2021 and to further enhance refining capacity. This facility can process heavy and light crudes. Al-Zour refinery will enable the realization of KPC's objective of increasing the State's export income derived from downstream activities from processing heavy crudes domestically, instead of exporting crude oil.
- Kuwait's power generation fleet is aging. The government is keen on increasing private sector involvement, the only power stations that are not operated by the Ministry of Electricity & Water (the state-owned utility) is the Az-Zour North power station and the first phase of Shagaya Renewable Energy Park. New conventional power stations are expected to be constructed at Al-Khiran and Al-Nuwiseeb, which will provide more opportunities for private sector involvement in the power generation sector under the law of Kuwait Authority Partnership Projects (KAPP). Kuwait is also expected to invest in renewable energy development with the upcoming projects of Shagaya Phase II and Phase III.
- The government of Kuwait has formally created a national champion, the Higher Energy Committee (HEC), to advocate for the coordination of the multiple dimensions of the

government's national energy strategy. The HEC has the mandate to develop policies and strategies toward the development of a sustainable energy system. It has the authority to set priorities, and oversee the implementation of approved mandates intended to move Kuwait towards a sustainable energy future. The HEC reports directly to the Council of Ministers semi-annually. The HEC is headed by the Minister overseeing both positions of the Minister of Oil and the Minister of Electricity and Water.

- The demand projections in this KEO-2020 Special Report are based on the Kuwait Energy Model, used in the Kuwait Energy Outlook for 2019 (KEO-2019), which highlights energy trends in a Business-As-Usual Case (BAU) and considers current policies by Kuwait. This Special Report holds that *the paucity and opacity of energy statistics precludes a more detailed and comprehensive analysis of Kuwait's energy future*. To enhance the Kuwait Energy Model and future KEO publications, disaggregated energy statistics are needed.
- Trends in energy demand from KEO-2019 still hold. Although the Kuwaiti government has announced intentions to improve regulations for energy efficiency, energy demand in Kuwait continues to rise. Over the Outlook period which extends to 2035, the trend in total final energy consumption is expected to increase to 28.6 million of tonnes of oil equivalent (Mtoe) by 2035, growing at an average annual rate of 2.2%.
- The transportation sector was previously reported in KEO-2019 as one of the biggest drivers for local energy demand growth in Kuwait. The Ministry of Interior reported in 2017 that Kuwait had 1.8 million registered vehicles, making 80% of the total transport fleet. According to model estimates, over the Outlook period to 2035, energy demand in this sector is expected to grow at a rate of 3% per year. Specifically, motor gasoline is expected to grow to from 3.7 Mtoe in 2015 to 6.9 Mtoe by 2035, and diesel demand from 0.2 Mtoe to 1.6 Mtoe over the same period.
- This KEO-2020 edition provides context and economic analysis of the importance of Kuwaiti energy sector and the necessity of reform. This analysis provides economic outlook primarily on the BAU Case as a guide for assessing necessity of reform. The analysis relied on assessments from Kuwait Energy Model used for projecting trends in the KEO-2019 edition coupled with results from a computable general equilibrium model of the Kuwaiti economy used for assessing energy pricing reform in Kuwait.
- Under the BAU Case assumptions, export revenues will decline in the Outlook period due to oil price movement and declines in global demand for conventional oil and gas. Simultaneously, subsidies' cost rises with increasing demand, worsening the fiscal deficit throughout the Outlook period. The share of non-oil sectors in the economy's gross domestic product (GDP) is likely to increase, but only modestly and not meaningfully in that these sectors' revenue will not replace the decline of oil export revenue.

- Values of shares of energy and non-energy sectors in the economy point to limited improvements towards meeting economic diversification goals of the Vision 2035 plan. Contrary to the plan's stated policies, total reported subsidies received by the electricity and water industries increased from 30% of these industries' consumption (at consumer prices) in 2013 to 37% in 2015 (the most recent available complete sectoral data).
- The growth in the transport sector in the Business-as-Usual Case is unsustainable, as it will account for approximately 30% of total energy consumed domestically and 22% of total emissions in 2035.
- Residential electricity consumption remains highly subsidized, with an average subsidization rate of 94%. In the BAU Case, residential electricity consumption is expected to grow at an annual average of 1.2% over the Outlook period. Assuming efficiency levels, margins, and production costs remain constant, simulations estimate that the cost of subsidizing residential electricity consumption would increase by 26% over the Outlook period.
- Reforming energy subsidies is a necessary step towards more efficient allocation of economic resources and reduction of wasteful consumption as well as achieving fiscal and economic sustainability. Such reform will largely reduce energy consumption and, therefore, the fiscal cost of subsidies, health care, and environmental protection.
- Energy efficiency reform offers ample opportunities for progress towards these goals. Importantly, it can be implemented to facilitate energy subsidy reform.
- As Kuwait advances towards achieving the development goals of its Vision 2035 plan, the BAU Case shows that it will not be possible to achieve the Plan's targeted goals of reducing energy consumption and raising the renewables' share in energy production to 15% of supplied capacity. Achieving these goals will not be possible unless appropriate reform is applied, of which energy subsidy and energy efficiency are the most important and urgent areas.

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Energy Supply

The energy sector dominates Kuwait's economy and is highly dependent upon oil exports for government revenue. The State of Kuwait, an arid country, has proven reserves of 101.5 billion barrels of crude oil and 1,784 billion cubic meters of natural gas,¹ as well as ample solar resources with one of the highest levels of solar power potential globally. Oil prices over the past decade have fluctuated drastically. As a result, revenues from these fluctuating oil prices have impacted the Kuwaiti economy and government revenue. Further, in the short to medium term, Kuwait's oil exports are affected by geopolitics and other factors that could impact global oil supply. According to the CEO of Kuwait Petroleum Corporation, market stability and global energy security are corner stones of Kuwait's oil exports.

Major projects to develop the country's energy sector have been undertaken by several government entities, led by Kuwait Petroleum Corporation (KPC) and its subsidiaries (known as K-companies). Production capacity from crude oil continues to grow. Kuwait Oil Company (KOC), the upstream entity responsible for the exploration and production of oil and associated products, has achieved a daily production capacity of 3.151 million barrels per day (bpd) of oil in 2018. Further, Kuwait National Petroleum Company (KNPC), Kuwait Integrated Petroleum Industries Company (KIPIC), and Petrochemical Industries Company (PIC) manage the downstream oil industry including oil refineries and petrochemicals.

To meet its production targets, KOC is developing fields in western Kuwait and in Kuwait's territorial waters in addition to oil field developments in the northern Jurassic oil fields of Kuwait. These fields are increasing Kuwait's production of not only light oil for exports, but also associated natural gas that will be utilized for local energy demand. As part of the Northern field developments for heavy oil, KOC awarded contracts for the development of Ratqa and Umm Naga oil fields. Finally, in line with meeting its oil production capacity target, KOC is improving hydrocarbons recovery from existing reservoirs and pursuing aggressive exploration programs. The current increase in capacity was achieved by drilling almost 650 new wells, most of which were Cretaceous, Jurassic, and heavy oil wells.² Kuwait continues to develop its natural gas supply. KOC is aggressively developing Kuwait's onshore fields (including Jurassic) and offshore fields to increase Kuwait's production of associated and non-associated natural gas in order to meet local energy demand. To meet local power generation demand, KPC seeks to increase non-associated gas supplies. To this end, the flaring of natural gas by the Kuwait Oil Company has decreased to 4.16%.² The total production of natural gas in Kuwait, associated and non-associated, reached 1.777 billion standard cubic feet per day (SCFD).² This non-associated gas was produced mainly from the development of Jurassic gas field reservoirs.

¹ OPEC, "Kuwait facts and figures 2018," *Organization of the Petroleum Exporting Countries*, Accessed Dec. 2019, https://www.opec.org/opec_web/en/about_us/165.htm.

² Kuwait Oil Company Annual Report 2017-2018.

This development of new oil and gas production fields in Kuwait has led to an increase of, on average, 2.1% in oil production over the period from 2000 to 2017. Natural gas production has been a key priority for KPC and its subsidiaries. Overall, the natural gas supply has grown by 5.8% over the same period. In that time, total natural gas production has grown at a rate of 4.4% and associated natural gas at a rate of 5.2%. The increase in associated natural gas production can also be attributed to initiatives by the K-companies, primarily KOC, to reduce flaring. In 2006, KOC reported that 17.2%³ of natural gas was flared; but with subsequent efforts to reduce flaring, it reported flaring of 4.16% in 2018. KOC has ramped up the development of the associated natural gas production in recent years, making it a priority for meeting local energy needs, especially the power generation sector.

In recent years, the country has relied on imported liquefied natural gas to supplement its natural gas supply to meet shortages in gas supply. In 2017, Kuwait imported 5.02 million of tonnes of oil equivalent (Mtoe) of liquefied natural gas, an annual average growth of 39.6% over the period from 2000 to 2017 (see Figure 1). Imported liquefied natural gas has advantages as it is utilized in the power generation sector and produces lower levels of emissions than oil, according to projections in KEO-2019. Nevertheless, relying on these imports no longer makes Kuwait energy-independent and reduce energy security. In response, regulators in Kuwait can promote energy efficiency and renewable energy. Increasing production of power using renewable energy coupled with efficiency improvements can replace part of the power generated by imported liquefied natural gas, thereby improving both environmental and economic improvements as well as energy security.

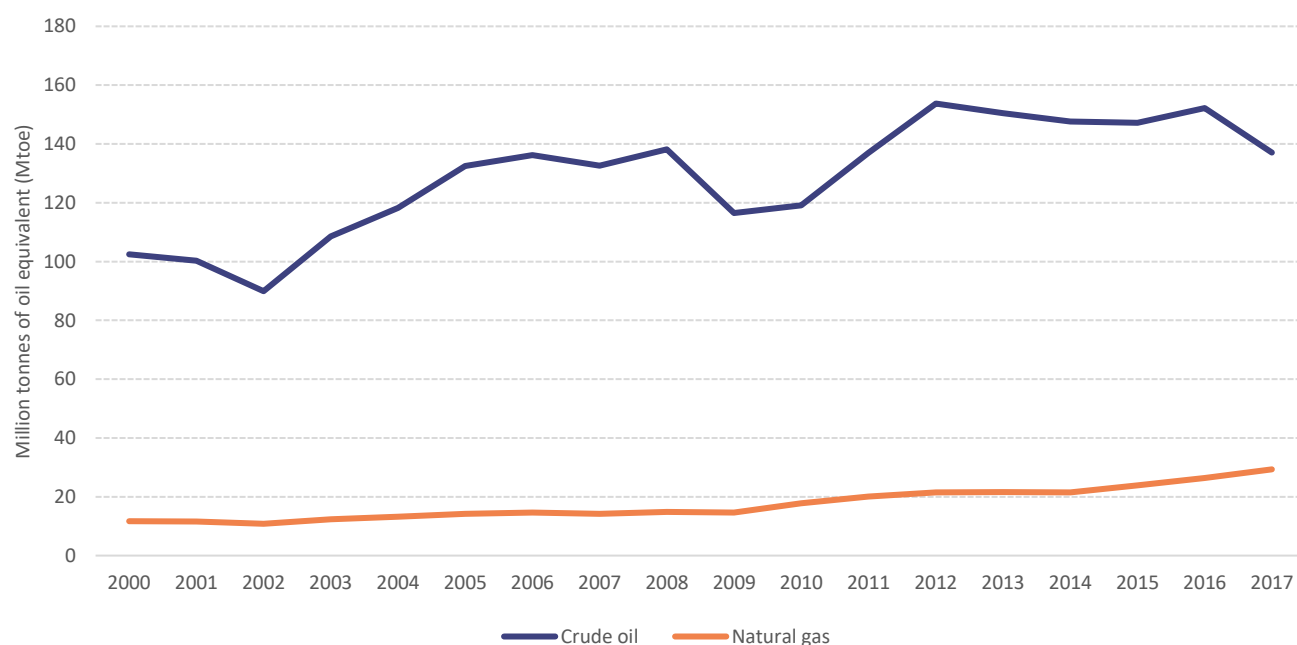


Figure 1 | Based on International Energy Agency (IEA) statistics, Kuwait is ramping up gas production and enhancing gas supply with imports. Mtoe of oil production (left axis) versus natural gas supply (right axis) in Kuwait.

³ Kuwait Oil Company, "Annual Report 2006-2007."

Refining

Downstream oil activities are overseen by Kuwait National Petroleum Corporation (KNPC), a subsidiary of Kuwait Petroleum Corporation. KNPC currently has two fully operational refineries in Mina Abdullah and Mina Al-Ahmadi. Both refineries contribute to a total processing capacity of 736,000 barrels per day (bpd). Mina Al-Ahmadi has a gas processing capacity of 2.485 billion standard cubic feet per day (SCFD). KNPC continues to upgrade these two facilities. The Shuaiba refinery was closed in April 2017.⁴

One of KNPC's flagship projects is the Clean Fuels Project. It aims to combine Mina Abdullah and Mina Al-Ahmadi refineries into one major complex. As a result, the overall capacity is expected to increase to 800,000 bpd by the year 2020.⁵

The most notable project currently undertaken in Kuwait is the Al-Zour refinery, expected to be completed in 2021. This facility will have the capacity to process heavy crudes. Al-Zour will enable the realization of certain goals identified by KPC as national priorities, by capturing additional revenue from downstream activities for the government of Kuwait. Notably, in 2016 KPC created a new subsidiary, Kuwait Integrated Petroleum Industries Company (KIPIIC), to oversee the operations of the Al-Zour refinery complex. The Al-Zour refinery is expected to have a capacity 615,000 bpd (100% Kuwait Export Crude (KEC) basis), and 530,000 bpd (mix crudes basis). In the Al-Zour refinery, a mix of Kuwaiti crudes will be converted into low sulfur fuel oil and lighter products.⁶

The additional refining capacity along with these upgrades can enable Kuwait to potentially diversify its energy portfolio (currently comprised of crude and petroleum products) to increase export revenue of the State of Kuwait. This goal can be achieved through enhancing the specifications of petroleum products to meet quality standards of international markets. Further, these upgrades can improve the quality of products for the local market by reducing the sulfur content in fuel oil burnt in power stations.

With regards to crude exports compared with oil products exports, the State of Kuwait applies a marketing strategy aimed at maintaining and/or increasing its global market share. Historically, between 2000-2017, the volume of crude exports has grown on average by 3.89% over the period, while the volume of exports from oil-derived products has decreased by 0.34% (see Figure 2).

⁴ Kuwait National Petroleum Corporation, "Annual Report 2017-2018."

⁵ Kuwait National Petroleum Corporation, "Annual Report 2015-2016."

⁶ Kuwait National Petroleum Corporation, "KNPC Tech Magazine Special Edition, April 2018."

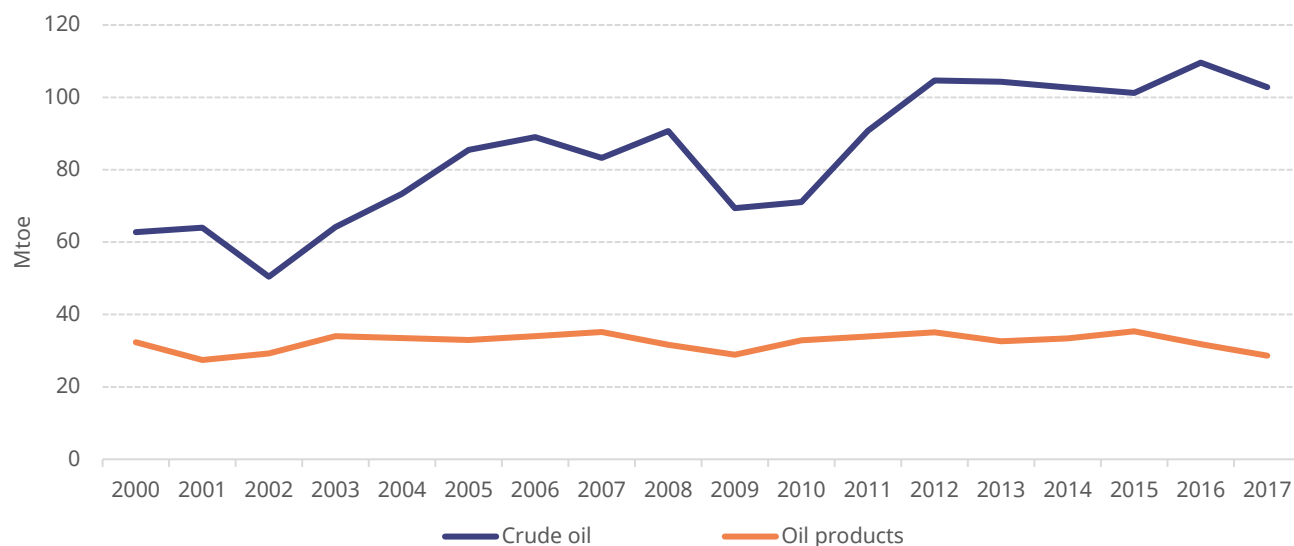


Figure 2 | Volume of crude oil versus oil-derived products exported by Kuwait over the period from 2000 to 2017, based on IEA statistics.

Power Generation

The Ministry of Electricity and Water (MEW) is the operator, regulator, and owner of most of Kuwait's power generation assets. While the government has announced plans to increase private sector involvement in the power generation sector, the only power stations that are not operated by the MEW are the Az-Zour North power station and the first phase of Shagaya Renewable Energy Park.

Nevertheless, steps have been taken to continue to expand private sector involvement in the power generation sector. The Kuwait Authority for Partnership Projects (KAPP) is overseeing the next phase of the Az-Zour North independent water and power project (IWPP) and is brokering the public-private partnership (PPP) agreement. KAPP completed an initial public offering (IPO) of IWPP in November 2019 by offering 50% stake on *Boursa Kuwait*, the Kuwaiti Stock Exchange, contributing a total of 550 million shares in the company formally known as the Shamal Az-Zour Al Oula Power and Water Company (KSC).

The planned capacity of the Az-Zour North is expected to be 2.7 gigawatts (GW) of combined cycle gas turbines. Furthermore, MEW has proposed new sites for power generation. One such site, Al-Khairan, which will be enacted as another IWPP, has an expected capacity for its first phase of 1.8 GW.⁷ Another planned power station will be located in the south of Kuwait at Al-Nuwaiseeb. It is unclear at the time this Special Report is issued whether this station will be an IWPP. Its first phase

⁷ Capital Standards – Kuwait Utilities Sector 2013.

is expected to have a capacity of 3.6 GW.⁸ A list of Kuwait's power stations is provided in Table 1 below.

Table 1 | Kuwait's power stations in 2018.

	Technology	Installed Capacity (MW)
Doha East	Steam turbine (7) OCGT (6)	1,158
Doha West	Steam turbine (8) OCGT (5)	2,541
Az-Zour South	Steam turbine (8) OCGT (4) CCGT (15) CCST (4)	5,806
Az-Zour North*	CCGT (5) CCST (2)	1,540
Sabiya	Steam turbine (8) OCGT (4) CCGT (8) CCST (4)	5,866
Shuaiba South	Steam turbine (6)	720
Shuaiba North	CCGT (3) CCST (1)	875.5
Shuwaikh	OCGT (6)	252
Shagaya	PV, wind, CSP	70
Umm Gudair	PV	10
TOTAL CAPACITY		18,838

* Private sector owned

These new power stations are vital to Kuwait's ability to meet new electricity demand. The MEW has several aging units. Older stations, such as Doha East, Shuaiba South, and Shuwaikh, are approaching retirement. Kuwait has approximately 6350 megawatts, or 17% of the total capacity produced by plants, that are 30 years old or older (see Figure 3) and, therefore, will be retired in the period leading up to 2035. Therefore, it is critical to enhance existing power generation capabilities by complementing conventional generation facilities with renewable power stations, which are expected to come online in the next 15 years. Furthermore, these new power stations provide opportunities for more private sector involvement.

⁸ Ministry of Electricity & Water Statistical Year Book 2018.

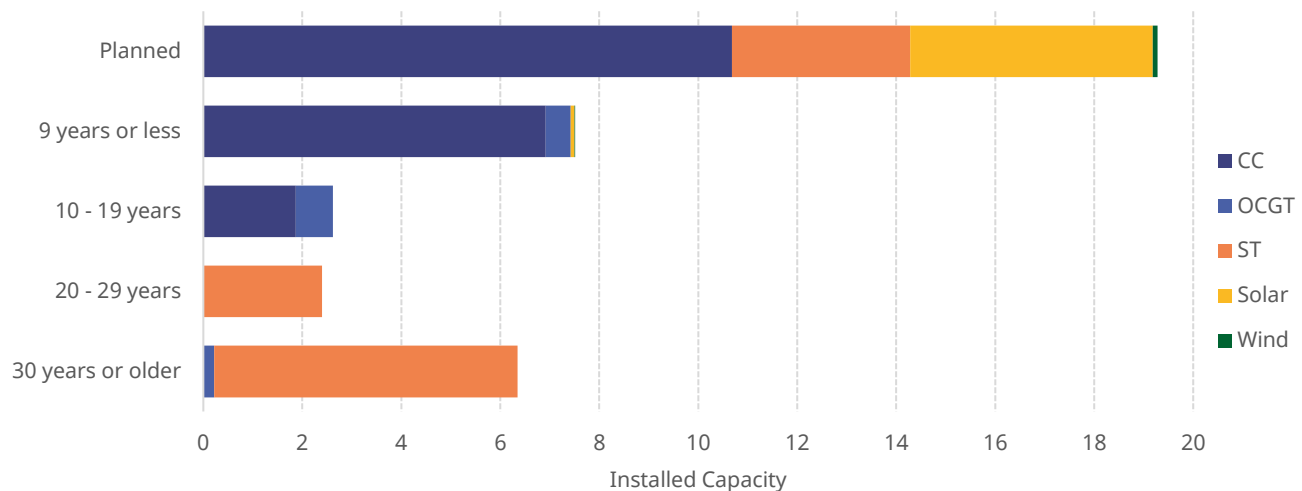


Figure 3 | Age of Kuwait's power generation fleet. CC= combine cycle; OCGT= open cycle gas turbine; ST= steam turbine.

As for renewable power generation, Kuwait is also expected to invest in renewable energy development with the upcoming projects of Shagaya Phase II and Phase III. Shagaya Phase II, which is distinguished as Al-Dibdabah, is under review by the Council of Ministers. This process might delay the execution of the Al-Dibdabah project. For the third phase of Shagaya, Kuwait Authority for Partnership Projects is currently going through the process of establishing a public-private partnership (PPP) structured company, which will develop a 1.5 GW renewable energy multi-technology power station. This company will be tasked to negotiate the power purchase agreement and operating procedures with MEW. The final layout of the station is yet to be decided. Although it is likely that Phase III will have a mix of the three technologies from the first phase, photovoltaic will likely contribute the highest portion of capacity. Overall, the stated goal for Shagaya is to have an installed capacity of 4 GW by 2030.

Role of the Higher Energy Committee (HEC)

The national energy strategy has multiple dimensions and numerous stakeholders. As such, Kuwait has formally created a national champion body to advocate for the coordination for developing and executing Kuwait's energy strategy. The process began in 2013 by the Kuwait Foundation for the Advancement of Sciences (KFAS) that had held a number of workshops for the development of a national energy white paper and resulted in the production of several versions. The white paper development was carried out by the Energy & Building Research Center of KISR. The final version approved by the main stakeholders, entitled *White Paper on a Sustainable National Energy Strategy*, was published in 2017. One of its main recommendations was to establish a national champion body to advocate for policies toward a sustainable national energy system. In 2018, the Council of Ministers issued decree No. 524/2 to establish the Higher Energy Committee (HEC). It assigned the Minister overseeing the Ministry of Oil and the Ministry of Electricity and Water to chair and form the HEC. Under Ministerial decree No. 12/2018, the HEC was formed and included members from

the main stakeholders: Kuwait Petroleum Corporation (KPC), the Ministry of Electricity and Water (MEW), Kuwait Institute for Scientific Research (KISR), Public Authority for Housing Welfare, Kuwait Municipality, Public Authority for Industry, the General Secretariat for the Supreme Council of Planning and Development (GSSCPD), and the Kuwait Foundation for the Advancement of Sciences (KFAS).

The Higher Energy Committee (HEC) has the mandate to develop a roadmap toward the development of a sustainable energy system. Moreover, it has the authority to approve policies and strategies, set priorities, and oversee the implementation of approved mandates intended to ensure local energy security and sustainability. It reports directly to the Council of Ministers semi-annually. The HEC has a *Technical Office* that is overseen by the Managing Director of Planning and Finance at KPC and is responsible for coordinating and monitoring the activities of the specialized subcommittees.

Strategies and Policies Subcommittee: The first subcommittee is a temporary committee on *strategies and policies*. It is headed by the Deputy Director General of KFAS with members from KISR, MEW, GSSCPD, and KPC. The objective of the subcommittee is to draft and advocate the national energy strategy for the State of Kuwait.

Permanent Subcommittees: In addition, the HEC has established a Program Management Office (PMO) and three permanent subcommittees on energy efficiency, renewable and alternative energy, and consumer behavior. The PMO coordinates and reviews the strategies and policies as well as the progress of the three subcommittees. It also reviews deliverables prior to obtaining approvals from the HEC. The *Subcommittee on Energy Efficiency* seeks to improve energy efficiency in the industrial, power generation, and desalination sectors in Kuwait. This subcommittee will also recommend standards for improving energy efficiency in the building sector targeting major drivers of demand, namely air conditioning for space cooling and appliances. It is headed by the MEW and includes representatives from the Public Authority for Industry, Ministry of Commerce and Industry, Public Authority for Housing Welfare, Public Authority for Road and Transport, Kuwait Municipality, Environment Public Authority of Kuwait, Kuwait National Petroleum Corporation, KPC, KFAS, and KISR. The *Subcommittee for Renewable and Alternative Energy* is tasked with developing a clear roadmap for increasing the adoption of renewables and potential clean fuels (such as hydrogen, see Box 1) and setting targets for renewable energy to 2040. This subcommittee is headed by KISR and has representatives from the KFAS, MEW, Public Authority for Housing Welfare, Kuwait Authority for Partnership Projects, Kuwait Municipality, and the GSSCPD. The objective of the third *Subcommittee on Consumer Behavior* is to draft strategies for shaping consumer behavior to rationalize energy consumption. Led by a representative from the General Secretariat for the Supreme Council of Planning and Development, this subcommittee has members from the KISR, MEW, Ministry of Education, Environment Public Authority of Kuwait, and Ministry of Information.

The establishment of the HEC is a positive step towards rationalizing energy consumption and promoting the adoption of renewable and alternative energy; thereby, guiding Kuwait towards a more sustainable energy future. Per capita consumption of energy in Kuwait is among the highest in the world. Per capita electricity consumption in Kuwait was 14.95 MWh in 2015, close to double the average for the Organisation for Economic Co-operation and Development (OECD) countries (8 MWh) and considerably higher than the average for the Gulf Cooperation Council (GCC) countries excluding Kuwait (11 MWh)⁹ (see Figure 4). Having robust representation from several government authorities affords the HEC the insights, access, and the flexibility needed to foster greater horizontal coordination among the various government agencies, which is required to facilitate the implementation of the goals and policies set by the HEC.

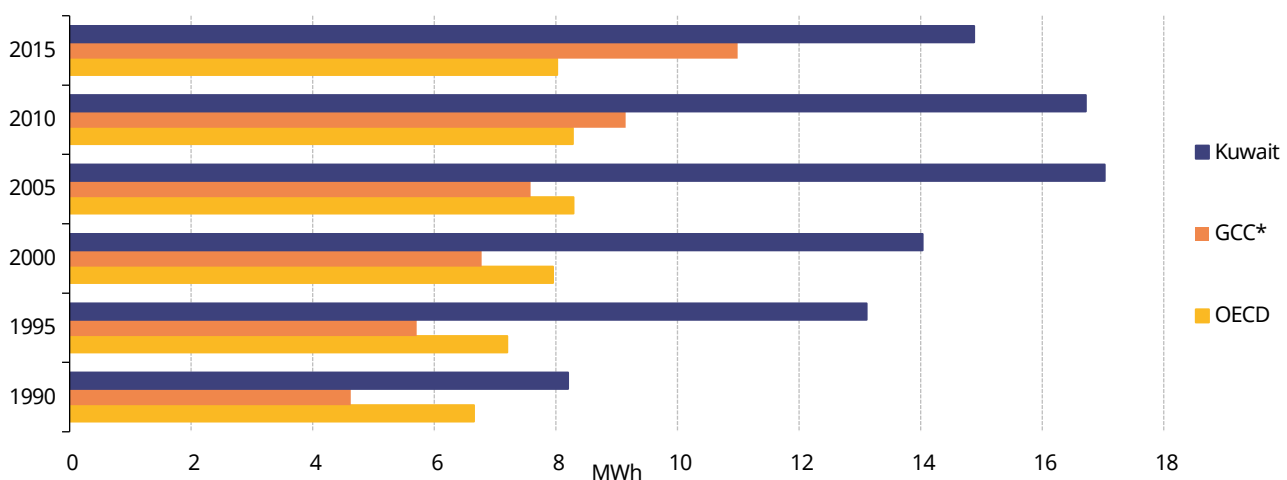


Figure 4 | Based on IEA, per capita electricity consumption in Kuwait compared to averages in OECD and GCC* countries, excluding Kuwait. * Excludes Kuwait.

Box 1 | The Role of Hydrogen in Power Generation Application

Global demand for hydrogen has spiked in the last decade, owing to hydrogen's physical properties of being light, reactive, and having a high energy content per unit mass. Current demand for hydrogen in its pure form reached around 70 million tonnes per year.¹⁰ Until 2019, the primary use of hydrogen globally has been as an industrial feedstock involving the production of ammonia, methanol and petroleum refining. To date, hydrogen has had a negligible role in the power generation sector, accounting for less than 0.2% of electricity generation globally.¹⁰ Nevertheless, the use of hydrogen as an energy source, including in the power sector, has gained momentum globally throughout the development chain from research and development to commercial applications.

The growing global interest in the use of hydrogen in energy systems is driven mostly by the fact that its applications would contribute to mitigating greenhouse gas (GHG)

⁹ Figures for per capita electricity consumption for Kuwait, GCC countries, and the OECD are based on IEA data for total electricity consumption in 2015, which include own use.

¹⁰ IEA, "The Future of Hydrogen - Seizing today's opportunities," June 2019.

emissions. Several pathways are recognized for hydrogen production and various feedstocks, including renewable sources (like biomass), nuclear, and fossil fuels (like oil and natural gas).¹¹ When hydrogen is produced from fossil fuels sources with low GHG emissions via carbon capture, it is referred to as blue hydrogen. These feedstocks of hydrogen could be produced by oil exporting countries in the future. The appealing features of hydrogen have been the drivers for using it as an alternative to current fuels or as a complement in transport, heating, steel production, and electricity generation. In the case of power generation, hydrogen can be used in its pure form, which can be mixed with natural gas. For example, Mitsubishi Hitachi Power Systems has announced the success of a large-scale gas turbine firing test for use in power generation using a 30% hydrogen fuel mix.¹² Alternatively, hydrogen can be converted to hydrogen-based fuels, including synthetic methane, synthetic liquid fuels, ammonia, and methanol for various applications, including power generation.

The minimal use of hydrogen in power generation at the present time is expected to increase noticeably in the future. Given rising environmental concerns and electrification demand, hydrogen is expected to be a key element in future power generation's fuel mix. The IEA¹⁰ foresees the roles of hydrogen and hydrogen-based products in power generation through co-firing ammonia in fossil fuel power stations, which would have a significant impact on mitigating GHG emissions. Moreover, hydrogen will support flexible power generation by overcoming the negative effects of the variable renewable energy on the power system. Dispatchable generators, which could be fired with mixed hydrogen fuel, would compensate for the growing renewables installations and their intermittent production. In addition to power generation, hydrogen can take a back-up role through fuel cell technology in generating electricity, which can be utilized as on- and off-grid distributed energy source.

Currently, several challenges face the utilization of hydrogen in power generation. Using pure hydrogen in power generation is very costly due to high transport and storage costs. The transport challenge could be solved if a hydrogen production facility were included on the power generation site. Hydrogen storage systems still require more investment in research and development to achieve cost effectiveness. The use of hydrogen-based products, such as ammonia, in power generation results in nitrogen oxides (NO_x) emissions, which would require further treatment and, therefore, higher generation costs. However, such additional generation costs could be recovered when demand during peak load hours drives electricity prices higher.

¹¹ F. Al-Ragom, "Reactivity of Iron Powder Fluidized Bed for Solar Hydrogen Production," PhD. Dissertation, Dept. of Mech. & Aerospace Eng., University of Florida, Gainesville, FL, June 2012.

¹² Mitsubishi Hitachi Power Systems, 29 Jan. 2019, (<http://www.powerworldanalysis.com/mhps-successfully-tests-gas-turbine-fueled-30-hydrogen-fuel-mix/>), Accessed Dec. 2019.

Demand

The demand trends reported in this section of KEO-2020 Special Report are based on projections from the Kuwait Energy Model, used in KEO-2019, which highlight energy trends in a Business-As-Usual (BAU) Case. The BAU Case takes into account current policies stated by the government of Kuwait. This Special Report highlights energy sector issues that were not addressed in KEO-2019. As held in the previous KEO-2019 edition, this KEO-2020 holds that *the paucity and opacity of energy statistics precludes a more detailed and comprehensive analysis of Kuwait's energy future*. Over the previous year and in the future, the KISR Energy Policy Team has been engaging with several government agencies to acquire data to enhance analyses of future KEO publications.

Trends in energy demand from KEO-2019 still hold. Although the Kuwaiti government has announced intentions to improve regulations for energy efficiency, energy demand in Kuwait continues to rise. Over the Outlook period from 2015 to 2035, total final energy consumption is expected to increase to 28.6 Mtoe by 2035, growing at an average annual rate of 2.2% (see Figure 5). This growth is lower than in the 2000 to 2015 period, during which energy demand grew at an average rate of 4.8% annually due to a construction boom. During the period to 2035, growth rates in gross domestic product (GDP) and population are expected to be lower than rates during 2000 to 2015. While the residential and services sectors consume 18% of total final energy consumption in 2035, the biggest consumers of local energy are the industrial and the transportation sectors, with consumption levels increasing by 3.1 and 3.8 Mtoe, respectively, over the Outlook period. Energy demand for water desalination grows by 0.3 Mtoe over the Outlook period due to the switch to more energy efficient reverse-osmosis and multi-effect distillation.

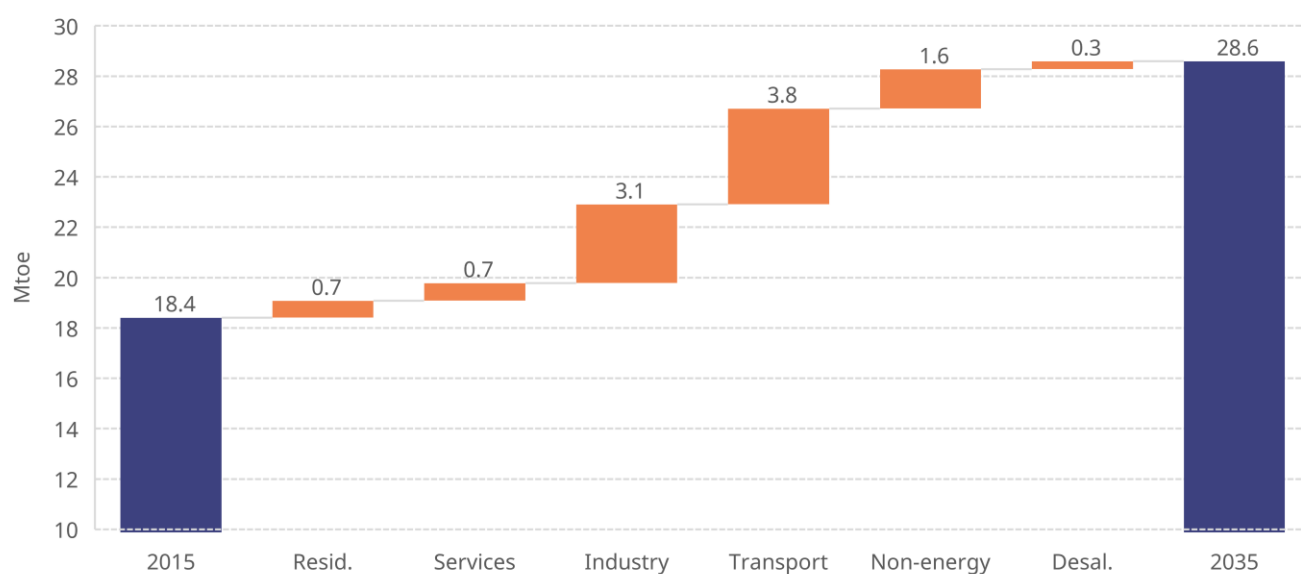


Figure 5 | In the Business-As-Usual Case, demand increases to 28.6 Mtoe over the Outlook period to 2035. Desal.= Desalination.

Energy demand grows most rapidly in the transportation sector. The transportation sector was previously reported in KEO-2019 as one of the biggest drivers for local energy demand growth in Kuwait. The Ministry of Interior reported in 2017 that Kuwait had 1.8 million registered vehicles, accounting for 80% of the total transport fleet. According to model estimates, over the Outlook period to 2035, energy demand in this sector is expected to grow at a rate of 3% per year. Specifically, motor gasoline is expected to grow from 3.7 Mtoe in 2015 to 6.9 Mtoe by 2035, and diesel demand from 0.2 Mtoe to 1.6 Mtoe over the same period. In the KEO-2019 projections, demand for energy in the transportation sector was reported in terms of fuels. In Figure 6, trends are presented for transportation by vehicle type. Due to the lack of public transportation options, ownership of private cars and trucks increase over the Outlook period to 2035. The vehicle fleet is expected to triple. To meet this increasing demand, Kuwait would have to allocate approximately 8.5 Mtoe of motor gasoline and gas oil to supply the transportation sector.

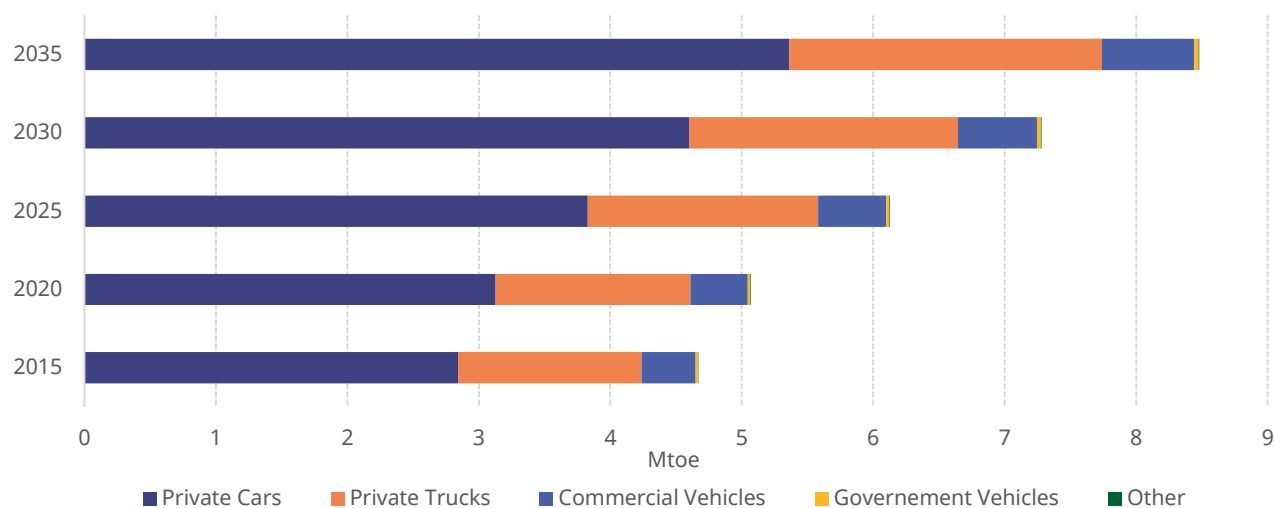


Figure 6 | Energy use by vehicle type over the Outlook period. Energy use in the transportation sector is expected to grow at the fastest rates due to the lack of public transportation options.

Energy statistics are key to a complete analysis of Kuwait's energy sector. A complete analysis of Kuwait's energy sector as intended in these KEO publications has been greatly constrained due to data limitations and shortage in energy statistics across the various agencies in Kuwait. To date, Kuwait Petroleum Corporation has provided to KISR essential historical data, covering the 2015/2016, 2016/2017, and 2017/2018 fiscal years, to allow the start of populating local energy statistics. Members within the Ministry of Electricity and Water seem keen on assisting with data for the publications. Finally, Kuwait's Central Statistical Bureau (CSB) has started perusing the task of developing local energy balances. The energy efficiency subcommittee of the Higher Committee of Energy (HEC) is developing horizontal coordination between KISR and the CSB to develop proper mechanisms for data collection. The engagement with all government agencies has been positive, but the outcome has still been deficient. At the time this Special Report is published, the shortcoming of a lack of disaggregated demand data, especially in the industrial and services sectors, faced in KEO-2019 persists. The model and trends presented in this Special Report use IEA

statistics where local data are missing. Addressing this data shortage will be focal for improving projections and analyses of future KEO publications.

Economic Importance of the Energy Sector and the Necessity of Reform

This KEO-2020 edition provides context and economic analysis of the importance of Kuwait's energy sector and its reform. Due to the paucity and opacity of energy-related data, it is difficult to undertake proper analysis of proposed policy for energy, efficiency, and energy pricing reform in a manner that can meaningfully guide comprehensive reform of Kuwait's energy sector. Therefore, this analysis provides an economic outlook based primarily on the Business-As-Usual (BAU) Case as a guide for reform assessment. To help guide the analysis, assessments from Kuwait Energy Model used for analysis published in the KEO-2019 edition have been coupled with results from a computable general equilibrium model of the Kuwaiti economy used for assessing energy pricing reform.¹³ The economic analysis below is based on simulations for projections in the BAU Case that assume an average international oil price of US \$60-70, given recent economic conditions and oil price movements. The economic analysis on effects of energy subsidy and efficiency reforms below are also based on simulations that assume reductions in the oil price from 2013, the most recent year of high oil prices for which data are available. The economic analysis also assumes no major changes in the economic structure or energy sector public ownership due to transformative technologies or to microeconomic or industrial reform. Any industrial changes are continuous, occurring steadily due to existing economic dynamics. No unexpected changes in the global energy market or the global economy are taken into account.

Despite the country's economic development plans under Vision 2035 'New Kuwait' (Vision 2035) to expand non-energy industries, the energy sector continues to dominate the Kuwaiti economy and is likely to continue to do so in the BAU Case. The decline of the international oil (export) price in mid-2014 and its subsequent modest recovery caused the nominal share of oil and gas sectors (crude, services, and refining) to total GDP to decrease (from 59% in 2013 to 50% in current prices in 2018), falsely suggesting a weakening in the oil and gas sectors' position in the economy. Yet in reality, there was no associated change in Kuwait's economic structure; in constant prices (with 2010 being the base year), the share of oil and gas to GDP stabilized at 55% in 2018, compared with 57% in 2013.

Further, the overall contraction in the oil industry since the decline of the oil export price in 2014 affected all sectors of the economy in a manner that non-oil sectors had not been able to reverse. To demonstrate, between 2013 and 2018, in constant prices, oil and gas sectors' GDP declined by

¹³ M. Shehabi, "Assessing Kuwaiti Energy Price Reforms"; M. Shehabi, "Diversification Effects of Energy Subsidy Reform in Oil Exporters: Illustrations from Kuwait."

9%, and the non-oil sectors' and the overall GDP declined by 12% and 6%, respectively. Oil exports continue to dominate Kuwait's exports, contributing more than 90% in both years (2013 and 2018). In addition to the oil and gas sectors, the role of other energy sectors in the Kuwaiti economy has expanded, owing to a 72% increase in the electricity and water industries' GDP. This increase is entirely for domestic consumption, so does not generate export revenue to the government. These values point to limited improvements towards meeting economic diversification goals of the Vision 2035 plan.

Under the BAU scenario assumptions, there are severe fiscal pressures and no changes in energy consumption patterns or in domestic energy prices. Export revenues will decline in the Outlook period due to oil price movement and declines in global demand for conventional oil and gas. At the same time, subsidies' cost rises with increasing demand, worsening the fiscal deficit throughout the whole Outlook period. Reduced revenue and fiscal deficits have effects beyond the energy sector, as they diminish available resources that are necessary to fund non-oil sector projects and other reforms under the Vision 2035 plan.

The share of non-oil sectors in GDP is likely to increase, albeit modestly and not meaningfully, thus the imperative for economic and energy reform remains strong in the Business-As-Usual scenario. This is the case for the following reasons.

First, in the BAU scenario, the share of non-oil sectors in GDP grows but not their contribution to export or government revenue. Following Kuwait's energy pricing reform that took place in 2016, the expansion of non-oil exports has been limited and mostly in non-tradable sectors, which continue to receive subsidies and pay negligible taxes.¹⁴ The industry that is expected to expand the most is the construction industry, which would generate economic value add in the non-tradable sectors, without improving export or fiscal sustainability.¹⁵

Second, the imperative for economic and energy reform remains strong because oil export revenues over the Outlook period are expected to be inadequate for meeting the government's fiscal commitments. This shortage will follow existing trends and is expected to occur even with the unanticipated volatility in the oil export price. In the fiscal year 2018-2019, the Ministry of Finance reported a fiscal deficit of Kuwaiti Dinar (KWD) 3.346 billion despite an actual oil export revenue that was larger than planned due to modest recovery in the oil price.¹⁶ Over the Outlook period, assuming an average international oil price of US \$60-70, a moderate estimate given recent economic conditions and oil price movements, this fiscal shortage is likely to persist because of volatility of demand and the global energy transition. The latter causes downtown pressures on global demand for hydrocarbons. Moreover, the growth in domestic energy supply allocated to

¹⁴ M. Shehabi, "Diversification Effects of Energy Subsidy Reform in Oil Exporters: Illustrations from Kuwait."

¹⁵ M. Shehabi, "Diversification Effects of Energy Subsidy Reform in Oil Exporters: Illustrations from Kuwait."

¹⁶ Ministry of Finance, "Closing Accounts for the Financial Management of the State of Kuwait for Financial Year 2018-2019."

exports will be insufficient to generate additional revenue that could meet budgetary requirements. That is the case because a larger share of supply will be allocated to domestic commitments to meet domestic energy demand— expected to grow by 2.2% over the Outlook period.

Third, local energy consumption and future demand in Kuwait are unlikely to decline. The expected expansion of the construction industry for residential and nonresidential buildings entail greater needs for cooling capacity. Therefore, overall energy requirements will increase given inadequate energy pricing and efficiency reform. Energy subsidy reform in Kuwait has been slow, especially when compared to other oil producing economies in the region. Meaningful energy price reform shows no sign of being a government priority, as no reform has occurred since August 2016 when domestic gasoline prices were raised, contributing to a reduction in energy consumption by both households and intermediate industries.¹⁷ Yet these energy price increases have not impacted consumption of energy by electricity and water desalination, the most subsidized energy-intensive industries. Total reported subsidies received by the electricity and water industries increased from 30% of these industries' consumption (at consumer prices) in 2013 to 37% in 2015 (the most recent available complete sectoral data).¹⁸ Over the Outlook period, the value of subsidies received by these two industries is expected to continue to grow with the expansion of electricity supply and the construction of new power plants.

The 2016 energy price reform was also inadequate because the ensuing drop in welfare, measured by real disposable income- deflated for consumer price index (CPI), was temporary in nature, thus causing a temporary reduction in energy demand. This drop was alleviated by subsequent increases in government subsidies and by subsequent economic recovery owing to the increase in the international price of oil. Demand for energy by the transportation industry is expected to increase in the Business-As-Usual Case, contributing 28% of total increased energy demand. The growth in the transport sector in the BAU Case is unsustainable as it will account for 22% of total emissions in 2035. In sum, in the BAU Case, the consequences are negative both for the potential export revenue as well as emissions, which will in turn have negative health, environmental, and quality of life implications.

Fourth, total subsidies and energy subsidies have increased and are expected to continue to increase over the Outlook period. Between 2013 and 2015 (the most recent sectoral data available), reported total industry and consumption subsidies rose by 17%. Total subsidies received by the electricity and water industries increased by 7% during the same period. In the 2018-2019 government accounts, total reported subsidies (excluding other transfers and goods and services)

¹⁷ M. Shehabi, "Assessing Kuwaiti Energy Price Reforms"; M. Shehabi, "Diversification Effects of Energy Subsidy Reform in Oil Exporters: Illustrations from Kuwait."

¹⁸ Kuwait Central Statistical Bureau, "National Accounts Statistics: Input and Output Table," (2013, 2015).

reached KWD 1.43 billion, 6.5% of total expenditures.¹⁹ In 2018, the sum of total subsidies officially reported exceeded 8% of GDP. Detailed data for the electricity and water industries are limited, but subsidies are reasonably estimated to be very high. This is evidenced by the large discrepancy between the official figures reported in the Ministry of Finance's closing accounts for 2018-2019 for MEW's expenditures (KWD 2,527.5 million) and revenues (381.6 million), which amount to a deficit of 85% in 2018-2019.

As for households, their consumption of electricity remains highly subsidized. The electricity price has remained at 0.002 KWD/kilowatt-hour, reflecting an estimated subsidization rate of approximately 90-94%. In the BAU Case, residential electricity demand is expected to grow at an average of 1.2% per year, from 27.2 terawatt hour (TWh) in 2015 to 34.4 TWh in 2035. Assuming efficiency levels, margins, and production costs remain constant, simulations estimate that the cost of subsidizing residential electricity consumption would increase by 26% between 2015 and 2035, reaching a total of KWD 1.2 billion at the end of the Outlook period (see Figure 7). High subsidies contribute to excessive and wasteful consumption, so Kuwait is likely to continue to be one of the world's largest per capita energy consumers.

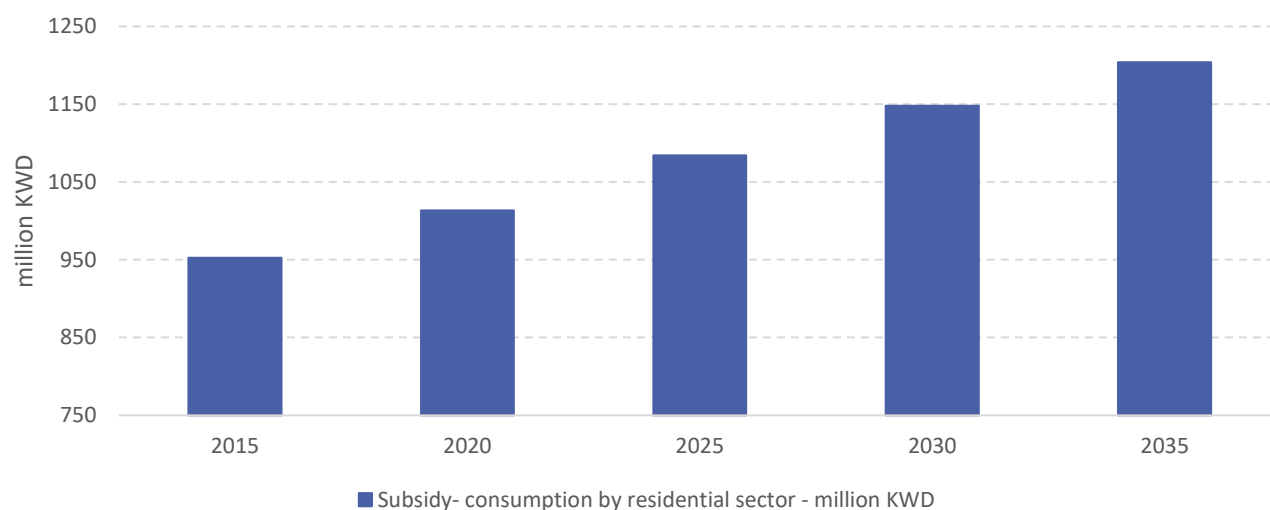


Figure 7 | Simulated nominal costs of subsidizing residential electricity consumption given total energy demand estimates of the Business-As-Usual Case and assuming constant efficiency levels and margins.

Fifth, the development and deployment of renewable energy sources in power generation continues to be slow. This fact would entail increased reliance on subsidies to accelerate renewable energy expansion as well as continued and increased reliance on imported natural gas for power generation and water desalination. Consequently, the government will bear additional costs of increased fiscal, environmental, and energy security implications. Implementing energy and

¹⁹ Ministry of Finance, "Closing Accounts for the Financial Management of the State of Kuwait for Financial Year 2018-2019."

economic reforms is thus imperative to reduce energy consumption and increase the potential hydrocarbon and non-energy export revenue.

Based on the aforementioned analysis and simulations, two areas of reform appear imperative and urgent: energy subsidy reform and efficiency reform. Examples of policies and measures to apply efficiency reform are detailed in the KEO-2019 edition.

Reforming energy subsidies is a necessary step towards more efficient allocation of economic resources and reduction of wasteful consumption as well as achieving fiscal and economic sustainability.²⁰ Such reform will largely reduce energy consumption and, therefore, the fiscal cost of subsidies, healthcare, and environmental protection. The ensuing fiscal savings can serve as resources required to fund various elements of the government's development initiatives. The implementation of energy subsidy reform will cause a decline in the real disposable income (defined as the post-tax and benefit income available to household, adjusted for price changes and CPI) that would be initially high in the first few years. If applied during episodes of economic contraction such as that following a drop in the oil export price, then energy subsidy reform would have an initially larger negative and contractionary effect on all economic activity, production (including non-energy exports), overall consumption, and welfare.²⁰

To demonstrate, simulations show that in the long run, reducing energy (excluding electricity) subsidy by 5% can reduce real GDP by 1.4% if implemented during a stable international oil price environment, compared with a decline as big as 10.1% if implemented following a 5% decline of the international oil price.²¹ Similarly, simulations show that this energy subsidy reform in a low oil export price environment reduces real disposable income, CPI inflated by 3.67% in the short run and by 5.8% in the long run.²² To mitigate these negative effects and inflationary consequences, implementing energy subsidy reform during high or stable international oil prices is a viable option.

Furthermore, reducing electricity and water subsidy is also necessary for a complete and meaningful energy price reform. This is particularly important as electricity consumption increases (due to population growth) and also as the total cost of producing electricity increases over the Outlook period (due to the construction of new power plants, deployment of renewable energy sources, and importation of natural gas for power generation). While necessary, energy subsidy reform requires careful assessment and planning given the political sensitivity of this endeavor. The negative effects of energy pricing reform can be substantially mitigated if said reform is

²⁰ M. Shehabi, "Assessing Kuwaiti Energy Price Reforms."

²¹ M. Shehabi, "Is Energy Subsidy Reform in an Oil-Exporting Small Economy Beneficial to Trade? Illustrations from Kuwait."

²² M. Shehabi, "Assessing Kuwaiti Energy Price Reforms; M. Shehabi, "Diversification Effects of Energy Subsidy Reform in Oil Exporters: Illustrations from Kuwait."

applied in combination with other microeconomic reforms, such as competition and productivity reforms.²²

Energy efficiency reform offers ample opportunities for reducing energy consumption, improving Kuwait's environmental footprint, maximizing hydrocarbon resources available for exports, and enhancing security of energy supply. Applying said reform has distinct advantages: it is one of the most cost-effective ways to achieve these desired results; its application is politically less challenging than energy subsidy reform; and it can enhance the country's comparative advantage while also supporting its diversification efforts. Measures and technologies that improve energy efficiency can reduce wasteful energy consumption without disturbing the country's economic structure or dynamics. Such measures will be most effective if applied in the sectors that are growing the largest and/or in which demand is increasing the fastest, namely: transportation, cooling, refining activities, electricity generation, and water desalination. Some improvements in energy efficiency can be achieved with the enforcement of stricter codes and regulations in the buildings sector.

Importantly, energy efficiency measures can also be applied as part of the aforementioned microeconomic reforms that would mitigate the negative effects of energy subsidy reform. Therefore, energy efficiency reform would indeed facilitate the application of energy pricing reform. Such complementary reforms can be applied through well-known policy avenues, including regulations and standards, market-based incentives, and innovative financing models. Finally, energy efficiency measures applied to consumer behavior, fuel efficiency, and vehicle type would reduce the unsustainable environmental effects of the growth in transport demand.

As Kuwait advances towards the development goals of its Vision 2035 'New Kuwait' plan, the Business-as-Usual Case shows that it will not be possible to achieve the Vision's targeted goals of reducing energy consumption and raising the renewables' share in energy production to 15% of supplied capacity. Achieving these goals will not be possible unless appropriate reform is applied, of which energy subsidy and energy efficiency are the most important and urgent areas. The implementation of these reforms ought to be done in combination with or parallel to a larger set of policies or reforms that are part of the Vision 2035 plan. They can also be incorporated as a part of new policies and regulations surrounding renewable energy generation and new power plant construction. Therefore, successful implementation would require extensive data assembly to support careful and comprehensive assessments of the effects of these reforms, not only on the government, but also on industries, household consumers, export sectors, and the environment.

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