

ELECTRICAL GENERATION, TRANSMISSION AND DISTRIBUTION NETWORK IN KUWAIT

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Abstract: This research presents the history of electric power in the State of Kuwait and the sources used to generate this energy and the size of the electrical network and how to generate and distribute this energy till reaches to the homes and also present future solutions proposed to produce electricity from renewable sources such as the sun and wind

Keywords: electric power, electrical network, generate and distribute, produce electricity.

1. INTRODUCTION

Electricity entered Kuwait in 1913 through a contract with a British engineer to be incorporated into the SEEF Palace. Its delivery to the population began in 1934 through a small power generating station established by Kuwait Electricity Company Limited, which was established at the request of a group of traders with the approval of Sheikh Ahmed Al-Jabber Al-Sabah, [1]

Nasser Al-Amoud was entrusted with the task of setting up the Kuwait Electricity Project under the supervision of the British Electricity Company. He completed his mission successfully. He is of Kuwaiti origin living in Iraq. He established the electricity project in the city of Kirkuk and the city of Amara under the supervision of the British company. The population in Kuwait had a low electricity demand, reaching 700 in 1940, which led to the bankruptcy of the company and the transformation of the concession to other company. [2] The second power plant was established in Al-Mirqab area and started operation in early 1949. After the reconstruction and development and the increasing in demand for electricity, the Government of Kuwait in 1951, Sabah bought the shares of the National Electricity Company and established the General Electricity Department.

Sheikh Jaber Al-Ali Al-Salem Al-Sabah was appointed as its Chairman. [3]

In 1952, the Electricity Department constructed the first electric power plant in the Shuwaikh area near the coast and was named it Shuwaikh station. Now the power stations in Kuwait are Shuwaikh, Shuaiba North, Shuaiba South, Doha East, Doha West, Sabyia station and AZ-AZur north and south.

In 1934 electricity started the production with two generators with a capacity of 30 kW of direct current and voltage of 200 volts. With the increasing need for electricity, the company gradually converted to a 3-phase system of alternating electricity and ceasing direct current work in 1950. Electricity production in 1951 was 1,100 kW. In the same year, the Government of Kuwait bought the company's shares and established the general electricity management. In 1952, the installation of generators started at Shuwaikh Electricity Station, the first power plant in Kuwait. [4]

2.1. Generation.

The first source of electricity consumed in Kuwait is chemical energy in fuel consisting of gas and liquid petroleum products. The process of converting primary fuel energy into electrical energy is carried out in several stages within generating stations (and distillation), which includes special and complex equipment. Large financial investments require oilers that burn huge quantities of fuel and turn their chemical energy into thermal energy that produces large quantities of compressed steam at very high temperatures. This steam, in turn, turns on steam turbines that convert the steam energy. Exclusive to the kinetic energy runs electric generators that convert kinetic energy into electrical energy, and exported to the electrical grid for transmission and distribution, and deliver them to subscribers.

The power facility uses steam thermal turbines mainly to generate the electric power needed to meet the electrical demand. The generation plants also include some of the gas thermal turbines, which constitute about 28.7% of the total installed capacity, which is usually used in emergency situations and when the maximum electrical load occurs except they remain available for high-volume use due to high gas turbine operation and low thermal efficiency.

For the operation of the power generation plants, the fossil fuels available in Kuwait from their local sources are natural gas, heavy fuel oil, crude oil and gas oil according to the design of the boilers in the stations, giving priority to the natural condensation within the available quantities. The old stations burn the gas in addition to the gas oil in the case of emergency; the modern stations are capable of burning four fuels.

The power plant has grown in quantity and quality over the past five decades. After the first steam station in 1952 with a total capacity of 2.25 MW (three units of 0.75 MW), the plant sizes increased until they reached the 1980s, 1984 to a capacity of 2400 MW (eight units of 300 MW capacity) and the South Zor station and the Sabyia station, all of which are in service.

Naturally, the construction of larger stations in terms of the number of units and their sizes was the only way to meet the increasing demand which was rising at high rates in the 1950s and 1960s and until the 1970s, but began to calm down during the eighties.

The total electricity capacity in 2010 is 11.300MW and total primary energy in 2009 is 30.173 ktoe.

The two main sources of Kuwait are oil and natural gas where Kuwait is member of the Organization of Petroleum Exporting Countries (OPEC), exporting the fourth largest volume of oil among the group in 2010. [6].

Oil: 66.5%

Natural gas: 33.5%

In 2009, Kuwait generated 53126 GWh of electricity.

KUWAIT'S SOURCES OF ENERGY 2009

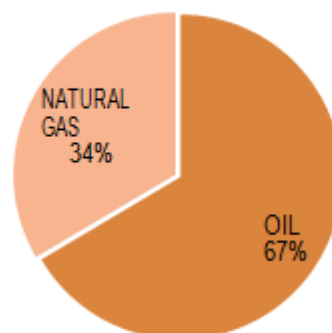


Figure 1

Electrical energy sources of some power plants at Kuwait as the following table:-

Az-Zour South	Natural gas
Al-Subiya	Natural gas
Az-Zour North Phase1	Natural gas
Al-Khairan	Low sulfuric fuel oil and natural gas
Az-Zour North Phase 2	Natural gas
Doha West Power plant	Heavy Fuel Oil

2.2. Network size.

2.2.1 Generating capacity of the system:-

The State of Kuwait is one of the highest in the world in the consumption of electricity, where the consumption of the capita in the country about 15 kWh in 2012 to become one of the top five countries in the world in electricity consumption [7]. Now the generating capacity of electric network at Kuwait close to 16.0GW and it is expected to reach 28 GW by 2030. [8]

2.2.2 Maximum demand ever realised:-

In August 2016, the Ministry of Electricity and Water recorded the highest rate of electricity consumption in its history at about 13.39 GW. [9]

2.2.3 The maximum demand of electricity in the most recent year:-

So the maximum demand of electricity in the most recent year is 13.39GW at 2016.

2.2.4 Generation Peak Utilisation Factor:-

The Ministry of Electricity and Water in Kuwait recorded the highest consumption rate in this year 2017 with a value of 13.800GW, while there is the amount of electricity currently in the electrical network has at this moment 16.700 GW, therefore the utilisation factor of electrical network in Kuwait is 82.63% in 2017. [10]

2.2.5 The annual electrical energy used in the most recent year:-

The annual of electrical energy used in Kuwait in 2014 is 54,000,000,000KW.h/yr. and the average power per capita is (watts per person) is 2176. [11]

2.2.6 Number of large power stations:-

In Kuwait number of large power stations are five power plants Az-zour north power plant, Doha East Power plant , Al-shuaiba south power plant and Al-Subiya power plant [12].

The following table overview the large power stations of Kuwait:-

Project	Generation capacity	Plant type
Al.zour north	4800MW	Gas turbine
Al-sabiya	1000MW	Gas turbine
shuawikh	2000MW	Gas turbine
Doha east	2300MW	Steam turbine
Al-shuaiba south	1400MW	Steam turbine

2.3 Transmission and Distribution.

Kuwait is a member of Gulf Cooperation Council (GCC) that consists of six countries the Saudi Arabia, United Arab Emirates (UAE), Qatar, Oman and Bahrain. These countries face rapid growth in demand for electricity.as a result GCC established one electrical network in all six countries that contains of three phases. Completed in 2012.this project connected the southern system (UAE, OMAN) to the northern system (Kuwait-Bahrain-Saudi Arabia and Qatar).

Kuwait is importing the electricity from the northern system to meet the electricity demands. [13]

2.4 system.

The system operating frequency in electrical network of Kuwait is 50HZ and the tolerance of this frequency is between (50 ± 3) HZ. [14]

□ Voltage levels

I. Voltage generation: this stage is carried out in power plants, which often generate electricity at a voltage of up to 11kV with very high current based on generator capacity. All the generators are connected to the BUS and then to the transformers which are raising the voltage to 300 kV ready for to transfer.

II. Voltage Transmission: A 300KV go to substations to lower 300KV to 132KV, 33KV and 11KV these voltages called high voltages grid.

III. Voltage Distribution: When the voltage is lowered to 11KV, it goes to other substations to lowers 11KV to 415V three phases and 230V single phase (415V and 230V called utilization voltages).[15]

2.5. Growth in demand.

The growth of the population and the development in the State of Kuwait led to increase the demand for electricity is strong and the Kuwaiti government has provided this service at a very low price throughout history. The first production cost was equal to the sale cost but over time the Kuwaiti government reduced the price of electricity, this led to occur gap in the price between production and sale.

In 1953 the sale price was 27 fils/kwh but in the period from 1953 to 1955, when oil was discovered in the country, the government reduced its price cap to 18 fils/kwh. Electricity tariffs continued to decline over the years until 1966 when the government set a price of 2fils/kWh for industrial companies and 1fils/kW for ordinary consumers. These prices are very low for the world price and this tariff is still in place. Figure.2 view the gap between the cost and price of electricity in Kuwait (from 2004 to 2011)[16]

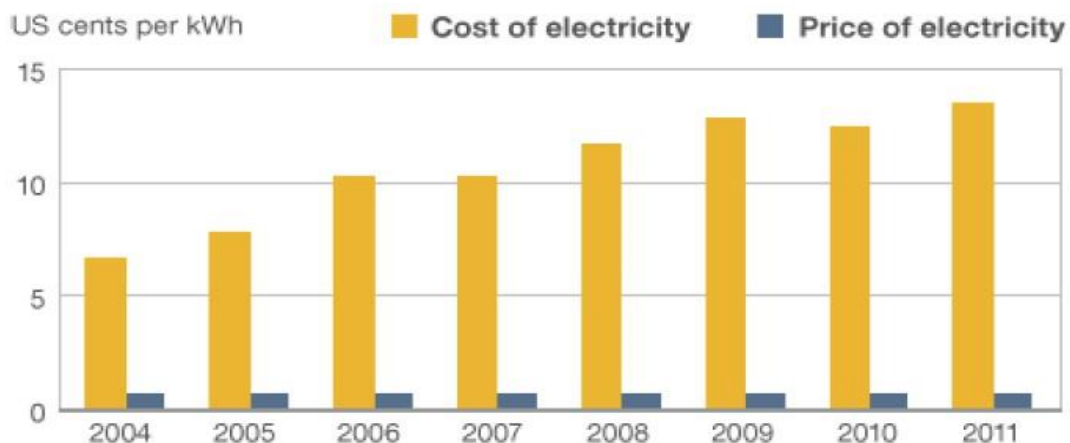


Figure 2: (gap between cost and price of electricity in Kuwait)

2.6. Personal viewpoint

The State of Kuwait is one of the countries with the sun shining over the four seasons of the year so I would suggest if the sun is used to generate electricity from solar energy, which may make Kuwait exports electricity in the near future and Wind is considered an important element in Kuwait. My opinion is that the State of Kuwait must more interested in producing electricity from renewable sources such as the sun and wind, because of its many advantages, besides being a friend of the environment, does not cause any pollution to the atmosphere.

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