Kuwait Energy Profile for Electrical Power Generation

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ABSTRACT

The State of Kuwait, a major oil exporter, consumes a huge amount of its natural hydrocarbon resources to meet the rising demand for electricity. The forecasting of domestic energy demand and optimal allocation of energy resources are necessary requirements for a balanced energy policy. This article assesses the energy resources profile of Kuwait in order to reveal the potential base and level of utilization of resources. The analysis of the energy profile indicates that, in 2009, Kuwait had proven crude oil reserves of 104 billion barrels and 63 trillion cubic feet of natural gas reserves. Heavily sustained, subsidized electricity and water prices are the main factors behind the rise in irrational consumption (demand). The analysis revealed that the installed capacity of electricity and water supply can barely meet the rising demand. The article proposes sustainable strategies regarding the energy resources required for generating electricity. The strategic thrusts for the energy policy should now be centered on venturing into alternative energy, restructuring the low prices charged for electricity and water, diversifying sources of income in the economy, and determining the role of natural gas in the energy balance forecast.

INTRODUCTION

Over the last five decades, total consumption of electricity in Kuwait has increased drastically. Between 1960 and 2008, total consumption of electricity increased from 380 million kWh to 45,234 million kWh. The rise in consumption was largely due to increases in both per capita consumption and population. In particular, over the period 2000-2009, annual per capita consumption of electricity increased at an annual rate of 6.8%, surpassing the population average growth rate of 3.9% per annum (Ramadhan, 2011). However, the capacity for power

generation has not been able to keep pace with the surge in demand. The forecasting of energy demand and optimal allocation of energy resources are necessary requirements for a coherent and balanced energy policy. A prerequisite step in this regard is to evaluate the energy resources profile of Kuwait in order to reveal potential base and level of utilization.

Kuwait is a small country with a rich, open economy and an abundance of hydrocarbon resources*. By the end of 2009, proven crude oil reserves were estimated at around 104 billion barrels (8% of total world oil reserves), and reserves of natural gas were estimated at 63 trillion cubic feet (1% of global proved reserves). Kuwait produces a relatively modest volume of dry natural gas, approximately 449 billion cubic feet in 2009. Most of the dry gas is associated gas and therefore linked to oil production. While Kuwait is major oil exporter (about 2.4 million barrels per day), it also consumes a huge amount of its natural hydrocarbon resources to meet the rising demand for energy, in particular electrical power (IEA, 2010).

Kuwait relies almost exclusively on fossil fuels, primarily oil and natural gas, for its energy supply. Oil is the vital component of Kuwait's energy supply, representing more than 62% of its total primary energy supply in 2009, when its total primary energy consumption reached around 185 million barrels oil equivalent. More importantly, most energy consumption is for electrical power generation. Assuming a conservative crude oil price per barrel of US$ 50, the total cost of primary energy sources was estimated to be nearly US$ 9 billion, around 30% of GDP, in 2009 (MEWa, 2009).

OVERVIEW OF KUWAIT'S ENERGY PROFILE

Oil

Generally, Kuwait's oil production is primarily defined by OPEC's quotas policy, the world oil market, and global economic growth. However, as most of the oil fields in Kuwait are over 60 years old,

*The GDP in 2009 was around $112 billion, and per capita income was estimated to be $31,482, one of the highest in the world. The economy depends heavily on oil exports and revenues. Oil accounts for 50% of GDP, 95% of exports, and 80% of government income. Kuwait has a very high savings rate (averaging 30% of GDP), by which huge financial surpluses were accumulated over the years and invested in global markets.

physical production capacity has been the key constraint in limiting total oil production and exports. In 2009, Kuwait's total oil production was around 2.5 million (bbl/d), with 2.3 million bbl/d being crude oil and 200,000 (bbl/d) being non-crude liquids. Kuwait's total oil consumption equaled around 350,000 (bbl/d) (EIA, 2010). As current export levels are not constrained by OPEC quotas, Kuwait is looking to expand its oil production to 4 million (bbl/d) by 2020. All oil that is freed up can be exported or refined.

Natural Gas

In 2008, Kuwait began production of approximately 175 million cf per day from several fields found near Sabriya and Umm Niga (with an estimated 35 Tcf of non-associated gas). Kuwait also consumed approximately 449 Bcf of natural gas. On average, natural gas consumption has always equaled production. However, in recent years, the demand of natural gas for electricity production has surpassed natural gas production during the summer months, resulting in the shutdown of refineries and petrochemical operations to meet the increased demand for electricity. To alleviate the demand shortage, in June 2009, Kuwait signed a deal with Shell Oil to import liquefied natural gas (LNG). The first shipment was received in August 2009, at the Gulf region's first LNG regasification terminal, Mina al-Ahmadi Gas Port. The facility has a regasification capacity of approximately 10,300 tons of LNG (500 million cubic feet) per day. Kuwait and Qatar continue to explore options by which Qatar might supply Kuwait with LNG cargoes*. Negotiations between Kuwait and Iran regarding the disputed Dorra offshore natural gas field are also under process; any development requires resolution of demarcation issues†.

Based on the current energy balance, Kuwait seeks to significantly increase its use of natural gas in electricity generation, water desalination, and petrochemicals in order to allocate more oil for export. Plans are to increase drilling for natural gas and to limit flaring of associated gas by upgrading the necessary infrastructure. The facts

*Besides Qatar, Kuwait seeks to import natural gas from Iran, most likely from its huge South Pars gas field. Iran and Kuwait signed a preliminary memorandum of understanding for natural gas sales in March 2005, but commerce requires the resolution of maritime border issues in the region, specifically with regards to the Dorra field.

†The Dorra field has been claimed by Saudi Arabia, Kuwait, and Iran. It may contain up to 11 Tcf of recoverable natural gas reserves, still not in production.

derived from the above analysis were emphasized in the 2009 Kuwait national energy policy, which is centered on three main objectives (www.kpc):

- Increase the refining capacities by up to 50% within 5 years.
- Double lean gas production and commission future gas fields so that gas could represent up to 40% of Kuwait's energy production (compared to 20% today). This strategic feedstock should enable Kuwait to become self-sufficient in the gas required for power generation.
- Capitalize on the savings of fossil fuel that is about to be used by power stations to meet the soaring demand of electricity and water.

DEMAND FOR ELECTRICITY AND WATER

Domestic electricity and water production constitutes a major part of the total energy mix. In 2008, electricity fuel consumption was estimated at 14,000 ktoe, representing more than 55% of Kuwait's total primary energy supply. Electricity consumption in Kuwait has been rapidly expanding during the past three decades; total consumption more than doubled over a period of 12 years, rising from 21 TWhe in 1996 to 51.7 TWhe in 2008. Water demand witnessed a strong increase in the post-war decades, stabilizing at levels around 190 m^3/person per annum in the late 2000s. In 2008, more than 93% of fresh water demand was supplied by desalination plants. It was estimated that the domestic sector accounted for 81% of water demand in Kuwait (MEWb, 2009). The high growth in demand for electricity and water was driven by several factors, primarily:

- Growth of the economic activities facilitated by high oil revenues
- High growth rate of the population, due mainly to the influx of expatriate labor
- Improvements of living standards and a greater proliferation of electric appliances
- Sustained low prices for electricity and water
- Widespread use of air conditioning systems, due to the hot summer desert weather

The above factors have influenced the accelerated rise in electricity consumption. The most important of these factors is the government electricity and water subsidy program. Since its inception in 1966, the electricity and water subsidy program has aimed to enhance public social welfare by heavily subsidizing more than 95% of the cost of electricity. Over this period, consumers were only liable to pay the minimum of 2 Fills/kWh (less than one cent) out of the electricity generation cost of 34 Fills/kWh (12 cents). This public policy is characterized by a lack of energy conservation efforts, resulting in a huge waste of energy resources in terms of allocation and efficient utilization. More importantly, it has reinforced the behavior of negligent consumption of electricity by the public (Burney et al, 2007). Initiatives to raise these prices were met with strong opposition from the Kuwaiti parliament, and the government has shifted its efforts to large-scale awareness campaigns to curb electricity demand.

ELECTRICITY AND WATER PRODUCTION INSTALLED CAPACITY

In 2008, Kuwait had an installed capacity of 11.6 GWe of electricity production units and 423.1 MIGD (1.9 million m3/day) of water desalination capacity. Kuwait produces a large share of its desalinated water from dual-purpose (cogeneration) plants producing power and water. Water and electricity pairing allows significant reductions in total energy consumption when specific designs are used. The production of water and electricity is concentrated in 5 locations close to the main loads (major urban centers and industrial zones), with each location hosting 6-25 units of generators (MEWb, 2009). In order to face the growing demand of electricity and water, a series of plants are planned or are already under construction. The majority of the new plants will add capacity to the current five key electricity production sites.

In 2008, heavy fuel oil represented more than 55% of the total fuel used by power plants (in terms of equivalent oil energy). Heavy fuel oil remains the least expensive fossil fuel in Kuwait's current fuel mix. With the recent construction of natural gas power plants, the share of natural gas in Kuwait's fuel mix increased and reached more than 25% in 2008. Some gas turbines are adapted to run on different

fossil fuels (mainly gasoil), but natural gas is usually given priority, as it remains cheaper than other alternatives. However, constraints on the supply of natural gas have limited its share of the fuel mix.

The Ministry of Electricity and Water (MEW) is the sole provider of electricity and water in Kuwait. Therefore, the electricity generation industry is fully state-owned and is vertically integrated with the oil industry*. Fuel for the production of electricity is provided by the Kuwait Petroleum Corporation (KPC) to the MEW at no charge. KPC also decides what fuel can be used for power stations. Such decisions are directly tied to export schedules and production constraints. As a result, the MEW has limited visibility on the projected availability of different fuels for electricity production. The lack of direct control over the supply of fuel types can undermine all efforts to build long-term plants for electricity generation. Kuwait must address this critical issue, given the challenges it will face in the coming decades.

CONCLUSION

Kuwait has one of the highest per-capita electricity and water consumption levels in the world. Sustained, low prices have largely contributed to the increase of per-capita electricity consumption. The current government action on high consumption has been mainly limited to awareness campaigns. In addition to the value of the consumed resources, the large amount of fossil fuels consumed is negatively impacting Kuwait's local environment through the emission of carbon dioxide, NO_x, and SO_x gases. Kuwait's global image is also impacted—the country is rated as the third highest CO_2 emitter per capita in the world (Ramadhan, 2011). Due to the important role of oil in the Kuwait economy, it is in the interest of Kuwait to prolong the expected life of its supply of fossil energy. This can be achieved through these parallel strategic thrusts:

1. Kuwait consumes large amounts of fossil fuel to generate electricity for local consumption. By considering other types of alternative or renewable energy for power generation, Kuwait can

*The new, four-year development plan (2010/11-2013/14) indicates that Kuwait is considering the privatization of the generation sector.

lower its consumption of fossil fuel and consequently prolong the life of its oil reserves and increase its export quantity. The domestic energy mix should be diversified away from fossil fuel. This argument is very hard to sell to the decision makers in light of the abundance of hydrocarbon resources; however, the accumulated savings of financial capital must be used to explore initiatives in the areas of solar, wind, and nuclear energy. In addition, venturing into these new, clean technologies will have a positive spillover effect on the economy and will create many white-collar jobs for the Kuwaiti labor force.

2. Kuwait should aim to diversify sources of income by promoting the non-oil sector. The country has adopted an aggressive development plan in order to achieve, among others, this objective. By lessening dependency on oil, Kuwait's reliance on the oil export market can be relaxed to a certain degree.

3. Since the residential sector accounts for the bulk of electricity demand, the government must take major steps to reform and gradually eliminate the electricity and water subsidy program. This action will force users to consume electricity and water more rationally, leading to a lower per capita consumption in the long run.

4. The supply of natural gas could play a key role in future development of the electricity and water production sectors; Kuwait should seek to significantly increase its use of natural gas in electricity generation, water desalination, and petrochemicals to allocate more oil for export. Plans are to increase drilling for natural gas and limit flaring of associated gas by upgrading the necessary infrastructure. The availability of natural gas, whether through local production or imports, will determine the extent to which Kuwait can rely on combined cycle, gas-fired turbines (CCGT) to produce electricity. Within this context, the use of alternative (renewable) energy and gas-fired options for electricity generation must be analyzed.

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