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BÖLGESEL KALKINMA İKTİSADI TEZLİ YÜKSEKLİSANS PROGRAMI

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THE ROLE OF ENERGY IN REGIONAL DEVELOPMENT: A CASE STUDY FOR DUHOK

YÜKSEK LİSANS TEZİ

Danışman: Dr. Öğr. Üyesi Adem AÇAR

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SOSYAL BİLİMLER ENSTİTÜSÜ MÜDÜRLÜĞÜ'NE

Siirt Üniversitesi Lisansüstü Eğitim-Öğretim ve Sınav Yönetmeliğine göre hazırlamış olduğum " **The Role of Energy in Regional Development: A Case Study for Duhok**" adlı tezin tamamen kendi çalışmam olduğunu ve her alıntıya kaynak gösterdiğimi taahhüt eder, tezimin kâğıt ve elektronik kopyalarının Siirt Üniversitesi Sosyal Bilimler Enstitüsü arşivlerinde aşağıda belirttiğim koşullarda saklanmasına izin verdiğimi onaylarım.

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Bu çalışmanın temel amacı bölgesel kalkınma sürecinde enerjinin rolünü Duhok örneğinde elektrik talebi bağlamında incelemektir. Elektrik talebi gelişmekte olan ülkelerin hem ekonomik büyüme hem de ekonomik gelişme süreçlerinde önemli bir rol üstlenmiştir. Dünya ölçeğinde elektrik talebi zaman içinde önemli değişimler geçirmiş ve bu etkiler bölgesel kalkınma süreçlerini de etkilemiştir. Özellikle Irak'ta rejim değişimi sonucunda açığa çıkan istikrarlı siyasal ortamında ekonomik gelişme süreci elektrik talebinde önemli bir değişime yol açmıştır. Bu değişimin bir sonucu olarak Duhok'ta temel bir problem olarak elektrik kesintileri hâkim bir durum olarak göze çarpmaktadır. Bu bakımdan bu çalışma Duhok'ta elektrik talebindeki değişimi açıklamak için önem arz eden 1995-2003 ve 2003-2017 dönemleri arasında elektrik talebini inceleyerek bu talebin ekonomik büyüme sürecindeki rolünü açıklamaya çalışmaktadır.

Anahtar Kelimeler: Elektrik Talebi, Ekonomik Kalkınma, Enerji Krizi, Ekonomik Büyüme, Bölgesel Kalkınma

ABSTRACT

MASTERS THESIS

"THE ROLE OF ENERGY IN REGIONAL DEVELOPMENT: A CASE STUDY FOR DUHOK"

Abdulazeez Dndar ABDULAZEEZ

Supervisor: Asst. Prof. Dr. Adem AÇAR

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The main purpose of this study is to examine the role of energy in the regional development process in the context of electricity demand in Duhok Case. Electricity demand has played an essential role in both the economic growth and economic development processes of developing countries. Electricity demand worldwide has experienced significant changes over time, and it has also affected regional development processes. Particularly in the stable political environment that emerged as a result of regime change in Iraq, the economic development process has led to a significant change in electricity demand. As a result of this change, power outages are a principal problem the crisis of energy in the form of electricity demand in Duhok. In this respect, this study examines the electricity demand between 1995-2003 and 2003-2017, which is essential to explain the change in electricity demand in Duhok and attempts to explain the role of this demand in the economic growth process.

Keywords: Electricity Demand, Energy Crisis, Economic Growth, Economic Development, Regional Development

ABBREVIATION AND SYMBOL LISTS

Abbreviation	Explanation
CNBS	China National Bureau of Statistics
ESIA	Economic and Social Impact Assessment
EIA	Energy Information Administration
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GNP	Gross National Product
Hz	Hertz
IDPs	Internally Displaced Persons
IEA	International Energy Agency
IEC	International Engineering Standards Committee
KRG	Kurdistan Regional Government
KRI	Kurdistan Region of Iraq
KW	Kilowatt
kWh	Kilowatt-Hour
MW	Megawatts
MDG	Millennium Development Goal
NIMA	National Imagery and Mapping Agency
PPAs	Power Purchase Agreements
SEINA	Socio-Economic Infrastructure Needs Assessment
TW	Time Watt
UN	United Nations
UPS	Uninterrupted Power System
US	United States
WB	World Bank

Symbol	Explanation
ID	Iraq Dinars
$	Dollars
%	Percentage

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DEDICATION

I honored to dedicate this master thesis to my parents, my father, and my mother, so, the constant support and the guidelines provided extraordinarily. Thus, they are the backings that I will continuously lean on; this project would not have completed without their enormous sustenance.

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INTRODUCTION

The ultimate purpose of this study is to examine the role of energy in regional development: a case study for Duhok city. Electricity has a significant role in any modern economy since the growth in electricity consumption is one of the most important indicators of economic development. The electricity sector is one of the flexible segments in the production of energy. However, many countries, including Iraq, still suffer from a suffocating crisis in the areas of electricity production and use, a complex problem of global trends to use energy in the future (Khafaji, 2018).

The study hypothesizes that several variables are contributing to the increasing demand gap for electricity, including price, GDP, seasonal factors, and population growth. The study adopts a descriptive-analytical method in assessing the problem of the demand for electricity. The analytical approach also is one of the most critical and prominent methods of scientific research, which is used in the analysis of data in order to find the best solutions to the problems related to it.

As Khanna and Rao (2009, p. 571) points out that several studies related to electricity have followed to measure the reaction of the aggregate electricity demand and other factors of electricity demand including price of electricity using national or sectoral data for electricity consumption, namely real GDP, real electricity price and other related descriptive variables. Thus, the last comprise measures of seasonal factors (temperature), urbanization (population growth), stock/prices of uses, prices of other energy procedures, and a lagged measure of electricity consumption to determine the rate of adjustment in consumption to changes in economic variables. In this regard, annual electricity sales (consumption) data for households, commercial, governmental departments, industrial and agricultural sectors of Duhok for the period 1995-2017 are collected. The demand processing of electricity is examined adequately for all sectors of Duhok from 2011 to 2017 and calculating the gap in it using descriptive economics methods. Thus, this study attempts to show the relationship between GDP and electricity demand. The reflection in the incomes of the citizens of an increase in the GDP may lead to a rise in the need for public electricity and domestic generators for various purposes. Accordingly, it is possible to analyze the crisis of energy in the form of electricity production. In this sense, the descriptive approach bases on some information, statistics, and data in the estimation of demand-supplied and the problem of demand for electricity depending on temporal comparisons.

Electricity consumption and economic development forecast plans in medium, and long-term have to be comprehensive and adjusted for revisions. It is crucial to create the concepts of potential development in the production and demand for electric power as a basis for current and future economic policy, particularly about the generation, transmission and distribution of electrical power since it is a strategic commodity on the economic development of any country in the world. Hence, it proposes a solution to the problem of increasing the gap and the increasing demand for electric power by establishing gas stations and starting the strategic projects for large thermal, hydroelectric plants and the establishment of combined cycle stations to rehabilitate existing gas stations.

It dramatically witnessed the problem of electricity production in Duhok. The issue of electricity demand in Duhok has great importance due to electric power and its impact on social life. Currently, the power outage is the prevailing situation in Duhok. In this regard, the study also aims to shed light on the nature of the electricity consumption in all sectors for the period 1995-2003 and the electricity demand gap for the period 2003-2017. These two periods have a significant division to analyze the dramatic changes in Duhok. Historically, the previous regime in Iraq has opened a new development process. In general, Iraq has experienced a unique method of development in this process, and the energy demand has prominently gained importance. Regionally, this process has influenced urban development. Therefore, this study draws attention to electricity production in regional development.

In this historical transformation, Duhok needs to develop a solution to the increase in energy demand. The typical indicator in this development process is the electricity demand. Therefore, Duhok has faced a fundamental problem in the production of electricity. In this context, the economic development process since 2003 has pointed out, enter urban development, and more needs for energy have come to the fore in Duhok. From this point of view, the critical starting point of this study is the problem causing the shortage of electrical power in Duhok caused by many variables. These variables contributed to different percentages to the increasing problem of demand for electricity, including price, GDP, seasonal factors, population growth, urban development, displaced peoples, and refugees.

Historically the electricity entered Iraq for the first time in 1917 when the small power station established in (Abkhneh) to deliver electricity, which was created by the British occupation army during WWI, then established the Mosul station in 1921. Moreover, the National Electricity Authority established to supply electricity to all parts of the country in 1959. Mosul city established the distribution department in 1966. However, the significant development after the nationalization of oil in 1972 led to an increase in the annual rate of electricity demand. Duhok city established the Electricity Distribution Department in 2003.

As the Iraqi economy flourished after nationalization, followed by a significant increase in national income, industrial, and agricultural development projects, they have led to the rise in demand for electricity for ten years. The uprising of the Kurdish region in 1991 had a significant role in the adoption of the region itself and was adopted in the processing of electric power for citizens. There are also sub-directorates of the general directorates of the projects of transport, production, operation, and control stations are pursuing their work to control the electricity of Duhok within its responsibility in the geographic area. The peak load in Duhok in 2010 was 655 megawatts in July, and the highest amount in January was 1686 megawatts in 2017. The lowest annual temperatures are recorded with heating contributing to the observed increase. Thus, during the period 2011-2017, the most top load (demand) observed winter in December and January of the scarcity and high prices of fuel substitutes for heating, cooking.

Furthermore, this study is divided into three chapters. The first chapter addresses the study background (literature review) which related to the study variables, defining the study terms and concepts. Nevertheless, it develops a theoretical framework in analyzing the relationship between energy demand and economic theory. Notably, the energy concept relates to economic development; this chapter also focuses on the local development that led to an increase in electricity demand. The second chapter progresses from theoretical analysis to historical one as energy demand in the world economy and KRG-Duhok. In the world economy, the energy-electricity demand has theoretically increased with globalization dynamics. The interaction between local and global levels increases the demand for electricity. Therefore, this chapter focuses on the theoretical level to the actual level in analyzing the production of power.

The third chapter deals with data presentation and analysis and establishes an empirical connection between the theoretical and historical framework. Therefore, this study empirically shows the changes in electricity demand in Duhok. Moreover, it provides a rising electricity-demand between 1995 and 2017.

CHAPTER ONE
LITERATURE REVIEW

This chapter aims to address the literature related to the study variables, also defining the study terms and concepts. However, develop a theoretical framework in analyzing the relationship between energy demand and economic theory. Mainly, the energy concept is related to the economic development process. At the regional level, this chapter also focuses on local development provides increasing electricity consumption as the theoretical analysis points out the significant relationship between electricity consumption and economic development.

1.1. LITERATURE REVIEW

Khanna and Rao (2009) address the correlation between electricity consumption and economic growth in terms of price and income elasticity of demand. Moreover, they also assess the performance results of economic policies affecting the electricity sector, including institutional reforms such as privatization and regulation. Accordingly, this research points out that electricity demand is driven by GDP, prices, income, level, and characteristics of economic activities, as well as seasonal factors.

Odularu and Okonkwo (2009) are related to investigating the relationship between the consumption of energy and the Nigerian Economy from 1970 to 2005. The researchers deal with the energy sources used to test the relationship between crude oil, electricity, and coal. Through the use of co-interference technology, the findings have found a positive relationship between the current consumption of energy and economic growth.

The research conducted by Kasperowicz (2014) in the context of electricity consumption and economic growth in Poland is to discover the association between consumption of electric power and economic growth in Poland from 2000 to 2012. The research results show that there is a fundamental association between the consumption of electric power and economic growth in Poland, and the correlation is bidirectional. The research also points out that the bi-directional correlation between electricity consumption and economic growth.

In the same regard, Patrick and Dodzi (2014) deal with the electricity consumption effect on Ghana's economic growth. However, this research runs the Augmented Dickey-Fuller test, cointegration test, Vector Error Correction Model, and Granger Causality Test. Thus, it reveals that in the long run, an increase in electricity consumption of 100 percent will result in a real per capita GDP increase of about 52 percent. However, electricity consumption may negatively affect real per capita GDP. in the short-term. The research also finds that one-way interconnection runs from electricity consumption to economic growth.

The research conducted by Pata and Yurtkuran (2017) in the context of the International Energy Agency (IEA) member states analyses the relations between these countries' electricity consumption and economic growth among the UK, USA, Spain, Belgium, and Turkey during 1964 to 2014. The outcomes of the autoregressive distributed lag (ARDL) method, bounds testing, and error correction model demonstrated that there is a confident one-way and significant interconnection moving from electricity consumption to the growth of the economy in both of the short- and long-run. The experimental outcomes also suggest that electricity consumption and economic growth are not impartial toward each other. Electricity consumption promotes economic policies to support the economic growth of these countries.

From the macroeconomic perspective, another research conducted by David et al. (2017) attempts to examine the effect of electricity on the development of the economy. As a finding, this research finds that the use and access to electricity power powerfully linked with economic development. They argue that there is some indication that the consistency of the electricity supply is crucial for economic growth.

Zhanga et al. (2017) examine the electricity consumption relation with economic growth in China. The researchers also identify that it has analyzed as the overall state of electricity consumption and economic development. It finds the relationship between electricity consumption and economic development in China, such as the temporal dimension and the regional and industrial dimensions.

Wen-Cheng (2016) examines the electricity consumption and economic development as an indication from 17 Taiwanese industries during the period 1998–2014. In this context, this research observes the reality and nature of the Granger interconnection among electricity consumption and the economic development of 17 industries in Taiwan. The results of a panel cointegration test display a long-run equilibrium correlation, and a bidirectional Granger finds causality correlation between electric power and economic development. The result also indicates that a 1% growth in the consumption of electricity would increase the real GDP by 1.72%. Therefore, Wen-Cheng suggests that the authorities in Taiwan might pursue energy conservation and carbon decrease policy in some industries without obstructing the economic growth for changing the industrial structure.

1.2. THE RELATIONSHIP BETWEEN ELECTRICITY CONSUMPTION AND ECONOMIC DEVELOPMENT

The topic of the correlation between the consumption of electricity and economic development has become dynamic and practical studies for two decades. Most research finds a strong relationship between electricity consumption and economic development. In the context of these variables, Ferguson et al. (2000), point out the relationship between wealth and electricity consumption in 100 developing countries. Thus, the relationship is stronger between wealth and electricity consumption. (Kasperowicz, 2014, p. 46).

The effects of the invention and demand for electric energy technology create the second industrial revolution in human history. Therefore, it provides electricity as a sustainable energy for economic and social development. The rise in electricity consumption has further encouraged the progress of the industrial economy (Wen-Cheng, 2016).

The consumption of energy and mainly electricity plays a very significant role in economic and socio-economic growth not only in developed countries but also in developing countries. It is also detected that unidirectional connection continues from economic development to energy consumption; this indicates that some countries are not dependent on electricity for their economic development. Thus, in those countries, energy management policies have little effect on economic growth (Patrick & Dodzi, 2014, p. 6).

Despite that, many developing states are facing the problems of power shortage. An adequate and regular source of energy is one of the most significant factors that support economic growth in developing nations (Morimoto & Hope, 2001, p. 3). As indicated by Ferguson et al. (2000), the electricity demand is a resulting demand by households for home lighting, cooking, and heating. However, household or domestic production theory might be used to select the analysis of the electricity demand. (Khanna & Rao, 2009, p. 569).

While Khanna & Rao further argues that energy consumption in the world is likely to rise by 55% from 2005 to 2030, with electricity consumption doubling and coal use growing by 73%. Three-fourths of this rise in energy consumption is expected in developing countries and almost half of these from China and India. The International Energy Agency IEA (2007) valued that developing countries may need an annual investment of at least $165 billion. According to Varro (2018, p. 2), the energy investment led by electricity globally was 1.8 USD trillion only in 2017. It means that for the third frequent year from (2015, 2016, and 2017) energy investment was declined in 2017, by 2%, mostly due to less investment in power generation, lower costs and constant prudence in the sector of oil and gas, so energy efficiency was a separate growth area, as shown in Figure 1.1, below.

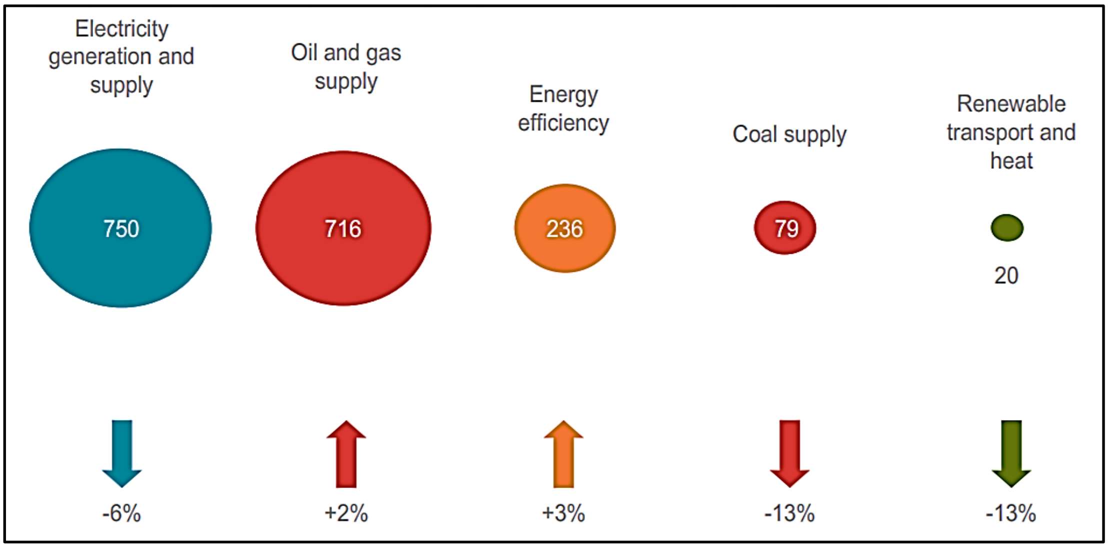

Figure 1.1. Global Energy Investment, 2017 (Billion USD)
Source: (OECD/IEA, 2018).

In Iraq, the situation appears very different, as Iraq is still suffering from a severe crisis in electricity production, due to many factors, including political and administrative problems. It is the most significant factor in the loss of efforts to establish an electricity system capable of providing acceptable electricity consumption. Therefore, it reflects negatively the delay in achieving economic development, especially industrial development. It causes disrupting the movement of factories and high production costs, and the low contribution of the industrial sector (Nawab, 2019, p. 2).

Nonetheless, Iraq's energy situation needs to ensure security since it has significant concern for the electricity sector in the country. It cannot supply the current peak demand, particularly with production at about 50% of the country's needs. There is no doubt that electricity demand over the coming years will exceed the capacity of existing power plants (Khafaji, 2018, p. 3).

According to Pata and Yurtkuran (2017, p. 342), energy sources can be classified into two types: primary and secondary sources. Thus, primary sources included raw oil, natural gas, coal, wind power, and uranium, which can be used in their usual form. Besides, the other type of energy sources can be gained through primary processing sources, which so-called secondary sources. Electrical energy is a secondary energy source commonly used by households, the industry, and service sectors. Electrical energy is the most flexible form of energy-requiring to constitute the infrastructure of socio-economic development (Pao, 2009, p. 1780).

In the same regard, Shepherd and Shepherd (1997) point out that energy could take many forms; as classified in Table 1.1, the comprehensive material is a form of high concentration — some of the materials used in nuclear energy applications. However, the application of many energy transfers in energy consumption usually involves switching among different forms of energy process known as energy conversion. Thus, this feature is usually described as conversion efficiency (Summers, 1971).

Table 1.1. Form of Energy

Biofuels	**Mass**
Chemical	**Mechanical – Kinetic**
Electrical	**Mechanical – Potential**
Gravitational	**Unclear**
Heat (Thermal)	**Radiation**
Magnetic	**Sound**

Source: (Shepherd & Shepherd, 1997).

Among the energy forms, electricity is crucial for the country's economic growth. The consumption of electricity per capita is run as a measure to determine the level of a country. So, this certainly demonstrates how electricity is substantial for any country's development. In this regard, discoveries in science and technology created electricity as a primary energy form. Similarly, it has more flexibility compared to other energy forms. Therefore, electricity can rapidly transform into other forms of energy. (Ibrahim & Kirkil, 2018, p. 2).

Electricity is fundamental for economic development and poverty reduction (Iwayemi, 2008). While electricity is one of the essential sources of energy for humanity, the importance of electricity per person increases with the average income as well as development. However, like other economic resources, they are scarce, so the world will have a problem meeting its needs electricity due to the continuous increase in demand for several reasons including the continuous increase in the population and the attendant increase in the level of individual consumption of electricity as a result of the high level of income.

1.2.1. Electricity Consumption

The importance of electricity and its direct impact as a critical element in all areas of life is a vital and influential role in the development of all sectors. So, not only electricity demand does directly include on the product or service, but also the purpose or benefit from the goods or services such as heating, cooling, and cooking (William, 1977, p. 240). Electricity is a final product such as lighting for domestic purposes and road lighting and might be considered a standard product (Sallou, 1995). It is an input used in industrial production processes. Demand for electricity is a demand derived from the need for its products of use and approved commodity services.

Moreover, demand varies from one subscriber to another because a subscriber demands more or less than the other individual's desire and collects the load (demand) and sufficient capacity to meet the maximum demand for subscribers at any time. The electrical system is similar to the water system (Khafaji, 2018). The fuel required for operation in the electrical order is taken from the fuel tank. The fuel may be petroleum, gas, or nuclear — electricity generated from the water outlets. The power station converts the energy in the fuel to electrical energy when burning the fuel in the boiler (Vinard, 1990, p. 21).

However, the essential characteristics of the electricity consumption, that highly volatile during the hours of the day, month, and season to another during the year. It is necessary simultaneous and instantaneous (moment by moment) production and consumption of electricity as product storage is limited and at a high cost. The obligation to meet the demand of power for all who need it at the time and place of its production capacity-building requires order not on the market in the short term, but by the expected demand for electricity in the long run. So, at peak time, where the demand for electricity is estimated to be about half an hour of up to 30 years or more (Rhys, 1984, pp. 23-33).

Short-term planning is to cover future requirements within a period not exceeding five years in most cases. Long-term planning covers future demands for more than ten years. The control units are operated and controlled by the control room; therefore, they are control tower associated with the National Control Center System's key (National Control Center) to ensure power supply to various consumer sites (Attar Bashi and Mahdi, 1990).

The electricity industry has a capital-intensive nature of production and a low degree of elasticity of substitution between labor and capital. The electric power output function is operating under increasing the size in the sense that increased production leads to decreased costs and optimize the use of available capacity by attracting more demand and lift it with a low consumption during non-peak times and reduce waste at a peak period (Othman, 2000, p. 269).

1.2.2. Electricity Consumption for Different Sectors

The purpose of the electricity consumption varies according to the categories into domestic demand, industrial sector demand, the commercial sector, the government sector, and agriculture, according to International Energy Agency IEA (2019, p. 8). Budget constraints and war damage point out that Iraq does not produce enough electricity to meet demand. High demand is widening this gap, with the population of Iraq growing at a rate of over 1 million per year. Where incomes are allowed, local neighborhood generators are used by many families to address this issue, but this measure is bridging the gap expensive.

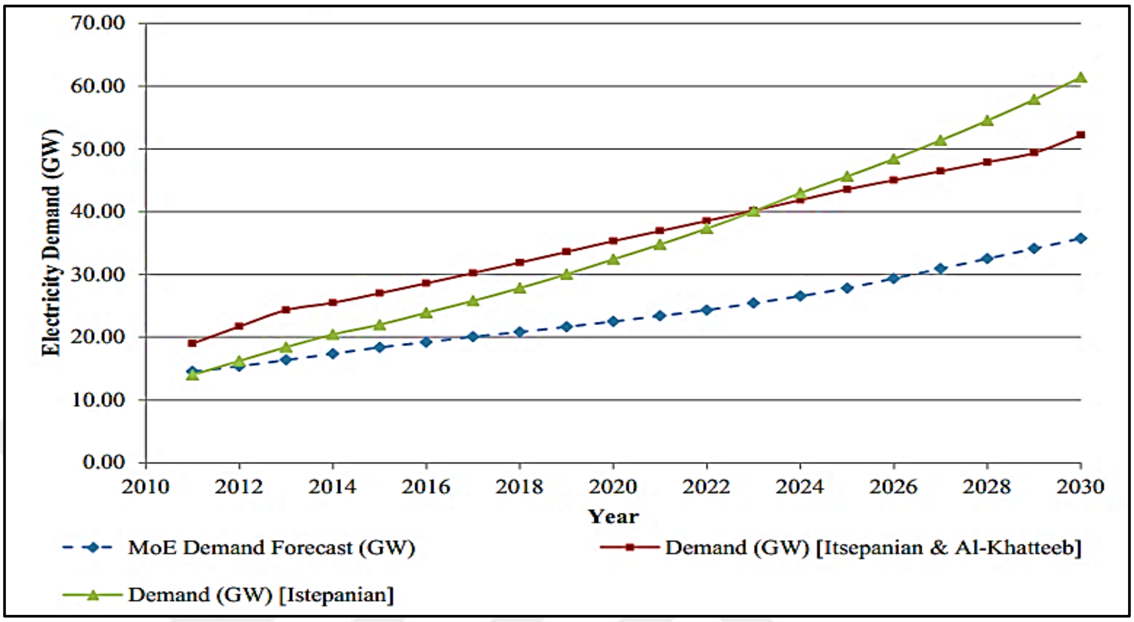

Figure 1.2. Electricity Demand Forecast

Source: (Khatteeb & Istepanian, 2015).

The electricity consumption or demand during the period up to 2030 will set to double, reaching about 150 terawatt-hours (TWh) (17.5 gigawatts [GW] typical during the year). Figure 1.2 takes into account factors such as fluctuating demographics and repressed demand. Overall, peak demand is expected to reach anywhere from 50,000 to 60,000 MW by 2030, whereas the ministry forecasts peak demand as a mere 35,000 MW.9 (Khatteeb & Istepanian, 2015, p. 2). Different factors affecting each category, so, demand pricing policy effects on the quantity of demand for different elasticity price and pricing depends on the estimate function to every segment of consumers (Othman, 2000, pp. 233-243).

1.2.2.1. Households' Electricity Consumption

Households or domestic consumer demand depends on electricity like any other product on consumer income and the price of electricity. Other commodities such as natural gas, alternative, and complementary goods, durable household goods as demand for electricity is affected by the short-term rate. In the use of goods that are integrated with electricity during a more extended period to analyze the balance of those goods exposed to growth, there is an available balance for consumers of these goods, one independent variable affecting the demand function in the long term (Nawab, 2019). As well as temperatures during specific periods of the year affect the electricity consumption, besides the average family, and prices of household energy alternatives like natural gas, oil, and other products influence the electricity consumption. Thus, the determinants of electricity consumption for households include:

First: Climatic factors electricity consumption rises in winter and summer and for heating and cooling, respectively.

Second: Social factors population growth rates as a result of natural increase as well as internal migration from the countryside to the city because of the high standards of urbanization or external migration (International) to get jobs.

Table 1.2 shows the rate of increase in Duhok from 2010 to 2017 as the natural percentage of population 1.032, (Sulaiman, 2018). Electricity consumption growth in Duhok notes that demand and supply for electricity beginning was a relatively minor gap that because of population growth, urbanization, and habitation were relatively insignificant, but, electricity demand dramatically increased in 2013.

Furthermore, the reason is the crisis of Iraq among Syrian exacerbating squeezed it. The crisis raises the camps for displaced people in Duhok, which has increased the demand for electrical power and limited the ability to increase the supply of electrical energy, creating a large gap between supply and demand (Kawherzi, 2018).

Table 1.2. The Population Growth Rate in Duhok During 2010 to 2017

Years	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Rate Increases	1.035	1.034	1.033	1.032	1.032	1.031	1.031	1.031

Sources: (KRG, 2017).

Table 1.3 demonstrates that the number of displaced Syrians and those coming from southern and central Iraq to KRI shows more significant numbers that created the electricity crisis and energy demand, where the total number of displaced Syrians 545205 in the province of Duhok. Furthermore, the total number of refugees reached (67822), and it has increased the processing capacity in demand for electric power in addition to the increase in the population leading to electricity demand.

Table 1.3. Census Final Results of IDPs and Refugees in Duhok During 2015.

Administrative	**Number**		**Total**
	Refugees	**IDPs**	
Duhok	6275	580222	64297
Semel	40252	199910	240162
Zakho	9930	108024	117954
Amedi	1488	22131	23619
Sheikhan	773	67196	67969
Aqrah	1392	44502	45894
Bardarash	7712	45420	53132
Total	67822	545205	613027

Sources: (KRG, 2015).

Third: Economic factors, the household level income influences electricity consumption, high-income households consume more electric power than exponentially from low-income households.

Firstly, it increases the average size of the households as a result of rising incomes, the space inhabited by every household tends to increase due to the demand for private residential units. The inhabited area has increased demand for larger houses that require large amounts of energy for lighting, cooling, and heating.

Secondly, it increases the number of machines and equipment energy-consuming high per capita income has led to the widespread phenomenon of air conditioning or refrigeration.

Thirdly, it increases demand for services consumed more energy such as machines and other modern electrical appliances for cooking, washing, and cleaning. Structural shifts in energy sources accompany rising incomes and change the trend towards more efficient (Al-Faris, 1995, p. 252).

1.2.2.2. Commercial Sector's Electricity Consumption

This type of electricity consumption includes rental apartments, tourist facilities (hotels, restaurants), commercial buildings such as clinics, law firms, and other exhibitions, including a broken space of residential exploited as shops, schools, hospitals. The public-use energy in the sector of lighting, heating, and cooling and water pump and run the elevators in storytelling worked atom and used in soldering operating rooms to private hospitals and others. However, the determinants of the commercial sector's electricity consumption include the following (Al-Faris, 1995, p. 243):

a) The most critical factors affecting the electricity demand in the commercial sector is the growth in spaces such as offices, galleries, buildings, forms of internal and external lighting, water pumping services, lifts, and air conditioning and first refrigeration end-use of electricity in this sector.
b) The growth of the tourism sector, particularly in hotels, restaurants, and other recreational facilities that increased electricity consumption.

Thus, electricity consumption in the commercial sector is high as the economic growth indicator leads to increasing per capita income (Khatteeb & Istepanian, 2015).

1.2.2.3. Electricity Consumption in the Government Sector

The government sector in Iraq and KRG comprises all governmental departments, including maintenance and supply centers of commerce, public banks, schools, public colleges and universities, public hospitals and health centers, mosques, and churches, also fire and police stations, courts, administrative units, communications services, airports, chambers of commerce (Kawherzi, 2018). In the same context, (DEGD, 2017) count the government ministries, water supply services, the electricity sector itself, and other service sectors that use electricity mainly for lighting, heating, cooling, and water pumping.

The government sector's electricity consumption includes seasonal factors, economic growth accompanied by booming government spending on facilities, and government departments. Technological progress is an example of computers and accessories from printers, scanners, and global computer network communication devices. Population increase reflected an increase in the number of employee changes to regulation in the structure of government departments.

1.2.2.4. Electricity Consumption in the Industrial Sector

The purpose of the production is to meet the demand, so the electrical equipment must keep pace with demand and comply with it to a large extent, and it is known that order depends on the level of income, which is the main factor in determining the demand (Seifou, 1988, p. 13). The continued increase in economic growth rates has led to the rise in GDP and hence, an increase in per capita GDP. There is a strong correlation between economic growth and the demand for electricity.

The per capita consumption of electricity is a global indicator of growth, and developed countries have an average per capita consumption of electricity outstanding, unlike the developing countries. The availability of natural resources in vast quantities affects the production of electric power in that country, which leads to accelerating the process of economic development (Saleh, 1992, p. 17).

Moreover, the recent technological developments have led to the emergence of new alternatives and close to non-renewable natural resources, for instance, the use of both solar and wind power in electricity generation has become a unique alternative to gas, oil (Al-Faris, 1995, p. 172). The coefficient of energy consumption is the amount of energy needed to produce one unit of income or (GDP). Developed countries have a factor of less than one energy consumption, as opposed to developing countries where the coefficient is higher than one. In some oil countries, energy consumption is more significant than one percent, because energy prices are subsidized by the state to help low-income groups to meet their needs (Zhanga, Zhoua, Yanga, & Shaoa, 2017).

Increased population growth leads to increased demand for various goods and services. This means an increased demand for a non-renewable natural resource. It contributes to the production of those goods and services because the demand for electricity derives from the need for goods and services. As a result of natural increase in population growth, internal and external migration, growing population overall economic products and industrial products in particular and the increasing population has an impact on the growing demand for electric power to finally meet the rising needs of the community (Saleh, 1992, p. 46).

Relative prices expected for a depleted resource in the future, as long as the supply depleted non-renewable (used in electric power generation), always decreases as a result of use. Its quantity continually decreases, and this means the higher price in the future must use waterfalls to generate power for an abundant and lower price. It is evident from the above that the renewed demand for a non-productive resource in the form of the current demand curve is the negative slope and descends from top to bottom right denote the existence of an inverse relationship between price and quantity of non-renewable resource used to generate electrical energy (Al-Saoud et al., 2006, p. 66). The economic policy of the state of the industrial and agricultural system is part of the financial plan of the state.

Moreover, those policies vary according to the system of government of those states and the procedures adopted by the state to intervene in economic life in general, and particular sectoral would generate variation in the sectoral development. In the states, with central planning gives priority to developing heavy industries in the early stages of industrial growth (Seifou, 1988, p. 69). In conclusion, the population growth increase in industrial production needs, which leads to increased processing power for this sector. Additionally, the plants depend on electricity production, so, the demand for developing countries follows in expanding through the growth of the industrial sector.

1.2.2.5. Electricity Consumption in the Agricultural Sector

The population growth also involves more electricity consumption in the agricultural industry derived from its multiple uses. It is the farm sector, a producer and consumer of electric power. It produces heat through animal manure, agricultural waste, and wood. It consumes electrical energy through lighting and in the food industry, such as canning and drying (Al-Faris, 1995). However, electricity use sprinklers in irrigation and water pumps, it also uses in incubators, hatching, and milking of artificial animals, in heating greenhouses for sensitive plants, refrigerated and frozen stores. According to Zerri (1984, p. 235), and (Al-Hit, 1993), there are some factors affecting electricity consumption in the agricultural sector:

a) Power factor: high energy plants in developing countries mean if production increased by 1% need to increase power consumption by 2% according to (FAO) studies.
b) Introducing advanced agricultural methods of modern industrial machinery, the use of sophisticated technological methods leads to dispensing with many labors migrated to the city in addition to getting rid of disguised unemployment and seasonal.
c) Economic development: Electricity is one of the most critical inputs in the production process, essential in running machines and machines without this energy means using first means of agricultural production of low production efficiency.

1.2.3. The Electricity Consumption and Economic Theory

According to Brunekreeft (2004), economic theory emphases on optimization and equilibrium, thus, macroeconomics addresses the general economy and enquires whether macroeconomic indicators, such as inflation, unemployment, and the cost of capital, are in balance. Microeconomics also discusses the optimizing behavior of consumers and producers and demands whether the observed equilibrium prices and quantities in each market are economically efficient. The most critical elements in a power system are generators that make use of the primary energy from coal, oil, gas, nuclear, or hydroelectric power. The costs for operating generators can classify as fixed and variable (Watson, 2001).

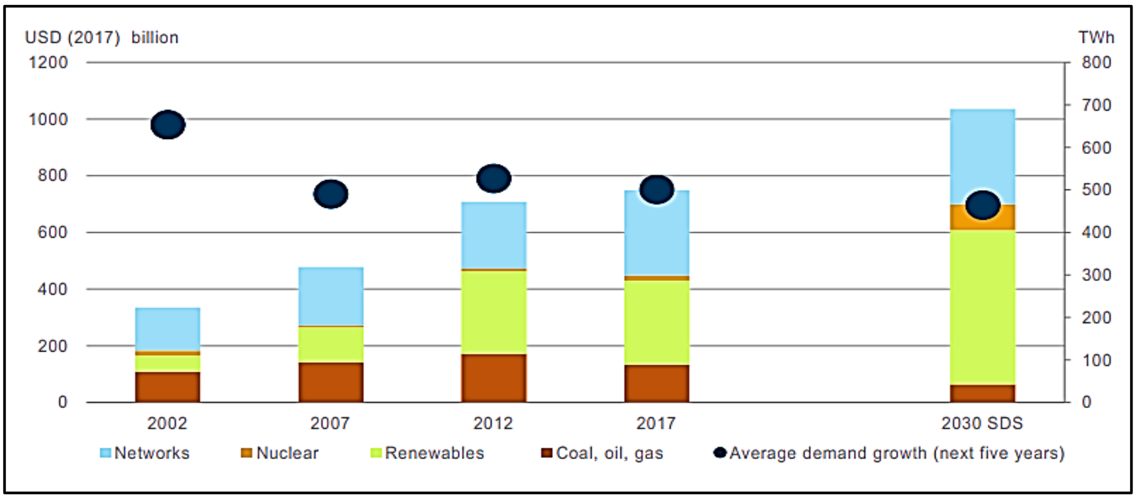

Figure 1.3. Increasing the Capital Intensity of Electricity
Source: (OECD/IEA, 2018) and (IEA, 2019).

In this regard, buying and selling electricity involves at least three productive activities: generation, transmission, and distribution, including wholesale and retail distribution. These activities can bundle in a single market in which producers generate, transmit, and distribute electricity to consumers, or these activities can be unbundled for more on electricity markets (Reid, 2002, p. 548). Likewise, another critical economic concept is the sunk cost. While sunk costs are those costs that cannot recover when production ceases, for instance, many prices in preparing a site for the installation of new generating capacity declined. If it is uneconomic to move generating equipment to a new location, the entire value of the generating capacity might drop.

The importance of recognizing sunk costs is that they should not be taken into account when making decisions. If an old generating unit is uneconomic, then its cost of construction is fallen and should not be considered in determining whether to withdraw the group; the firm should only find the plant's operating costs (Richard, 1971). As revealed in Figure 1.4, over 95% of investments in the power sector depend on regulation or bonds beyond the short-term. So, the significant markets for their primary remuneration, as regulators pursue competence and environmental aims (OECD/IEA, 2018).

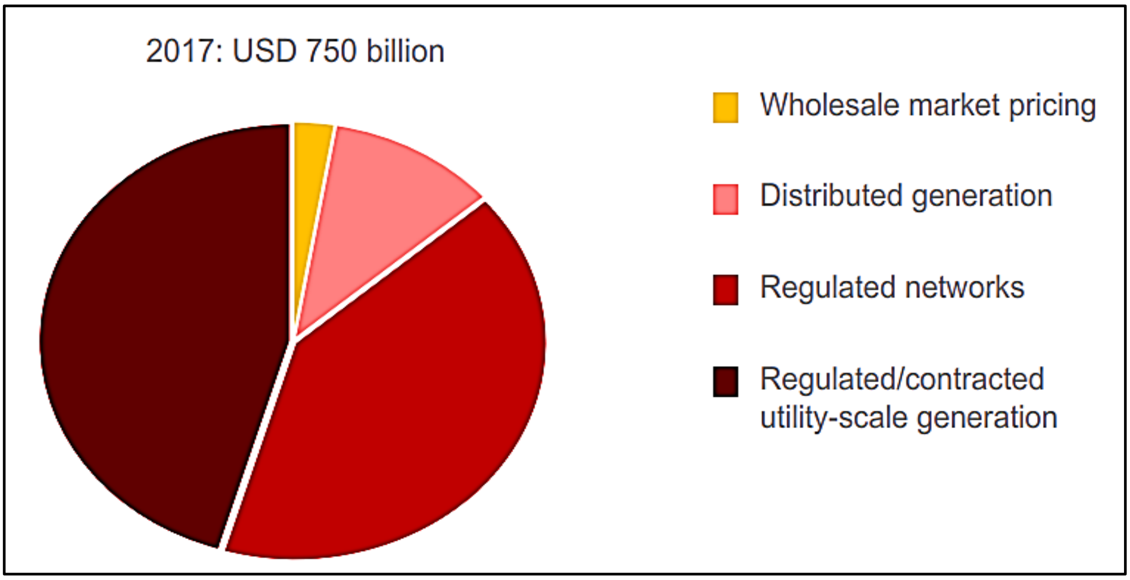

Figure 1.4. Global Power Sector Investment by Main Remuneration Model
Source: (OECD/IEA, 2018).

Regulation is an administered contract between utilities and society for the safe and adequate provision of electric service at just and reasonable rates. At first, utilities sought control to protect themselves from the competition, especially competition from municipal electrical systems. In return for regulation, utilities have accepted certain obligations, including the provision of efficient service. One of the principal goals of the law is to provide competitive market efficiency. Therefore, as part of the utilities' obligations, they must strive to provide information that will result in well-reasoned decisions. The relationship that describes the utilities' obligations in exchange for their monopoly privileges is known as the regulatory compact or bargain (Pechman, 2012).

1.2.4. Economic Efficiency

In regard, the term efficiency, there is a difference between technical efficiency and economic efficiency. Technical competence means that the maximum output product has a particular set of inputs. Furthermore, this means that lower levels of information are used to generate a certain level of production. However, economic efficiency implies that the maximum output has proved at a given opportunity cost, or that a minimum (chance) cost has achieved for a given level of production. So, the low competition of electricity, and minimum value made a price equal to marginal cost, that is the economically efficient price; it allows that the consumer knows the cost of producing another unit.

When the price does not reflect minimal cost, the market has done to provide efficient prices. For instance, if the price of energy set below the effective rate (marginal cost), (1) consumers will demand more than the economically efficient level, and (2) producers will produce less than the economically efficient level. If the price of electricity set above marginal cost, (1) consumers will demand less than the economically efficient level, and (2) producers will produce more than the economically efficient level. Nevertheless, if the price set at the marginal cost for a natural monopolist, revenues will be too low to sustain production. Regulators find a price that will encourage production at a minimum value (Brunekreeft, 2004, p. 29).

1.2.5. Electricity Generators

The demand for electricity power increasing in Duhok governorate and lack of electricity cannot continue with considering the weak experienced Iraq and KRI. The electricity sector suffered from constant interruption of power supply for several hours affected the lives of the citizens, and it had to provide part of the increasing need for electricity. However, according to IEA (2019, p. 9), there is massive potential to cut network losses, which are among the peak in the world. Hence, reducing these losses by half would help to improve the efficiency of grid supply, effectively increasing available capacity by one-third.

Thus, through different generators and investments in private electricity generators of various sizes and types, local investors started to produce (1 KVA to 120) and supplied for all residential districts, including the commercial sector. Accordingly, another area of electrical power is a generator, where the generator is divided into two personal generators ranging from capacity generated between one to 10 kW and usually placed in homes or shops and run on gasoline. Further, on the supply side, more gas needs to be captured and put to use inefficient power plants. Besides, Iraq desires to take advantage of its abundant renewables potential and raise the share of solar photovoltaics (PV) – in specific – in the power mix. Transporting the share of renewables up to 30% of the electricity supply by 2030 would bring environmental gains without growing total costs for electricity supply (IEA, 2019, p. 9).

CHAPTER TWO
ENERGY PROBLEM IN THE WORLD AND IRAQ INCLUDING (KRG)

This chapter addresses the features of the electricity in the world economy and Iraq, including KRG, in particular, energy demand in the world economy and KRG-Duhok. In the world economy, electricity demand has increased with globalization dynamics when compared to the growth rate of GDP, particularly in China, as the world-leading energy consumer. Thus, the interaction between local and global levels increases the demand for electricity. Therefore, this chapter focuses on the theoretical level to the actual level in analyzing the production of power.

2.1. The Energy Problem in the World

Global energy security and sustainability in the 21st century will depend less on the overall global population of income and distribution. So, this, in turn, will largely depend on how effectively it is addressing the lack of energy services, now limiting economic opportunities in less developed regions. Besides, energy security will depend on the country's ability to maintain reliable sources of energy to meet their needs (Yeager, 2011). According to OECD and IEA (2011), energy demand globally is increasing rapidly, as population and economic growth, particularly in developing market economies. However, the increase in demand creates new challenges; therefore, energy security concerns can arise as more consumers require more energy resources.

Also, higher use of fossil fuels leads to higher greenhouse gas emissions, mainly carbon dioxide (CO2), which causes global warming. At the same time, the number of people without access to electricity remains excessively high. Fossil fuels extracted from the subsoil consists of coal, oil, natural gas and used this kind of fuel in steam plants. (Nader, 2007, p. 10). In this regard, estimates demonstrate that there will be an increase in global demand for energy in the predictable future. Likely, energy demand increases faster than the increase in the world population because of the increasing industrialization and rising living standards.

Furthermore, the energy demand rate is excessively increasing in developing countries in the non-OECD. The US Department of Energy projections (Figure 2.1) expect to increase the use of fossil fuels and renewable sources for 20 years and is expected to remain relatively stable nuclear energy. Separate source projection shows, within the oil industry, (Gay, 1996, p. 16).

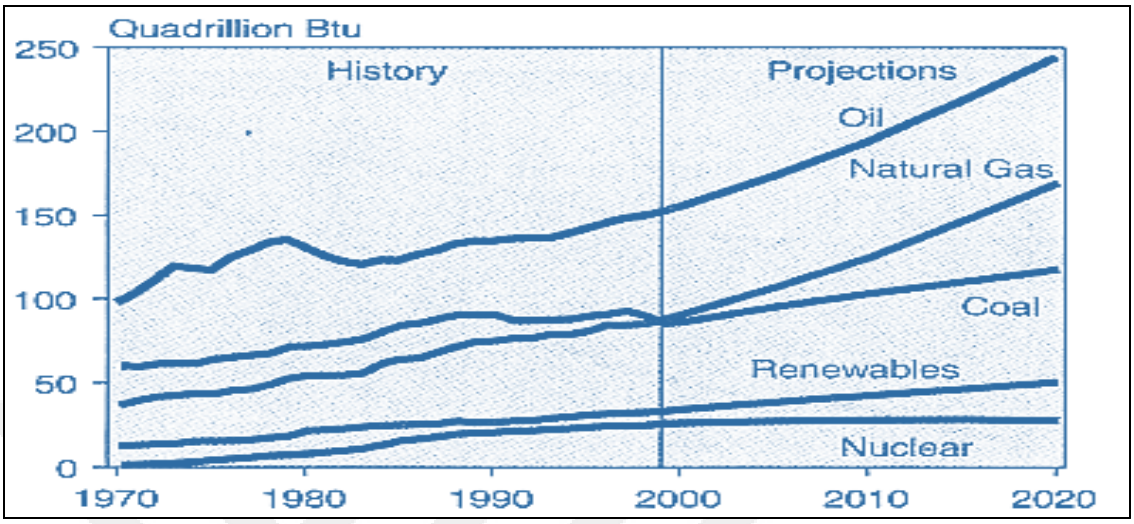

Figure 2.1. World Energy Consumption, by Fuel Type, (1970-2020)
Source: (EIA, 2001)

As shown in Figure 2.2, China and India drive global energy demand higher while non-OECD countries account for almost 90% of the expected rise in world primary energy demand in the New Policies Scenario (NPS). So, this reflects faster growth rates in economic activities, so, China's demand has flowed during the past decade, and it accounts for more than 30% of the expected growth in global energy consumption from 2009 to 2035. Thus, by 2035, China accounts for 23% of global energy demand, growth by 11% in comparison to its demand in 2000.

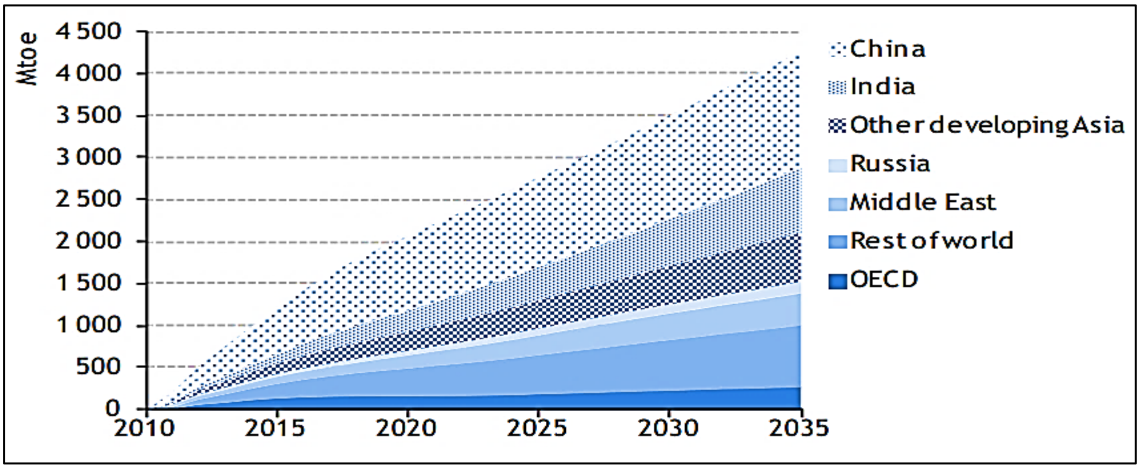

Figure 2.2. Projected Increase in World Primary Energy Demand
Source: (OECD/IEA, 2011).

The same figure reveals that India, as the second-largest, participates in the growth of the global energy demand to 2035, accounting for 16% of the increase to more than doubling. Meanwhile, the Middle East countries experience the fastest increase rate by over 2% per year. Whereas the United States remains the world's second-largest energy user by 2035, the main energy demand in OECD countries raises by around 8% from 2009 to 2035. However, as the data on China's energy, electricity consumption, and GDP growth rates from 1990 to 2013 are shown in Figure 2.3, the results revealed that the average annual of China’s energy consumption growth rate is lower than it is GDP growth rate.

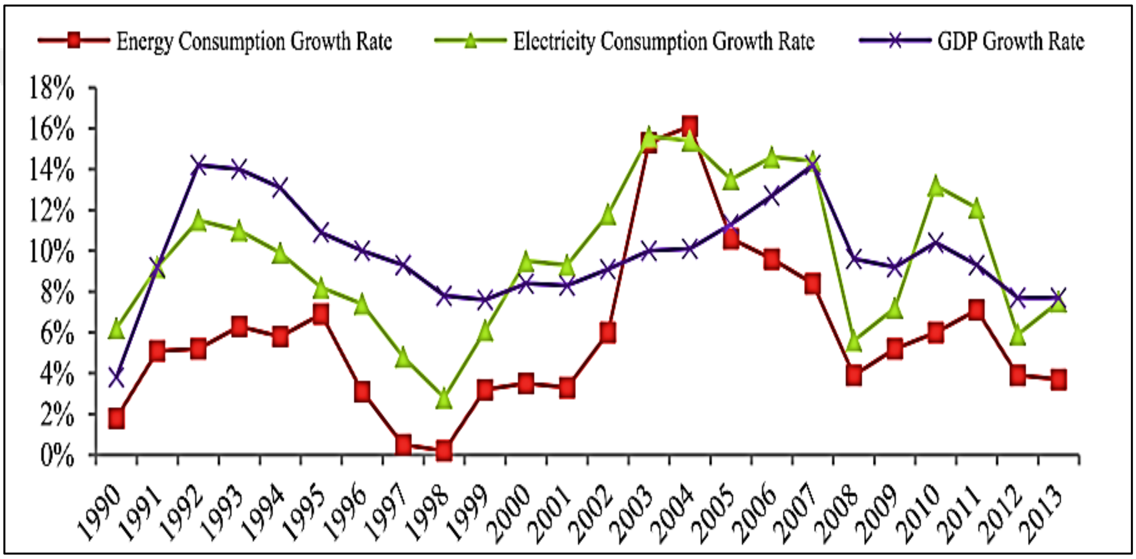

Figure 2.3. The China Energy, Electricity Consumption and GDP Growth Rates from 1990 to 2013
Source: (OECD/IEA, 2018).

Figure 2.4 (a) shows that the growth rate of energy consumption in China is meaningfully lower than China's GDP growth rate before 2001. However, the electricity consumption growth rate higher than energy consumption. It is lower than the growth rate of GDP. When compared to GDP, electricity consumption continued a consistent change. According to the China National Bureau of Statistics CNBS (2015), China joined the WTO in 2001, that accelerated China's economic globalization and trade liberalization process. In 2014, the overall annual energy consumption in China was 42.6 tons of standard coal, with an increase of 2.2% when compared to the previous year. Figure 2.4 (b), shows that in the United States, the consumption of oil and natural gas still accounted for a requisite amount of main energy consumption. Despite China, the consumption of coal was up to 66%, far higher than the world average level (Figure 2.4c).

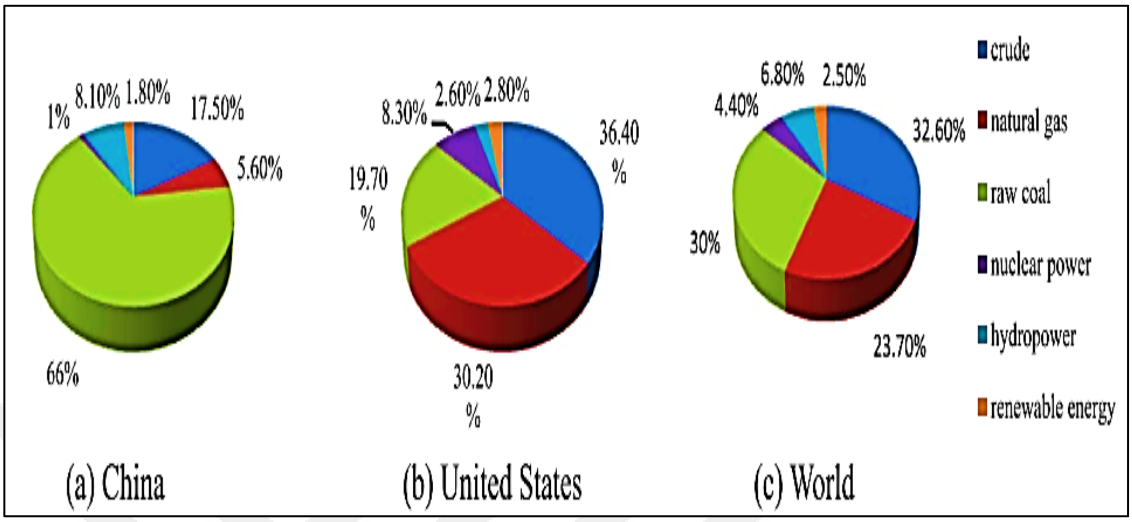

Figure 2.4. Primary Energy Consumption Structure in 2014. (a) China (b) United States (c) World.

Source: (OECD/IEA, 2018).

In this context, the energy efficiency of Japan, USA, China, and the European Union, where they are the global leading energy consumers, is revealed in Figure 2.5. Therefore, energy efficiency refers to GDP divided by energy consumption represented by oil. The results of the energy efficacy of Japan, the USA, the EU, and China have grown gradually in recent years. Hence, these show that world energy consumption and environmental problems imbalance is steadily enhanced. Nevertheless, for China, energy efficiency is still lower than Japan, the USA, and the European Union, while low energy use leads to energy waste and unnecessary releases of pollutants, which have taken immense pressure on sustainable economic development, particularly in China.

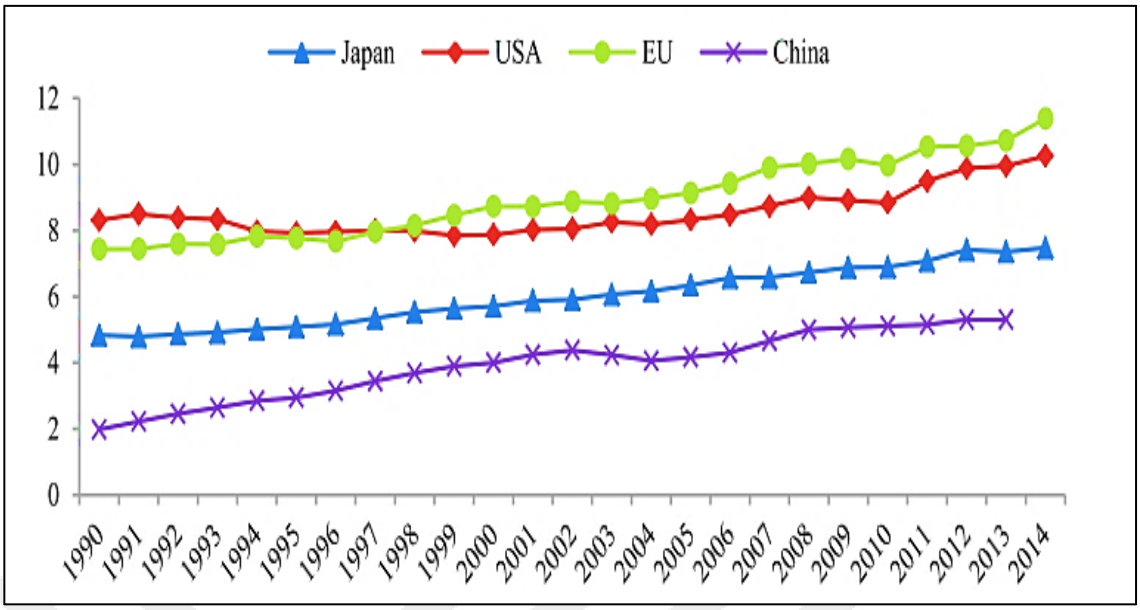

Figure 2.5. The Energy of Japan, USA, China, and the European Union During 1990- 2014. **Source:** (OECD/IEA, 2018).

2.1.1. Electricity in the World Economy

Currently, the world is stirring towards dropping dependence on traditional energy sources, namely oil in all production fields. Subsequently, oil and other sources aim to generate electricity, which is the pillar of the country's development. It also means using low electricity and high costs. Thus, most countries tend to reduce dependence on these traditional sources in reducing costs and preserving the environment (David, Paul, & Stephan, 2017). However, the electricity sector is changing, with many structural and disruptive transforms were challenging the traditional way.

Like a combination of technical, economic, directing, environmental, and societal factors, which results in a lower carbon, and electricity system digitized with new contributors evolving (Ibrahim & Kirkil, 2018). Thus, this innovative landscape will be more compound and interconnected than ever before. The international energy agency also evaluates that an investment of $7.6 trillion by 2040 will require from countries in the OECD. In this context, the electricity sector modified to long-term investment cycles and stable policy frameworks, so, this change presents policy doubts and market design complexities (OECD/IEA, 2011). As a result, global upstream oil and gas investment share by asset type (Figure 2.6), suggests more instability ahead in the energy markets shifting towards short-cycle developments and assets with high production decline rates.

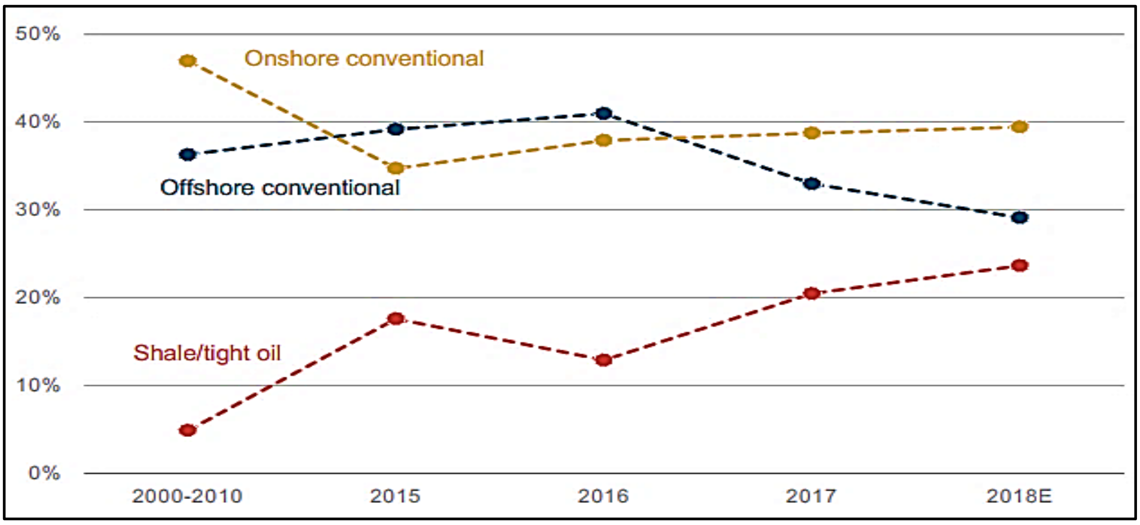

Figure 2.6. Changing Dynamics in the Oil and Gas Industry
Source: (OECD/IEA, 2018).

As shown in Figure 2.7, the power generation projected from new construction starts as a percentage of global power demand. In the past decade, the output from new solar and wind grew 45% faster than investment. However, solar is the energy used when direct heating of water and heat can be converted directly into electrical energy using solar cells. It is one of the most abundant energy sources upon which to build a clean energy source and hopes but finite resource. Research progress of high costs in this area is decreasing to become economical. This source is not as free as think to be concentrating solar even be tapped.

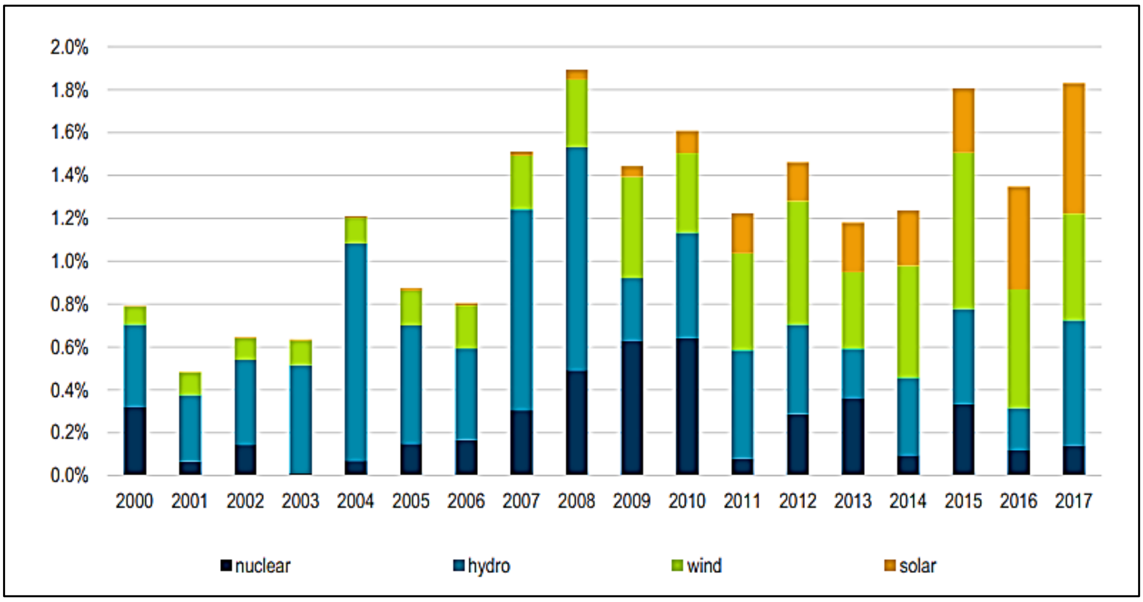

Figure 2.7. The Power Generation from Wind, Solar, Nuclear and Hydro
Source: (OECD/IEA, 2018).

The only difference between thermal and nuclear power stations that burn fuel furnace allowance is a reactor which generated as a result of the fission of uranium atoms heat. The first nuclear plant was carried out in 1954 in the Soviet Union (Arabic, 2007). They are not expected to be a shortage of energy sources (oil, gas, and coal) in the first half of this century. As the proven reserves of fossil fuels (Iraq, 2006, p. 8), the world's needs for decades and when proven oil reserves have been exhausted can resort to the enormous potential of non-traditional sources base of oil and gas, particularly after the development of methods of production and generation of electricity directly from them.

The considerable coal reserves are weak resource base beyond what knew of oil and gas. Applied technologies will allow coal extraction and production of the best of these significant sources, particularly for electricity production, by turning them into oil and gas, thereby reducing the harmful gases emitted from coal (Rasheed, 2008). The sum of all units in size capacity station called Gage station. It expressed the high capacity of stations and Mika wat units. Tagged as total stations and capacities on the volume purchased network capacity minus largest unit capacity in the system is called fixed capacity, which represents the maximum load borne by the system in the event of a larger unit (Vinard, 1990, p. 43). In 2017 recently sanctioned coal power cut 18% to a level one-third that of 2010, motivated by a slowdown in China, India & SE Asia. Sanctioned gas power cut nearly 23%, due to the MENA region & the US, as shown in Figure 2.8.

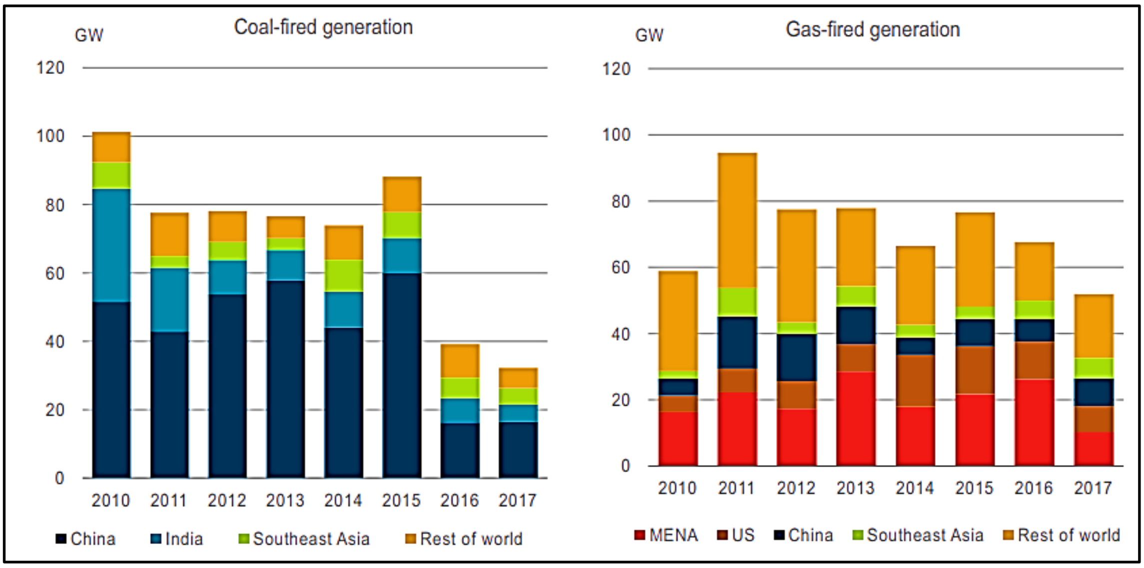

Figure 2.8. Thermal Power Fids Continued to Decline
Source: (OECD/IEA, 2018).

The hydroelectric plants produce 3230 TWh/year, about 15% of the global production of electricity from all sources, which amounts to about 22000 TWh. Given the particular criteria/transformation coefficients in primary energy (that penalize wind and PV as well), it has a primary energy market share of a little over 2%. In this respect, it is worth recalling that the hydroelectric potential in North America and Europe is exploited for more than 85%, in South America for 33% and in Asia and Africa for 22% and 7%, respectively (Clerici & Alimonti, 2015). Figure 2.9 shows the global investment in lifetime extensions for nuclear vs. solar PV, wind during 2013-2017. The result revealed that in 2017, half of the investment in nuclear was from expenditure on long-term operation for existing plants, while lifetime extensions can be a cost-effective transitional measure for maintaining low-carbon generation.

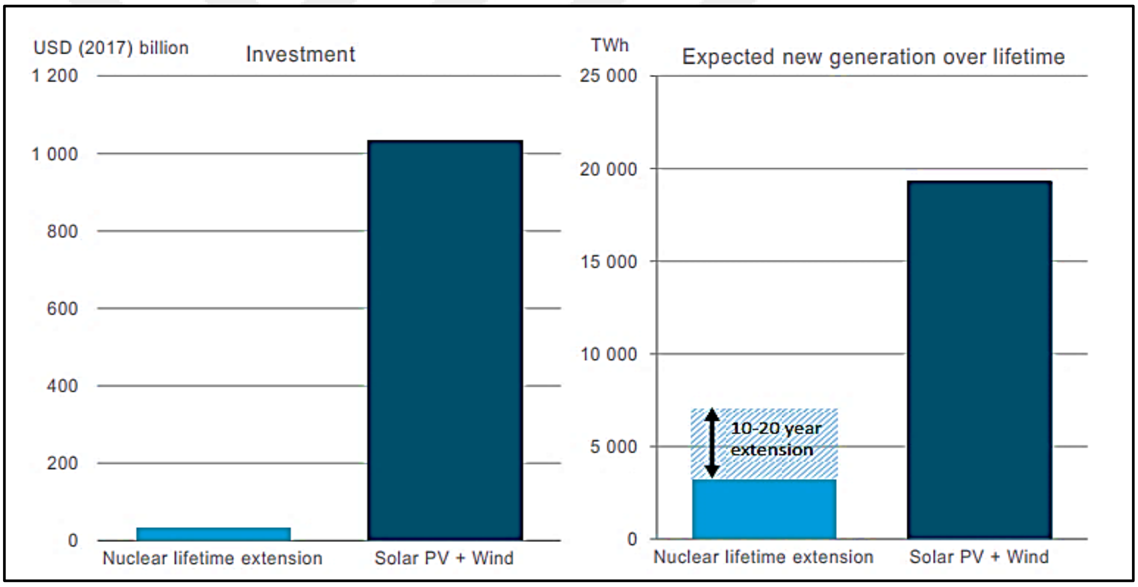

Figure 2.9. Investment in Lifetime Extensions for Nuclear Plants Have Risen
Source: (OECD/IEA, 2018).

The generation impact of new clean power has declined in the past two years due to slowing spending on nuclear and hydro. Energy is produced by nuclear fission in nuclear reactors operate stations that use this fuel to convert water into steam that spins the turbines and then spins the generator and electric power generated. However, hydrogen gas represents a significant type of fuel and a candidate to have a significant role in securing future electric power. However, the developed countries such as the United States, the United Kingdom, and Japan, are fluctuating from industrial to service economies. So, the economies service-based tend to consume less electricity compared to economies with industrial high-activities (WEF, 2015).

Further, the electricity sector is experiencing an extraordinary shift. In the past, the sector providing inexpensive, secure, and reliable electricity by attracting investors with low risk, stable returns. In the last decade, severe declines in the cost of renewable technologies, combined with new sources of natural gas, have presented the opportunity to concurrently decarbonize the sector while also growing energy security and dropping dependence on imported fuels. For instance, OECD countries have participated heavily to achieve this, spending $3 trillion on new renewable and conventional power plants, transmission, and distribution (T&D) infrastructure and energy efficiency measures. Thus, this investment has helped to reduce carbon intensity per unit generated by about 1% per annum and raise energy security by reducing imports of fuels by about 4%.

2.1.2. Global Electricity Storage Types

Electricity storage is a necessity since it controls the difference between availability and demand for energy. Besides, the storage type chose over the quality and use of surplus energy. As a result of increasing population growth, the development of income levels and using advanced technologies in the industry uses vast amounts of traditional fuels like coal, oil, and natural gas have led to reduced costs of the material reserve. So, this will come into effect in a short time, so there is the need to find new sources of energy such as solar, wind, hydro and geothermal energy, and others. Because of an excess of some sources of this energy in specific periods and decreases in other periods of storage, technology acquires great importance in improving the efficiency and performance of renewable energy systems and is the key to exploit these sources in Wide and on a commercial scale. Where will provide requirements and reduce the energy expenditure incurred? (Qarghuli, 1993, p. 25).

In this regard, electricity storage requires a large reservoir can build as a water source needed river or lake close to the site. Hydroelectric power stations made in this site and can be up to one million kW and run during low load on the steam plant as the engine to power cycle baseload plants. Water wheel motors run pumps to draw water from a river or lake and pumped to the reservoir to fill up. During peak hours, the electrical system launches the water from the tank on the rotor and then works as a generator to make electricity. The economical way to that, as a rule, the construction of storage and pumping plant and build a reservoir is less expensive than the regular steam station. It can use fans or pumps that operate the wind or solar energy to push water into the tank. Moreover, generate electricity for supplying the power stored in cases of effecting a quick peak (Vinard, 1990, p. 95).

The widespread use of a conventional battery lead-acid battery is a nickel-cadmium battery to store electricity for a specific period. Lead-acid battery features available in the market as reliable and good storage time and high efficiency. Moreover, drawbacks that age is limited and depends on a daily operation as well as lose shipped automatically with time. The ongoing efforts to make advanced batteries are characterized by improved storage density and decrease price while ensuring the survival of other characteristics of the cell, especially the number of operating hours. Moreover, modern technology currently towards high-temperature systems and more advanced degrees' heat batteries currently used is a sodium-sulfur battery. There is another cell that can operate at high temperatures and is the redox, and battery of the main pros is cheap cost and can be used in electrical power generation systems (Qarghuli, 1993, p. 47).

Advantages of hydrogen as a chemical energy storage medium being generate efficiently has excellent thermal storage specification. It can be secure for a long time and high storage density, with temperatures close to the outside temperature. It can be moved as a gas or liquid to remote areas and can be used to generate electricity in fuel cells or heartburn, which produces high flame temperature. It can produce hydrogen from water through several successive operations where the decomposition of water (H2O) with high heat. Storing hydrogen is typically compressed liquid gas in steel receptacles double shell, separated by a layer of air and hydrogen storage requires as a gas pot bears the high pressure. Rocky caves can be used in underground hydrogen storage (Richard, 1971, p. 22). The idea of storing energy in a way that the air pressure in the tanks within hours after the peak load periods and then reuse stored energy to generate electricity during hours of peak load periods.

Moreover, it established the first experimental unit with a capacity of 220 Mika Watts in Germany year 1978, and in the 1980s, the number of companies to create similar pilot units after they made some improvements to the Yankees company of America (Jubouri, 1993). Sun radiation energy can be converted into electrical power directly by solar cells and provide the necessary energy for spacecraft through these cells as well as phone relay stations and radio and television broadcasting and charging batteries (car battery) to provide small pumps with the power to run in marine beacons. There is another way of turning solar energy into thermal energy, turning water into steam through mirrors and sun pool complexes (Aodeh, 1979, p. 87).

2.1.3. Electricity Price in the World Economy

As indicated by the World Economic Forum WEF (2015), electricity prices are increasing, so, this scale of investment has a cost for society. Thus, the inflation adjusted electricity price across OECD markets, which resulted in increasing by 2.8% for households besides 5.3% for the industrial sector, particularly during 2006 and 2013. While Germany and Spain have realized the steepest rises, more than 8% annually since 2006 for households and industry. Between now and 2040, overall electricity rates are projected to remain to growth by 57% in the EU, besides 50% in the US, due to higher costs of operations, maintenance, and investments. Retail prices are expected to increase in actual terms by 15% and 9% in the EU and US, respectively, for industrial sector use, as demonstrated in Figure 2.10.

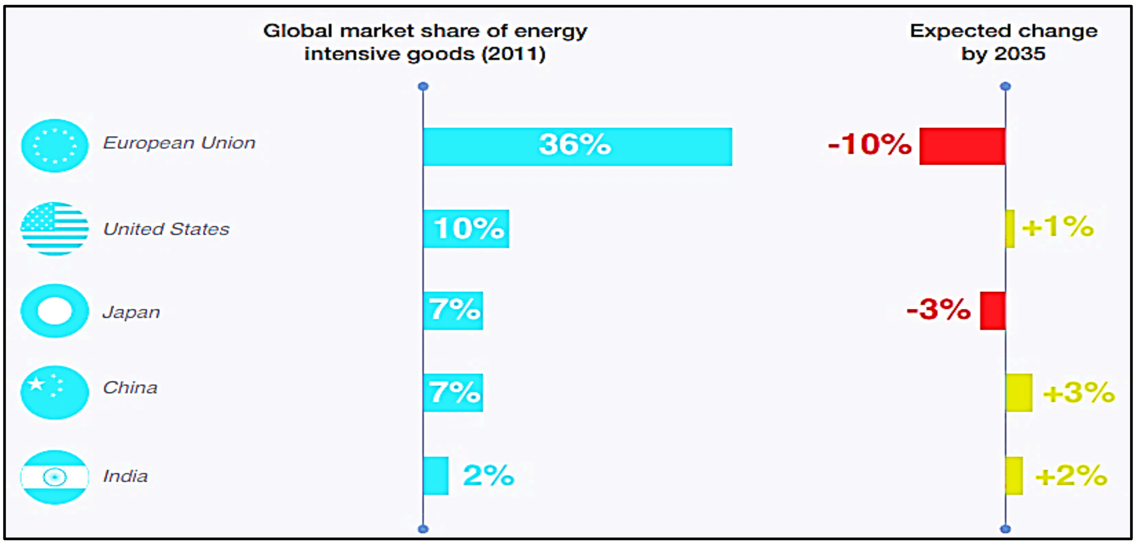

Figure 2. 10. Europe, with High Energy Prices, is Forecast to Lose Market Share in Energy-Intensive Goods

Source: (WEF, 2015).

In the same regard, the electricity prices for households in the United States are also expected to rise by 12% in real terms. However, in the EU countries, the prices are expected to remain to growth until 2020, and then reduce to levels similar to today's amounts by 2040. Subsidies for renewable energy in the EU countries have increased by 20% per annum for the last six years, besides it expected to rise by another 20% over the next six years (BP, 2019). However, as indicated by WEF (2015), various factors have led to the rise in electricity prices, such as renewables' support, network costs, taxes (VAT, industrial and excise taxes) also other charges like (policy support for nuclear neutralizing, and energy efficiency). Furthermore, to underlying costs increasing, rules in many markets still use the controlled electricity price to increase tax revenues for activities outside of the sector, such as social costs or debt repayment.

Thus, these trends increased the substantial variances in prices of the industrial power across developed nations, with inferences for global economic competitiveness. For instance, the prices of industrial power in EU countries are about twice those in the US (BP, 2019). Further significantly, the variance in gas prices among EU countries and the United States increased to 65% in 2013. Subsequently, these changes in the prices of energy (partially driven by low natural gas costs in the United States) are projected to lead to a decline in the market share of energy-intensive goods within high-cost regions. The EU, for instance, is estimated to decline its share from 36% to 26% over the next 20 years. Internationally, energy-intensive goods account for 25% of industrial employment and 70% of industrial energy use (WEF, 2015).

2.2. The Electricity in Iraq Economy

The Iraq electricity sector has met various difficulties and boundaries which have a significant impact on the economic growth and promotion of this sector. Such difficulties include the growing of the electrical load demand after 2003 and the presence of peak loads beginning the electricity generation deficit. However, some factors have led to this situation, such as the international blockade on Iraq, limited investments in electricity power, consecutive wars, security issues, and many others (Muslim, Alkhazraji, & Salih, 2017).

According to IEA (2019), many countries, including Iraq, continue to suffer from a severe crisis in the production of electricity and its use, which is a difficult problem of future global trends in the consumption of energy. Besides, the current reality of the energy situation in Iraq means an increasing gap between Iraq and the world abroad in the production and consumption of energy, which is the basis of electricity.

In this context, the International Energy Agency (IEA) predictably valued the Iraq systems loss at 1/3 of the power produced, which makes it one of the highest rates in the other Middle East countries, as presented in Figure 2.11. Statistics from the Iraqi ministry of energy connecting to the 2012 publicizing data show that overall of MWh 49 million was delivered in 2012. Nevertheless, only MWh 35 million sold. So, this explains losses near 30%. So, this situation had further worsened in 2013. According to the Iraqi of Energy Ministry informed statistics, approximately 37% of the electricity produced in 2013 is lost, which contains both technical and administrative losses (World Bank, 2014). There is vast possible to cut network losses, which are between the highest rates in the world: thus, dropping these losses by half would support to improve the productivity of network supply, hence effectively growing available capacity by one-third.

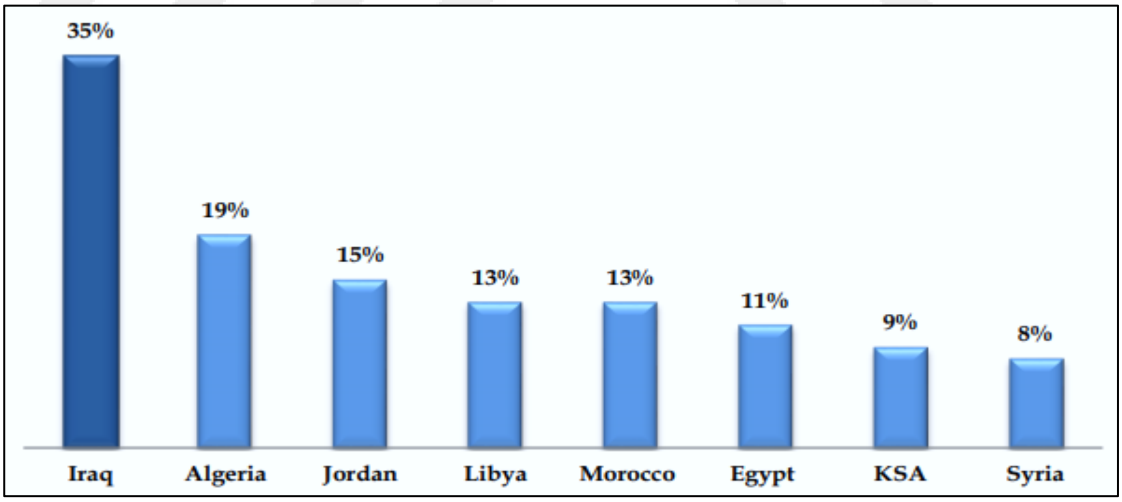

Figure 2.11. Electric Power Transmission, and Distribution Losses.
Source: (IEA, 2019).

Iraq is among the nations with the most capable energy resources. However, the electricity supply has insufficient to meet both the Iraqi demands of the population and the country's needs for economic development. The electricity consumption (standard sales) was approximately 8.3 GW in 2010 in Iraq. Though, the electricity peak demand estimated at 13.7 GW in Iraq. So, this deficit among electricity supply and demand in Iraq has met through some means, including electricity power importing from neighboring countries. In 2014, more than 3.5 million customers in Iraq, including in the Kurdistan Region. The household's electricity consumption in the country represented by 82% of these customers, consuming about half of all billed electricity. Due to the insufficient electricity supply, therefore, the average Iraqi household received power for only eight hours per day (IFP Grp., 2016). However, the household's electricity peak demand is projected to increase from around 11 GW in 2015 (Iraq without the KRI region) to around 32.5 GW by 2030 (Brinckerhoff, 2010). Accordingly, with Iraq's 8% average annual growth of electricity demand, the energy situation will only deteriorate in the future (World Bank, 2014).

However, regarding the electricity supply, more gas needs to be captured and put to use within efficient power plants. Iraq also needs to take benefit from potential renewables and to grow the share of solar photovoltaics (PV), particularly in the power mix. As shown in Figure 2.12, taking the share of renewables, up to 30% of the electricity supply by 2030 could take environmental advantages without growing overall costs for electricity supply. When compared to remaining the current structure of electricity supply, dropping network losses and depends on more severely on gas and renewables would free up 9 BCM of gas for other uses in 2030, plus 450 thousand barrels per day (kb/d) of oil for export (IEA, 2019).

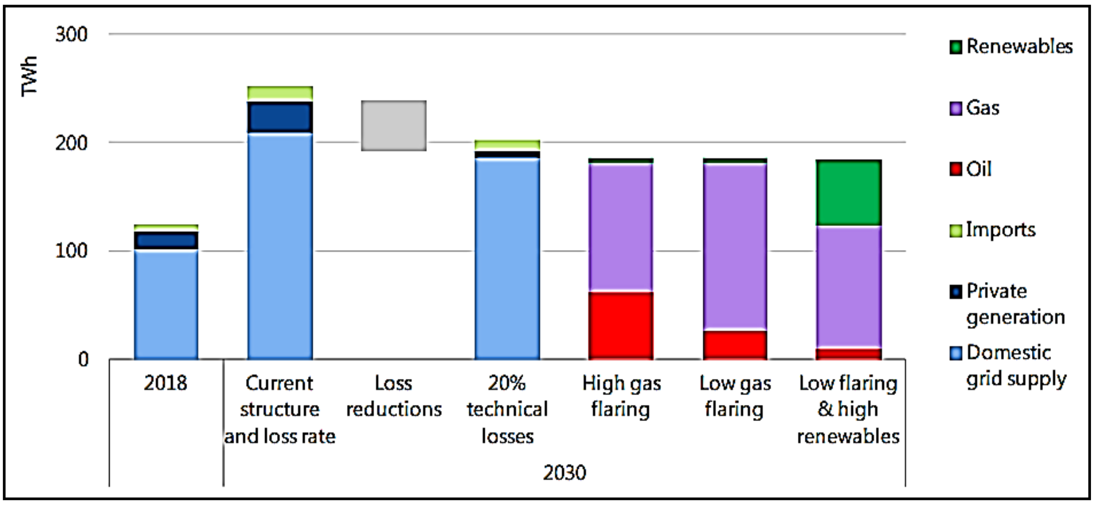

Figure 2.12. Potential Pathways for Electricity Supply in Iraq to 2030
Source: (IEA, 2019)

2.3. KRG Electricity

KRG is located in northern Iraq, and its energy structure suffered from a lack of electrical power, besides various challenges to be overawed to meet future rises in electricity demand, while about 85% of the power production is depended on fossils fuels, although the lasting 15% is covered by hydro-electrical plants. Hence, renewable energy sources are substitute energy sources for dropping demand for energy, then CO2 emissions in KRG, as shown in Figure 2.13. However, when compared to the other parts of Iraq, great stages have taken in electricity generation in the region through particular independent power producers. Currently, KRG has electricity for many hours of the day than anywhere else in Iraq (Morad, 2018, p. 94).

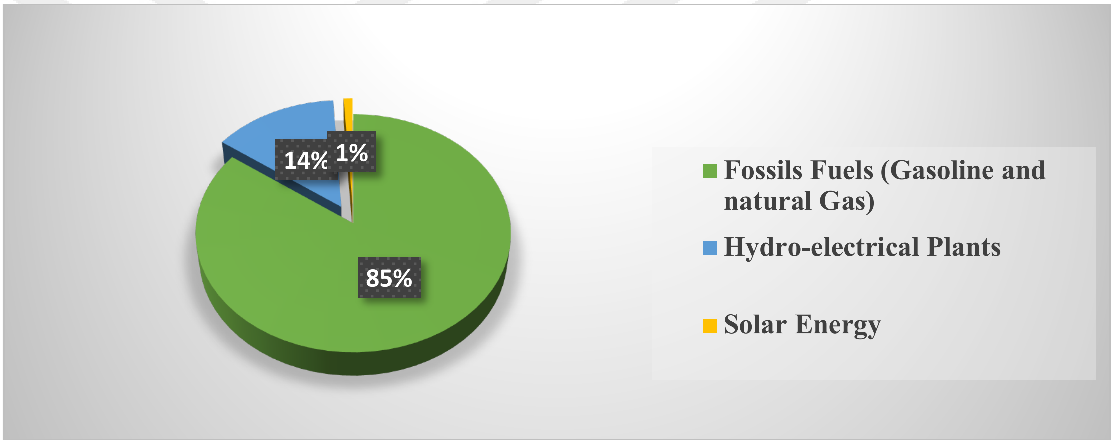

Fig 2.13. KRG Energy Sources for Energy Supply
Source: (Morad, 2018)**.**

The overall electricity improvement projects throughout the area are about 5 billion us dollars. By 2020, the region will have 24-hour electricity becoming a source of electricity in the level of access to the electrical grid for each of the urban and rural areas, unlike the access to water and sewage services. Seventy-two percent of urban areas and 64 percent of rural households' report that their primary source of electricity comes from the public network, while 28 percent urban and 34 percent of rural households' report use shared power source generators.

Although access to the primary power grid has dramatically improved, it needs to improve in hours. Many households in KRI are still experiencing power cuts for 12 hours or more a day. There is also a growing demand for electricity. As new office buildings, factories, hotels, residential complexes, other facilities, and increase the income of the population in the region, the need for effective management of electricity generation, transmission, and distribution are critical. Increasing the efficiency with which manage our infrastructure and ending the shortfall among the significant challenges facing our electricity. Our focus is to improve electricity services to residents in our area through 2017 (Sindi, 2013).

The electricity sector is governed in the KRG Ministry of Electricity. The ministry of electric power tool vertically integrated (generation, transmission, and distribution) with three directorates distribution in Erbil, Duhok, and Sulaymaniyah. Moreover, it possessed all transmission and distribution facilities, hydroelectric power plants, and a few old thermal stations (World Bank, 2015). The private sector is dominated by mostly on electricity generation in Kurdistan. At present, 95 percent of the production capacity of the private sector, and 5 percent owned by the government. Most productive capacity comes from thermal power stations. Hydroelectric power stations provide a small fraction (about 3-5 percent).

The vast majority of thermal installed during the past ten years by private companies with contractual power purchase agreements (PPA's). So, the KRG provides fuel for electricity generation to independent power producers. In contrast, independent power producers supplying electricity to the three provinces on the basic rules on the basis or pay. Because of growing demand, independent power producers have commissioned a new gas turbine power stations due to the Kurdistan Regional Government "plans to promote the use of natural gas in power generation (World Bank, 2012).

Electricity power recorded in critical achievements since 2010, generating capacity has doubled the vehicle more than tripled and reached 3.9 GWh, electricity supplies to about 22 to 24 hours of service. So, during the same period, power generation increased by 17 percent on average per year. However, during the past few years, electricity consumption in the region has significantly increased. Demand was up for 2013 3.5 GWh and exceed the expectations of the electricity plan for the KRG in 2009. However, the sector is still facing severe challenges, such as loss of high technical and non-technical, transport and distribution system bottlenecks, lower tariff rates and educational attainment, lack of regulatory frameworks, and heavy reliance on budget support. The total losses in the system about 35 to 38 percent, more than half of tech, and remain high compared to international standards. Commercial losses are amounting to about 20 percent of total energy transfer, which means that a large portion of electricity generated does not bring any income. There is a need for many investments in the physical infrastructure to improve the quality of transmission and distribution networks.

Moreover, Duhok, Erbil, and Sulaymaniyah are associated with a transmission with limited ability to move energy during peak months. However, these provinces will be better interrelated and can increase power transmission capacity between areas and neighboring countries. The electricity sector relies heavily on government support in terms of financial and operational sustainability. According to the joint report by the KRG ministry of planning and UNDP (SEINA) in December 2012 on KRI's infrastructure needs, financial subsidies reached $1.8 billion in 2011, equivalent to 2.8 times the total spending for ongoing projects in the electricity sector and 55 percent of total expenditure in 2011 for ongoing projects in the entire region. Because the current level of tariffs and collection rates are insufficient to cover operating costs and capital expenditure, the KRG Ministry of Finance continues to provide financial support to the ministry of electricity (KRG and WB, 2013).

The absence of effective regulatory and institutional schemes, combined with a lack of a strategic plan, undermines the sector's financial sustainability. To reduce the cost of fuel and improve the financial situation of the electricity sector, the KRG replace diesel natural gas in power plants within the next two to three years. The natural gas potential currently developed, and the new gas pipeline infrastructure is expected to be fully operational by 2016–17. Some of the completed projects include a 176-kilometer pipeline taking gas from the Khor Mor field to power plants in Erbil, and Sulaymaniyah to Khurmala and a 30 kilometer interconnector pipeline from the Summail field to the Duhok power plant, which was running on diesel/light fuel and is expected to entirely run on gas by the end of 2014. Projects to use gas to the power of Duhok station will save some expensive fuel $100 million every month (World Bank, 2015).

The World Bank ESIA relied on the SEINA study and broadened his assumptions to assess the impact of the crisis during the period 2012-2013. The previous estimate was for the financial cost of electricity 13.34 cents per kilowatt-hour. Under the assumption that increasing the efficiency of the new power plants that have been assigned, and transmission and distribution investments relatively well-executed over the past two or three years, and the gradual introduction of cheaper natural gas substitute for expensive fuel, revised the financial cost of electricity to 12.9 9.3 cents, and 7.2 cents per kilowatt-hour for 2012, 2013 and 2014, respectively. Also, the WB relied on the Ministry of Electricity estimates of the costs of the required investments and service delivery for electricity for refugees and IDPs living in camps 20 as a result, the impact assessment is evaluated at $383 million between the fourth quarter of 2012 and the end of 2014 (World Bank, 2015).

2.3.1. Electricity Sector Structure

Electricity power is critical for the country's economic growth. Hence, electricity consumption per capita is considered as a measure to determine how a nation is developed, so, this demonstrates how significant electricity is to the growth of any country. However, innovations in science and technology made electricity the most preferred form of energy. Electricity can be changed into other energy forms has more elasticity compared to other energy forms (Ibrahim & Kirkil, 2018, p. 2).

Electrical energy is a vital component in civilized societies, and the needs of all sectors of society in addition to an urgent need in everyday life used to run factories and various transport devices. All human movement need to consume some energy. Moreover, know (energy), physicist: its ability to accomplish this task either heat or change, turned from one format to another, such as converting the potential energy in the fuel to heat, wind electricity, mechanical, or chemical energy converted to heat (Khanna & Rao, 2009).

Electric current is known as the torrent of negative electrons moving cargo in a metal connector; this current generated by friction or chemical reaction or heat or electromagnetic induction, an electric current is measured in amperes, denoted (MB), and knows the amp that measuring unit electric current. The generator file from wires in an electromagnetic field generated (urge) electric current. As a result of cutting the magnetic field lines. It can produce from primary sources such as renewable energies (expendable) such as oil, gas, coal, and nuclear power and renewable energies (non-renewable) like solar and wind energy, watershed, and tides and Earth's geothermal (EIA, 2001).

Electric Energy Measuring Unit:

Watt-hour: one watthour is the amount of electricity expended by a one-watt load (e.g., a light bulb) raw power for one hour. A 50-watt light bulb will consume 500 watthours of energy if left on for 10 hours.

10^3 watt-hour = 1 kWh (Kilowatt-hour)

10^6 watt-hour = 1 MWh (megawatt-hour)

10^9 watt-hour = 1 GWh (gigawatt-hour)

10^{12} watt-hour = 1 TWh (terawatt-hour), (McDonald, 2009).

2.3.2. Electricity Structure in Duhok

The electrical power system in Duhok consists of some electrical items such as generators, transformers, and transmission lines, and can divide into the following main parts:

2.3.2.1. Power Stations in Duhok

Responsibility for the generation of electricity for Duhok Koichi station produces (1000) MW, Baadri provides 150 Mika Watts and Duhok, which produces (29) MW also the Aqrah station produces (10) Mika watts. The total was (1189) MW in 2014 and then set up maintenance contracts with companies to increase in the future, and electric power will increase in Koichi station about (500) MW. Then it will be productive and will have a capacity of (1500) Mika Watts as it will increase the size of Bishabery station (840) Mika Watts as it will increase gate control to station (37) MW and a total increase (1377) MW where total capacity (2566) MW. There are other projects in the region of Duhok Hydropower and Renewable energy sector, as shown in Table 2.1, production capacity.

Table 2.1. Hydropower and Renewable Energy Sector

Scheme Name	Power (MW)
Deralok	37
Khalsa	40
Chamsermo	10
Barthol-Pase	32

Source: (DEGD, 2017).

Associated power plants throughout the province with a significant network of high pressure (400 k) across Duhok station. Lines to other stations, and additional high pressure (132) kV, in Duhok, (13) and 33 and 11 KV conversions to a station (27) plants. So, the reality is hours long cut monthly rates some months of the year to 8-12 hours a day (Duhok, 2016).

Thus, the power plants must have standby units ready to run, to keep stream energy to the subscriber in case of failure any operating units or going out for maintenance and maybe the additional generating unit or reserve line connecting other regional stations. However, it keeps running without loading most of the time and goes into the service when it needs participants for more electricity or in case of emergency. Besides, the sum of all units in size capacity station called device station and expressed the high capacity of stations and Maggi units Watts. Tagged as total stations and capacities on the volume purchased network capacity minus largest unit capacity in the system is called fixed capacity represents peak load borne by the system in a state where the most extensive unit crashes (Vinard, 1990, p. 43).

2.3.2.2. Transportation Networks

The transfer of electric power generation sources to consumption areas through transmission lines, so, these lines are called the transmission and distribution networks or transportation system, divided regarding air and ground type. Pneumatic transport lines are known as hanging wires installed on towers by insulators and are moved by (Cables) within cities or areas that cannot put massive towers. Cables land transport is safer and uses in densely populated areas. Aluminum, the copper, has used the manufacture of wire transfer. It is lightweight and low resistance (to reduce heat dissipation) and appropriate tensile strength and reasonable economic cost for steel towers or wooden lists single or double shaped up-including a browser-based near the top of the tower.

It knows that loss of power cords depends mainly on the current value box, Where

Loss=C x^2 DC (where: circuit current, rated: resistance to conductive wiring).

The purpose of that use transformers to raise those voltages to 400kv high values are raising electricity generated transformers low voltage to the higher effort where being transported long distances. The line only used in the transfer of power from the power station to the center of the loads is called the transmission line conductor called together, which carries energy under a high voltage transmission network. Usually, the transmission lines emerging from the power station ring network with several apartment complexes and other plants so that it does not affect holidays happens to send electricity to any of compounds through the alternative line at the same time repairing the broken line (Vinard, 1990, p. 45).

Transmission lines 400 and 132 in terms of transport voltage values are selected depending on the distance required for the transfer of power and the amount of the same capacity as well as the stability of the electricity system and reducing the high voltages used in transport to small and relatively low volt stages (Attar Bashi and Mahdi, 1990).

2.3.2.3. Distribution Networks

That is where power reduction for delivery to consumers of the various magistrates and 33 distribution lines and 11 kV. For instance, the distribution stations volt 33 kV, 11 kV the processed volt usually some factories and enterprises that need high capacity. Called the primary distribution lines and is extended to areas where power will be distributed and still high voltage for use in the home or factory and therefore be reduced over the through composite adapter online by distributing adapter converts the energy of the primary distribution voltage to the secondary distribution of effort used in homes.

Moreover, usually, 220 volts and is called jumble of distribution lines elementary and secondary distribution lines and distribution transformers in a distribution network (Vinard, 1990, p. 48). These parts are connected to deliver electrical power the loads regularly may directly connect with loads or using the network transfer to connect the power station with developed standards for volts to consolidate power equipment used in the system and ease of use (Attar Bashi and Mahdi, 1990, p. 63).

2.4. THE ELECTRICITY CONSUMPTION CRISIS IN DUHOK

Nowadays, many electricity users entered in all areas of life, even becoming one of the components of the infrastructure for the economic progress and social advancement not in Duhok only but in KRG cities, besides electricity consumption rate is an indicator of standard of living and the degree of urbanization. Moreover, if electricity production in KRG-Duhok, has become a problem without a solution yet, the electric power consumption is another problem caused by the first significant production problem.

While Iraq's electricity problem is not current, the country has suffered from severe power absences from 1990, which were further compounded after 2003 by the unworthiness of the old power generation plants and the acts of sabotage during the overriding years (Khafaji, 2018). Therefore, this study devoted to examining the problem of energy consumption in Duhok, including production and distribution problems. Summed up the underlying problem in the question about the electrical power problem factors affecting consumption, supply, sectoral, spatial trends, and draw a picture of the balance between production and demand. Research assumes that economic factors and population are the most impacts in the energy report, the residential sector consumes the bulk of electricity. After collecting data, turn it into kilowatts-hours to doubling (2 k) instead of (3 k) because the generator owners deprived consumers of energy consumption.

Electric's 10 or 8 hours plus generator malfunctions or maintenance, add 80% of the energy produced by these generators for domestic sector and 20% for the commercial area, most of these generators and most of its subscribers from houses. It added that power stations (Kashi station and Baadri and Duhok and Aqrah) plus gate control to project Hydropower Renewable Energy Sector producing capacity 37 Mika Watts and hawkish production capacity 40 MW and Chameroy production capacity 10 MW and Barthol-Pase production capacity 32 MW (Ibrahim, 2017). Monthly aggregate demand is calculated in the Duhok distribution as follows:

Monthly demand = energy sales + domestic consumption+ broken load (Load Shedding) + Difference frequency compensation+ Losses and percentage of error in measurements.

Internal consumption: (generation, transmission, and distribution), and the service consumption includes energy consumed for fuel pumps, water pumps for cooling power generation units, air conditioning and refrigeration, charging batteries, protect the equipment and lighting. Overlay and error metrics: overlay as heat in conductors and transformers as a result of the passage of electric current transferred to the consumer, of course, that electrical power measurements as a percentage error of plus-minus (0.5-1.5%) according to the accuracy of the scale. Regard to the compensation of the vibration measurements and international standards (IEC International Engineering Standards Committee) for vibration and is 50 Hz for Iraq and Syria and Jordan and Kuwait and most of the Arabic and the European States and 60 United States and Japan and Hz for Saudi Arabia. Since the standard frequency of 50 Hz or Iraqi system (cycle/second) by international standards.

However now without power system (up to 49 Hz) so that the required load is greater than the available capacity, (for technical reasons as the decline in frequency and voltages is detrimental to consumers and makes it is not taking adequate electrical power, and it will benefit the service provider). When the rate 50 Hz system in balance any quantity of electrical energy equal to the amount required and balance is instantaneous minutes, then rudely removed. Moreover, Iraq now grid pulse 49 Hz. So, this means that there are shortcomings in the supply side. If the frequency were more than 50 Hz, it says that more of the demand which the system excess of electrical energy (Mohamed, 2017).

2.5. LOSSES ENERGY

The lack of electricity supply has concerned since 1990 in Iraq. Mainly through the Gulf War in 1991, around 90% of Iraq's generation of power and distribution systems demolished. Besides, While Iraq was able to reinstate about 50% only of the electricity generation infrastructure, the Iraqi electricity recovery was not achievable. The losses of electricity are in the three stages of generation, transmission, and distribution, which is similar to food commodities from production areas to consumption areas. There is a proportion of the loss or damage as a result of weather conditions. Electrical energy is either lost overlay between station obstetrics (hotness) and sold to subscribers and divided into stages (IEA, 2019).

2.5.1. Technical Losses

The current Iraqi weakened electricity network is worsened by years of disinvestment besides the absence of acceptable maintenance, which has left all three components of the value chain; generation, transmission, and distribution in critically degraded conditions. We can split it into two parts

1. In the connectors and transformers due to the passage of the electrical current as a part of the energy loses in the conductors. As heat and the amount of loss depends on the quality of the connector size difference and resistance, the voltage of the voltage appears in the form of high temperatures of the conductor resulting in loss of energy. As a result, copper or aluminum on a technical and economic basis, the small section increases thermal loss while the more significant part increases the financial damage.
2. It knows that the current power meters connected to homes are subject to lose over time as the disk turnover is low. Likewise, the percentage of this loss in the consumer counters increases or decreases according to the efficiency of the meter manufacturers.

2.5.2. Administrative Losses

According to Ibrahim (2017), administrative losses are part of the loss of heavyweight on the distribution networks not to counted within the energy sold to consumers (without standards). Since it is outside the technical specifications of the official electrical connection and due to the substantial and random increase of overloads. Which increases the loss of the professional network and thus loss of the financial return of this casual consumption. The most important of these violations is the lack of building materials, random building, and excesses on the adjacent network, the absence of a system, and the surplus due to the exchange of nutrition (due to the presence of programmed pieces) and the excesses due to costs and manipulation of meters.

CHAPTER THREE
DATA PRESENTATION AND ANALYSIS

This chapter deals with data presentation and analysis, establish an empirical connection between the theoretical and historical framework. Therefore, this study empirically shows the changes in electricity supply and demand in Duhok. In this regard, annual electricity supply data for households, commercial, governmental departments, industrial and agricultural sectors of Duhok during the period 1995-2017 are collected. Descriptive analysis of data and information used by analyzing values for the periods indicated increasing in energy demand with the regional development process.

3.1. METHOD

This study adopted a descriptive-analytical method in assessing the problem of the demand for electricity. The analytical approach also is one of the most critical and prominent methods of scientific research, which is used in the analysis of data in order to find the best solutions to the problems related to it. Accordingly, this states that the descriptive-analytical method is appropriate for examining numerical data than any other method. However, it deals with large size of data and figures. Therefore, a possible method of this study is descriptive-analytical or quantitative. An additional purpose for using this method is that the study examines data related to electricity supply and demand in Duhok.

3.1.1. Duhok's Electricity Data

The aim of the study is to explain an energy problem for regional development in Duhok's case. The data relates to electricity in Duhok during the period 1995-2017, playing a substantial role in the study outcomes. The primary data used in this study is about the electricity supply, electricity selling prices, changes in electricity consumption, sectoral distribution of electric power such as households, commercial, government sector, industrial sector, and agricultural sector. Similarly, the outcome of the sectoral distribution of electric power consumption, development, and average peak load on productive capacity. Furthermore, electricity losses during the period indicated, as well as the regular change of electric consumption, the balance between supply and demand, and actual demand.

3.1.2. Electricity Supply in Duhok During (1995-2002)

Before revealing and analyzing electricity data related to Duhok province, it is essential to mention that Iraq has suffered from a shortage of electricity supply since 1991 since the crisis has accumulated and exacerbated the problem after the US invasion in 2003. Although Iraq was one of the first countries in the Middle East to enter electricity 100 years ago, specifically with British colonialism in 1917. The first electrical machine was installed in the Khan Dallah building in Baghdad. Since then, Iraq has had a long history of events and variables that have affected the electrical grid and its uses (Khafaji, 2018).

Table 3.1. Electricity Supply in Duhok During (1995-2002)

Periods	Average Supply (MW)	Total Electricity Supply by (MW)	Changes in Electricity Supply per year (MW)	Changes in Electricity Supply per year %
1995	**19**	**228**	**-**	0
1996	**68.75**	**825**	**597**	72.36
1997	**66.33**	**796**	**- 29**	-3.643
1998	**53.33**	**640**	**-156**	-24.375
1999	**26.916**	**323**	**-317**	-98.142
2000	**28.7916**	**345.5**	**22.5**	6.51230
2001	**38.7316**	**464.78**	**119.28**	25.6637
2002	**65.0691**	**780.83**	**316.05**	40.47615

Source: (KRG, 2002).

As shown in Table 3.1, from 1995 to 2002, the electricity supplied to Duhok by the Iraqi government. However, the electricity supplied was a shortage, and while the northern region was disconnected from the Iraqi central government under Saddam Hussein in 1991, it also not supplied electricity to Duhok province. Consequently, in August 1995 Iraqi central government supplied a lower volume of electricity to Duhok province, where it began (8) MW, also see Figure 3.1, below.

During the 1991 Gulf War, the Iraqi electrical grid received thousands of airstrikes and about 90% of the electrical grid, and nearly 80% of the gas turbine units, as well as several transmission lines, destroyed or were affected by many substations damaged and out of service. The number of units operating after the war in 1991, only about 50 units with a generating capacity of 2,325 MW in the country. Table 3.1shows that total supply in 1995 was (228) MW and on average, (19) MW. The supply fluctuates also took place during the period indicated, where it reached (825) in 1996; it means that it increased by 72.36%. The supply in the year followed decline by losing -29 MW/h and continued to a shortage of electricity supply by -317 megawatt-hours in 1999. As the results indicated, the supply increase once again in 2000 by 119.28 MW was reached to 464.78 since the increase in supply obtains better, particularly in 2002 amount in 780.83 Megawatt or average 65.0691 per month.

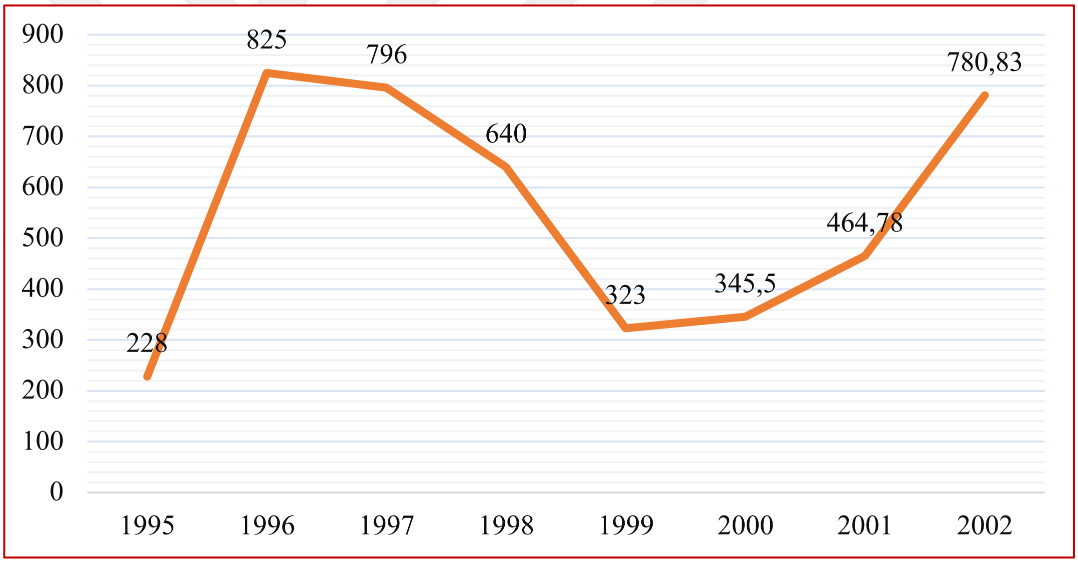

Figure 3.1. Electricity Supply Fluctuates in Duhok During (1995-2002)

Nonetheless, once the ceasefire was over, Iraq conducted a quick and imaginative reconstruction campaign with their spare materials and purely Iraqi expertise. In record time, the country was able to rehabilitate 25% of the 3,000 MW destroyed capacity during the first six months after the March 1, 1991 ceasefire. As indicated in 1991, Iraq suffered an unjust embargo and banned many aspects of life, which reflected on the production of electric power. In 1999, the Iraqi National Electricity Authority was established, which later became the Ministry of Electricity at the end of 2002. By the start of 2003, before the US invasion of Iraq, the available generating capacity had reached 4,500 megawatts.

It appears that there is a strong relationship between electricity production as well as consumption and economic growth that the decline in electricity production and supply negatively affects economic growth. For instance, global statistics show that continued power cuts reduce the growth of the country by 1.1% annually. Hence, this means that the number of jobs decreases by about 120 thousand annually, low access to electricity may also be a cause of technological incompatibility, which impedes access to and use of modern technologies, and thus adversely affects economic growth.

3.1.3. Electricity Supply During the Period (2003-2017)

In 2003, particularly after the falling of the Baath regime, the KRG had implemented the electricity projects in Duhok province. That started with several stations including small stations like (Kashi, Baadri, Duhok, and Aqrah power station) where the productive power of Duhok and surroundings with the fitted electricity supply by (72.5) MW on average, by the end of the year, reached to 870 MW, which higher than the previous year. However, as it shows in Table 3.2, it is possible to observe that in 2015, the total electricity supply in Duhok reaches to it is peak by 6803.37 MW, or on average, 566.9475 MW, that increased by 3.37% compared with 2014 was 6573.49 MW.

More significantly, in 2007, the KRG's capacity for electricity generation was 482 MW. Currently, it is close to 3 GW, while an additional 3 GW planned to be added to the power grid soon. Thus, this growth enables the region to supply electric power not only to cities but also to neighbouring regions. The KRG firmly believes that resources of hydrocarbons and related power production must benefit all Iraqis. Moreover, they might be used for reconstruction and development of the country as planned by the 2005 Iraqi constitution. According to KRG (2017), around $1.5 billion invested in electricity generation in the KRI. While the electric power stations in the KRI are dual-fuel gas turbines that can either run on diesel or gas, in this regard, KRG also focused on gas-fired power stations, as they are the fastest and most effective electricity production means.

Table 3.2. Electricity Supply in Duhok During (2003-2017)

Periods	Average Supply (Megawatt)	Total Electricity Supply by (Megawatt)	Changes in Electricity Supply per year (Megawatt)	Changes in Electricity Supply per year %
2003	**72.5**	**870**	0	**0**
2004	**98.57**	**1182.84**	**312.84**	**26.44820939**
2005	**137.8983**	**1654.78**	**471.94**	**28.51980324**
2006	**169.9925**	**2039.91**	**385.13**	**18.8797545**
2007	**156.423**	**1877.08**	**-162.83**	**-8.674643595**
2008	**128.583**	**1543**	**-334.08**	**-21.65132858**
2009	**152.47**	**1829.64**	**286.64**	**15.66646991**
2010	**226.585**	**2719.02**	**889.38**	**32.70957919**
2011	**325.8783**	**3910.54**	**1191.52**	**30.46944923**
2012	**417.5275**	**5010.33**	**1099.79**	**21.95045037**
2013	**471.52916**	**5658.35**	**648.02**	**11.45245522**
2014	**547.79083**	**6573.49**	**915.14**	**13.92167631**
2015	**566.9475**	**6803.37**	**229.88**	**3.378913685**
2016	**526.305**	**6315.66**	**-487.71**	**-7.722233306**
2017	**497.715**	**5972.58**	**-343.08**	**-5.744251228**

Source: (KRG, 2017).

Table 3.2 and Figure 3.2 demonstrate that the electricity supply steadily increased from 1182.84 MW in 2004 to 3910.54 MW in 2011. However, during the same period, particularly in 2006, supply decreased by -8.67% and continued to the following year 2007, even more, decline recorded by almost -21.65%. Further, the supply increased more than reached 5658.35 MW in 2012 when compared to 2011, which was higher by 21.95% due to the increasing demand. So, the electricity supply kept it was growth by another 11.45% in 2013. Before June 2014, the design capacity of power plants excluding the KRG was 26,900 MW. In June 2014, ISIS, quickly controlled Mosul as Iraq’s second-largest city, with some other cities in the country’s north and west leaving about a third of Iraq's total area in the hands of terrorism. Most power stations and substations in the area faced significant damage and losses to the network.

Thus, the crisis has damaged the country’s plans of economic development, counting efforts to reform a delicate electricity sector which has suffered lengthy blackouts for decades, as the result of struggling a large number of refugees flowing to KRI, especially Duhok province. That lead to more supply in power was reached to 6573.49 MW, while the generation capacity of electric power in KRI has developed various times during the last decade, mainly due to the investments by the private sector, consequently. So, the sector remains to be characterized by the massive financial burden of supports, which needed costly liquid fuels to meet natural gas deficiencies, transmission holdups, high technical and commercial losses, low prices, insufficient established capacity, and poor quality of supply.

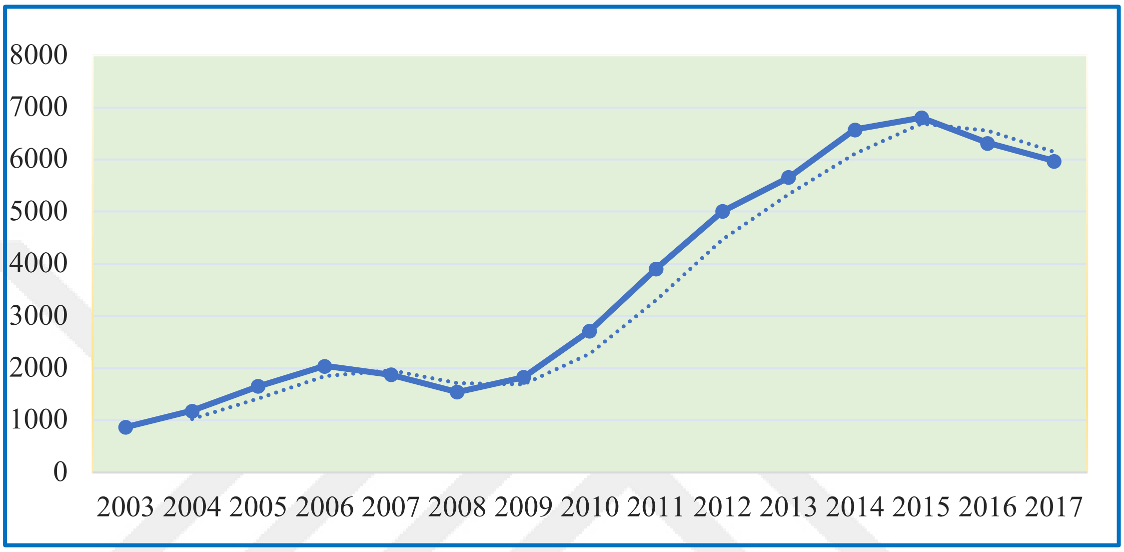

Figure 3.2. Growing Electricity Supply in Duhok During (2003-2017)

In the meantime, the Iraqi central government was confident that by May 2014, the country would lastly advantage from electricity supply 24 hours, based on its plan to add 8,000 MW capacity of electricity generation to reach 20,000 MW by the end of the same year. In the wake of ISIS advance, lack of public services in the areas mainly controlled by the Iraqi government, the Iraqi ministry of electricity announced electricity power grid losses of more than 8,000 MW.

Therefore, this long-lasting gap between electricity supply and demand is valued to have caused some $40 billion in annual losses for the Iraqi economy (Brinckerhoff, 2010). However, the worst situation in most Iraqi cities leads to more IDPs and refugees flowing to KRI. With the ISIS defeat and returning some refugees to their places electricity supply gradually decreased from 6315.66 MW in 2016 to 5972.58 MW in 2017 was declined by -343.08 MW.

3.1.4. Electricity Users in Duhok

As shown in Table 3.3, the number of electricity users or consumers in Duhok is affected by the number of inhabitants of the governorate and the use of advanced electrical appliances by the individuals when increasing their income. During the period 1999-2016, electricity users or consumption by households were recorded the higher in Duhok, it shows the impact of rising incomes for economic status improved in Duhok, the percentage of the number of electricity users had reached (83.9%) in 2016 as shown in Figure 3.3.

Table 3.3. The Number of Electricity Users in Duhok Province During (1999-2016)

Periods	**Households**	**Commercial Sector**	**Industrial Sector**	**Agricultural Sector**	**Government Sector**	**Overall**
1999	63447	8516	127	18	544	72652
2000	71708	8691	136	20	559	81114
2001	79989	8866	144	22	573	89594
2002	82039	8800	134	75	1182	92230
2003	86075	9358	117	97	1359	97006
2004	90110	9915	100	109	1535	101769
2005	101790	9803	47	115	1548	113303
2006	111811	11345	161	112	2025	125454
2007	122691	14412	184	161	1784	139232
2008	132354	17184	236	199	1940	151913
2009	143365	18315	250	296	2232	164458
2010	154376	21446	263	392	2524	179001
2011	172200	24752	337	575	3895	201759
2012	192629	27852	398	835	4277	225991
2013	208060	30816	491	1101	4725	245193
2014	230091	34892	541	1471	5087	272082
2015	247806	38586	589	1792	5289	294062
2016	261283	41647	633	2241	5467	311271
Share	83.9%	13.4%	0.2%	0.7%	1.8%	100%

Source: (KRG, 2017).

According to Figure 3.3, it is possible to observe that the household's electricity consumption increased by 17.73% for the period 1999-2017 due to the increase in per capita income and the increase in the use of electrical appliances. However, increase in per capita electricity to duration (1999-2017) annually, and this order index is rising per capita electric power after heading increased production and solve the problem of lack of energy, but that the citizens do not feel this improvement, the processing remains a third of the actual power it needs the increase in the number of participants. From 1999 to 2010 it had not been sufficient production to processing power by 25% but an increase in the year 2011 achieved, were reached to doubled compared to 2010 the proportion of participants (13.543%), and in 2011 amounted (22.758%) increased the height in 2014 at (25.889%). Moreover, it followed by a decline to the year 2017 as (14.770%).

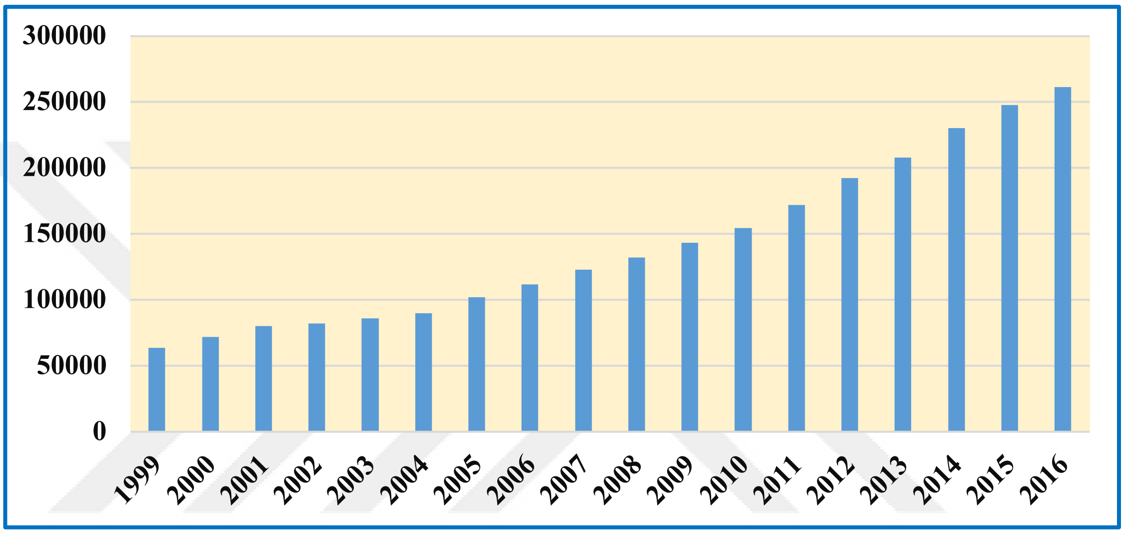

Figure 3.3. Household's Electricity Users in Duhok Province During (1999-2016)
Source: Depending on Table 3.3, Above

During the same period, electricity users or consumption by other sectors such as commerce, industry, agriculture, and government also recorded the increases in Duhok, while the second higher increase recorded by the commercial sector by 13.4%. So, it shows the influence of growing economic activities and progress in incomes for economic status that improved in Duhok, besides the percentage of the number of electricity users had reached (311271) in 2016, in all sectors, as shown in Table 3.3, and Figure 3.4, below.

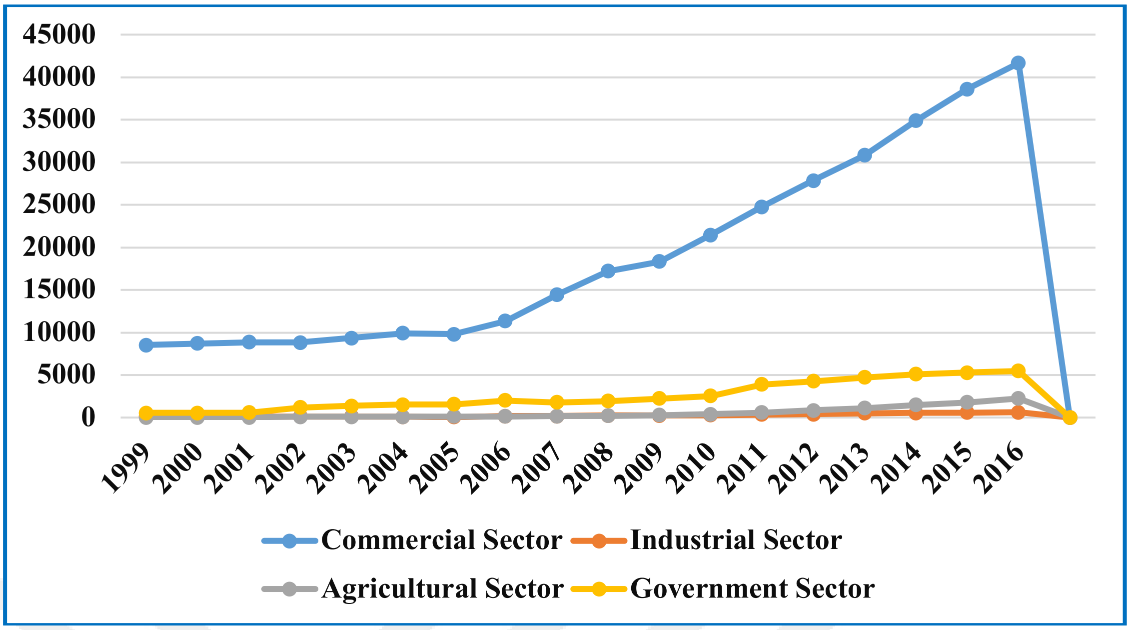

Figure 3.4. Electricity Users in Commercial, Industrial, Agricultural, and Governmental Sectors in Duhok Province During (1999-2016)

Source: Depending on Table 3.3, Above

3.2. SELLING PRICES OF ELECTRIC POWER

By expecting the amount of electricity demand for all sectors namely (households, commercial, industrial, agricultural, and governmental) and the light areas of the province (Duhok, Aqrah, Zakho, Semel, Amedi, Bardarash, and Sheikhan)) among variables affecting demand for each sector where data collected based on annual supply of electrical energy (energy sales) for all and the parts sectors.

Table 3.4 reveals that electricity sells prices for the household's sector, which represents the most significant electricity consumer. It is a low amount with high quantities of consumption, that rising from (6.750ID) (5.72$) per kilowatt-hour (540.250ID), (457.84$) per kilowatt-hour. Thus, it shows the desire of the authorities to provide services for citizens, including cheap energy power, to improve the economic reality for people with limited income.

Table 3.4. Electricity Selling Price to the Users according to Sectors in Duhok During (2009-2017)

Sector	MWH	Price (ID)	Exchange $1 to ID	price ($)
Households	**1-450**	**6750**	**1180**	**5.72**
	450-900	**15750**	**1180**	**13.35**
	900-1500	**36750**	**1180**	**31.14**
	1500-2100	**72750**	**1180**	**61.65**
	2100-3000	**140250**	**1180**	**118.86**
	3000-5000	**440250**	**1180**	**373.09**
	5000-5500 exceed.	**540250**	**1180**	**457.84**
Commercial	**-**	**130000**	**1180**	**110.17**
Government	**-**	**150000**	**1180**	**127.12**
Agricultural	**-**	**30000**	**1180**	**25.42**
Industrial	**400 V**	**120000**	**1180**	**101.69**
	11 KV	**100000**	**1180**	**84.75**
	33KV	**100000**	**1180**	**84.75**
	132 KV	**100000**	**1180**	**84.75**

Source: (KRG, 2017).

In the commercial sector, electricity is sold at prices (130) thousand dinars (110$) (kW/hour) to rationalize the increasing energy consumption in this sector as a result of excessive use of lighting and optical releases commonly used dramatically in most of the shops. As electric power sells in the government sector, agricultural prices are different from energy prices traded in the commercial sector lump and constant rate (150) thousand dinars ($ 127) (kW/hour) and (30) thousand dinars (kW/h).

Table 3.5. The Electricity Average Price in the Domestic and Commercial Sector 2016.

Average Price for Domestic and Commercial Sector	Directorate of Electricity
23.35	**Duhok**
19.01	**Aqrah**
21.36	**Zakho**
20.56	**Semel**
21.81	**Sheikhan**
21.85	**Amedi**
20.74	**Bardarash**
21.83	**Average**

Source: (KRG, 2016)

It is different, so use (400v) price (120) a thousand dinars ($ 102) (11kv to 132kv) for the price of 100 thousand dinars ($85) (kWh) in the industrial sector. Prices of electrical energy demand continue to rise in large amounts prompting the government to adopt the dynamic energy pricing to reduce consumption in proportion to the amount of energy fitted to the province. However, from the Table 3.5, it is possible to find that average prices in the domestic and commercial sector in Duhok are at a higher rate than the rest of the other areas (Figure 3.5), which accounted for (23.35) and the lowest was (19.01) (kilowatt-hours) in 2017.

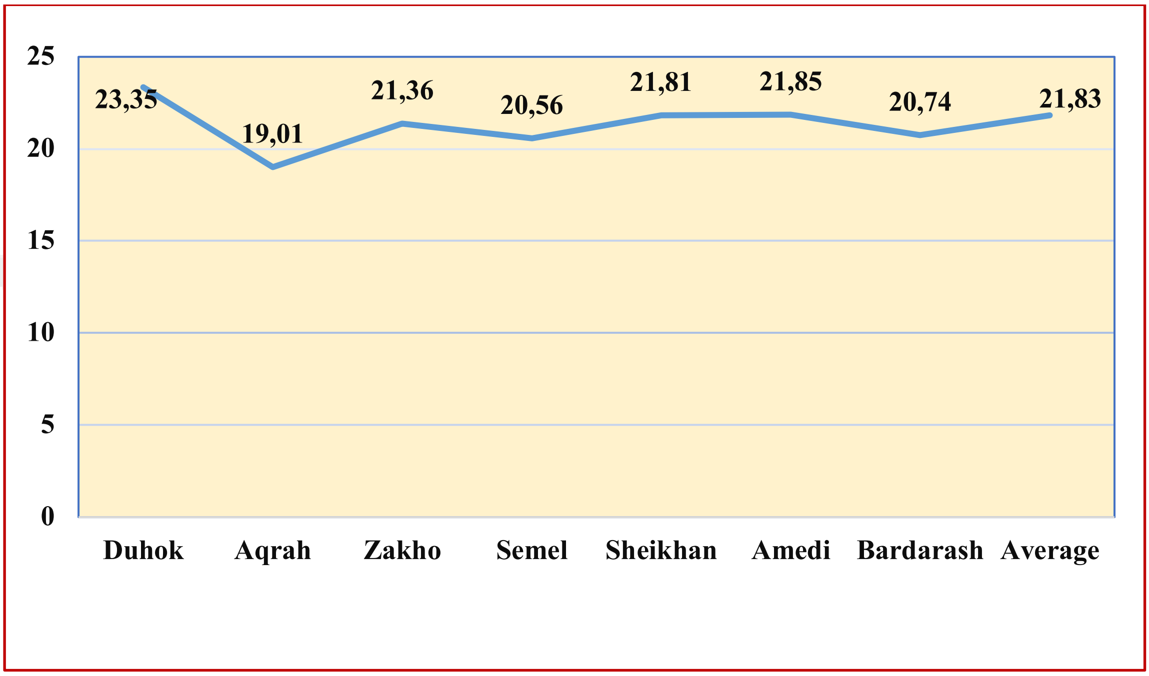

Figure 3.5. The Electricity Average Price in the Households and Commercial Sector 2016.

3.3. THE DIFFERENCE IN ELECTRICITY CONSUMPTION

The electricity distribution in the Duhok province and it is districts, particularly distribution lines fed by feature system programmer for consumption by dividing the distribution lines feeding stations with individual scales determine distribution through which electricity amount depending on the number of projects focus population Industrial and service. Table 3.6 shows that Duhok city occupies the top position in the energy consumed by (29.62%) of the total energy consumed in the province, and return it offers (26.32%) residents of the area and that the judicial power consumption exceeds the share of the population (3%). It indicates that a function of the community alone is not a decisive reason in energy consumption. However, there also are other factors, such as the level of supply, industrial activity, business, government departments, and services.

The town of Zakho is ranked second in the percentage of electricity consumed by (18%) of the total energy consumed in the governorate. Although 19.37% of the population of the province. It shows that electricity consumption in the judiciary is less than the community by about 1%, the percentage of electricity consumed in the place of SEMEL reached 14.67% of the total energy consumed in the governorate. Therefore, reaching third place in consumption despite the increase in its population and their percentage (13.14%). (0.5%).

Table 3.6. The Amount of Energy Consumed and Population by the Districts in Duhok (2017)

The Districts	The Amount of Energy Consumed (kWh)	Population/ People	Number of Populations Urban/ People	The Population of the Country/ People
Duhok	**96.574**	**409854**	**390688**	**19166**
Semel	**47.832**	**204706**	**157178**	**47528**
Zakho	**58.856**	**301635**	**270744**	**30891**
Amedi	**24.149**	**85505**	**56528**	**28977**
Sheikhan	**38.483**	**161747**	**98576**	**63171**
Aqrah	**32.393**	**197435**	**88684**	**108751**
Bardarash	**27.754**	**155140**	**51856**	**103284**
Total	**326.041**	**1557021**	**1143161**	**413860**

Source: (KRG, 2017)

Further, Quads SHEIKHAN ranks fourth in the amount of electricity consumed by (11.8%) of the total consumption of the district and comprises a population of elimination (10.38%) of the entire community of the District, and that share of the distributed energy for consumption by about (0.8%). So, in the district of AQRAH, the electricity consumed amounted to (9.93%) of the total electricity consumed in the governorate. Thus, it was ranked fifth in consumption despite its high population (12.68%), (2.5%).

Table 3.6 also shows that BARDARSH places in sixth place spend a proportion of electricity consumed by (8.5%) of the total electricity consumed in the province while featuring (9.96%) residents of the region. Finally, AMEDI occupies rank seventh in the province in the amount of electricity consumed by (7.4%). It includes a population of elimination (5.49%) of the total population of the Duhok province, thus the population surpassing the removal of distributed electricity for consumption by about (2%).

3.3.1. Households Electricity Consumption

As previously mentioned, in Duhok province, primary electricity consumption takes place in five sectors. Among them, the household sector, representing the significant electricity consumer. The use of electricity is essential for cooking and heating water. These are the essential uses. Electricity also used in lighting, cleaning, and entertainment. When dealing with household uses of electricity, these are the primary uses such as bathing, working from home on computers, and operating other appliances. Therefore, residential uses of energy account for nearly forty percent of the world's total energy use.

As shown in Table 3.7, demand for electricity in the household sector increased from 2014 (2,357,595,503) (kWh) to 2015 (2,413,099,560) (kWh). Since some displaced refugees in Duhok returned to their places particularly during (2016-2017) Electrical energy used at lower rate by (79.19%, 78.22%) equipped with card (2,224,108,570), (2,037,525,820) (kWh). Further, the results reveal that consumption in the household sector has fluctuated because of different electricity amounts that are fitted to the area. Decrease the amount of energy consumed the household sector in 2015 by 0.32% in comparison with the year 2014 to form (78.68) of the total consumption of electrical power in the same year; the ratio also reduced for the year 2017 when compared to 2016 by (0.97).

Table 3.7. Households Electricity Consumption During (2011-2017)

Years	KWh	Percentage %
2011	**1,425,659,000**	**79.49%**
2012	**1,885,250,200**	**80.20%**
2013	**2,227,842,000**	**82.%**
2014	**2,357,595,503**	**79.%**
2015	**2,413,099,560**	**78.68%**
2016	**2,224,108,570**	**79.19%**
2017	**2,037,525,820**	**78.22%**

Source: (KRG, 2017)

A gradual rise in the amount of energy consumed the household sector for the duration (2013-2017) and (5%) in 2013 than in 2017, (3%, 2%) year 2015 due to the high amount of electrical energy to sustain. In addition to a significant rise in demand for consumption through the expansion device purchase electric and substantially year after year and the rapid evolution of housing after the improvement in the economic situation of citizens and the country's security situation. A percentage annual increase of consumption in the household sector and length (2013-2017), (50%). Moreover, this is clear evidence of substantial growth in electricity demand with the evolution of the economic situation and living standards improved.

3.3.2. Electricity Consumption in Commercial Sector

As revealed in Table 3.8, the increase in the commercial sector recorded by a small margin, which is ranked third in the sequence. The use of electricity in the commercial sector includes heating, cooling, and lighting of buildings and commercial spaces, in addition to the electricity used by companies and commercial centers throughout the city for computers and fax machines, copiers and printers, elevators, and drawers as well as many others. The increase in the commercial sector from (2011-2017) reached (123054) (246546497) (kWh), as shown in the table below, during the period 2013-2014 total rise by (1.11), and the rate in 2011 was (6.86) met in 2017 (9.46). Increased energy demand and confirms the continuous increase in job relationships.

Table 3.8. Electricity Use for the Commercial Sector During (2011-2017)

Years	KWh	Percentage%
2011	**123054**	**6.86%**
2012	**171494.9**	**7.3%**
2013	**207913**	**7.63%**
2014	**260248890**	**8.72%**
2015	**281,666,450**	**9.18%**
2016	**255115442**	**9.08%**
2017	**246546497**	**9.46%**

Source: (KRG, 2017)

The results show that the electricity sector is one of the critical economic and social sectors because of its essential and significant role in stimulating economic activity. Moreover, social stability, as electricity is one of the elements of production costs that negatively affect the national economy in light of the high prices. Domestic production, import from abroad, and use in national production might be positive when the prices of quantities exported, resulting from the increase of domestic production to meet the domestic demand, known as surplus. Because the export of surplus at high prices will lead to increased public revenues from a foreign currency, it supports the strength of the local currency and economy.

3.3.3. Electricity Consumption in the Government Sector

The government sector is classified third in terms of electricity consumption. While justification of electricity consumption in the government sector is essential which data required by the government authorities, and the mechanism to provide the center with these data on electricity consumption from the technical coordinator in each government agency, and its role in the follow-up to the preparation and implementation of preventive maintenance programs for the most energy-consuming electrical appliances. As we note through Table 3.9, the rise in electricity demand in 2014, where the depreciation of government facilities increased the need for it by (9.68) percent and also in years (2012, 2015, 2011) increased by (9.90, 9.40, 12) percent in other years.

Table 3.9. Electricity Consumption in the Government Sector During (2011-2017).

Years	KWh	Percentage%
2011	212804	12%
2012	233679	9.90%
2013	212118	8%
2014	288993520	9.68%
2015	288193271	9.40%
2016	252184989	8.98%
2017	226529885	8.70%

Source: (KRG, 2017).

However, the government sector represents state institutions and street lighting and all facilities covered by contingency lines of hospitals, mosques, and religious Shiites will maintain it has occupied the second place in the domestic sector after consumption quantity. Consumption ratios ranged between (8-12%) of the total consumption in the Province, and from table 3.9, find that the amount of use in this sector soared during the period (2014) and (9.68%) to expand and increase electrical energy processing.

3.3.4. Electricity Consumption in the Industrial Sector

As shown in Table 3.10, the industrial sector produces the fourth largest electricity consumption, where the highest rate of 2% per year (2013) and reached (52599) (kWh). The economy depends on the trade of goods, and the circulation of manufactured goods worldwide, while manufacturing goods are by huge machines and large factories, thus electricity in the industry is of great importance since all machines require electricity. Furthermore, the importance of electricity is not limited here, which contributed to the emergence of the industrial revolution due to the use of electricity in industries and factories with modern technologies; to meet demands, manufacturing is made faster and more accurate.

Moreover, during the period indicated, the electricity consumption kept increasing, in (2017) was (34570206) (kWh). Note in previous years has less depreciation (2017). There is an increase in demand for the industrial sector calculated number (kW/h), which was average (1.33). Any increase in energy demand, which agrees, and if demand theory, there was a little percentage.

Table 3.10. Electricity Consumption in the Industrial Sector During (2011-2017)

Years	KWh	Percentage%
2011	19153	1%
2012	38253.4	1.60%
2013	52599	2%
2014	46177231	1.55%
2015	45479094	1.48%
2016	34108206	1.21%
2017	34570206	1.33%

Source: (KRG, 2017)

As previously mentioned, the industrial sector represents the manufacturing and workshop facilities of the public and private sectors in the province. However, the improved economic situation plays a role in increasing industrial activity by the private sector. It appears from the table above the high quantities of electrical energy consumed in the industrial area by (1.45%) annually. The lower level reached in this sector by (1%) of total consumption for the in 2011.

3.3.5. Electricity Consumption in the Agricultural Sector

Agriculture is one of the main economic activities that contribute to the national economy, the economic security of national security, and the achievement of food security depends on the essential degree of food provision from local agricultural production. Moreover, the advancement of the agricultural sector contributes to diversifying the economy, alleviating poverty, improving the trade balance, and achieving movement for most of the sectors directly and indirectly associated with it. So, electricity demand rose in the agricultural sector, mainly in 2017 by 2.29%.

Which reached (59744404) (kWh) in 2014, increased by (1%) denotes growing demand in recent years, so that the agricultural sector consumed the lowest electricity rate sectors hereafter, as revealed in Table 3.11. However, this sector needs government support, as the development of the agricultural sector contributes to combating unemployment, reducing the volume of imports, developing, advancing society, and strengthening the national economy. The development of the agricultural sector has a positive impact on improving the environmental situation.

Table 3.11. Electricity Consumption in the Agricultural Sector During (2011-2017)

Years	KWh	Percentage %
2011	12812	1%
2012	21253.2	0.90%
2013	28764	1%
2014	31116835	1.04%
2015	38665004	1.26%
2016	43031810	1.53%
2017	59744404	2.29%

Source: (KRG, 2017)

Figure 3.6 shows that electricity consumption in domestic sectors, commercial, industrial, agricultural, during (2011-2017), displays that the electricity consumed decreased slightly in 2013 to account for 1% of the total energy consumed and increased by 2.29% when compared to 2017. The sector did not increase consumption during the period 2014-2016, has remained small amounts despite the high quantities of energy processed in the province. There are two reasons. Firstly, many farmers leave their land without cultivation after sinking markets imported crops and low prices. Secondly, the water is insufficient for watering the areas after low water levels and dry with lots of lands which reflected in the absence of demand for electricity.

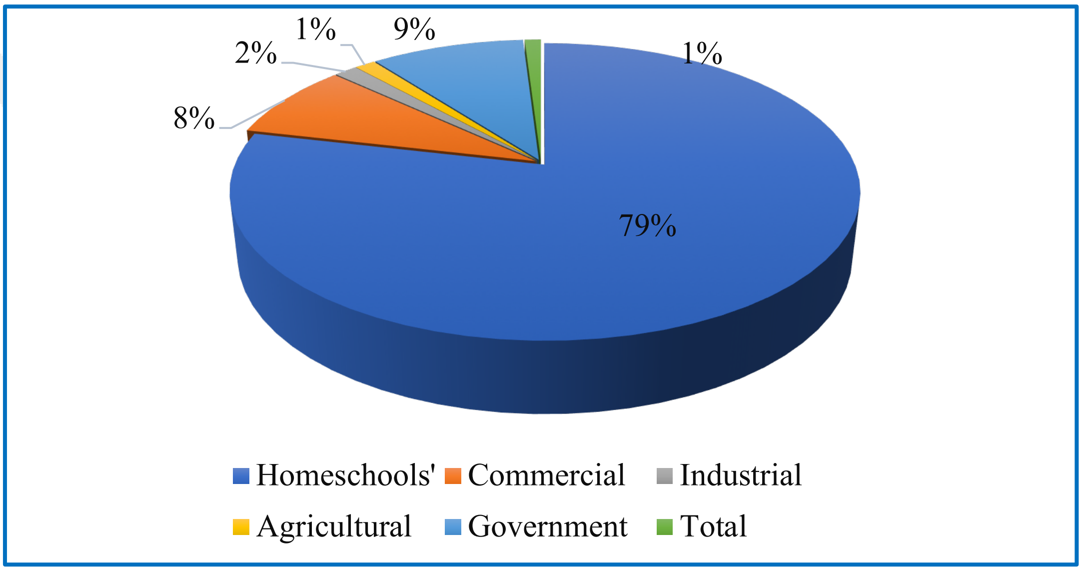

Figure 3.6. The Percentage of Electricity Consumption in Five Sectors During (2011-2017)

3.3.6. The Electricity Peak load and Production Capacity

Table 3.12 highlights the impact of peak load planning to develop the capacity of station obstetric (heat) and power transmission networks in the province to fill the need for electricity demand with a spare ability to meet the surge in demand. Naturally, the peak load in Duhok fast and continuous increase in 2011 to 2017 more than 40% to produce feeding stations in the province.

Table 3.12. Peak Load and Production Capacity

Periods	Enterprise Capacity MW/h.	Production Capacity MW/h.	Peak Load MW/h.
2011	698	325.88	467
2012	858	417.53	514
2013	1037	471.53	617
2014	1240	547.79	763
2015	1418	566.95	875
2016	1643	526.31	1014
2017	1686	497.71	1014

Source: (KRG, 2017)

So, this growth is due to the high number of displaced populations refugees from the South and centre of Iraq. The Ministry of Electricity continued to develop the institutional capacity of the stations in Duhok by directing the installation of new generation plants. Peak load rate of 566.95 MWh capacity reached in 2015, with the enterprise capacity, higher than the peak load rate of 763 MWh.

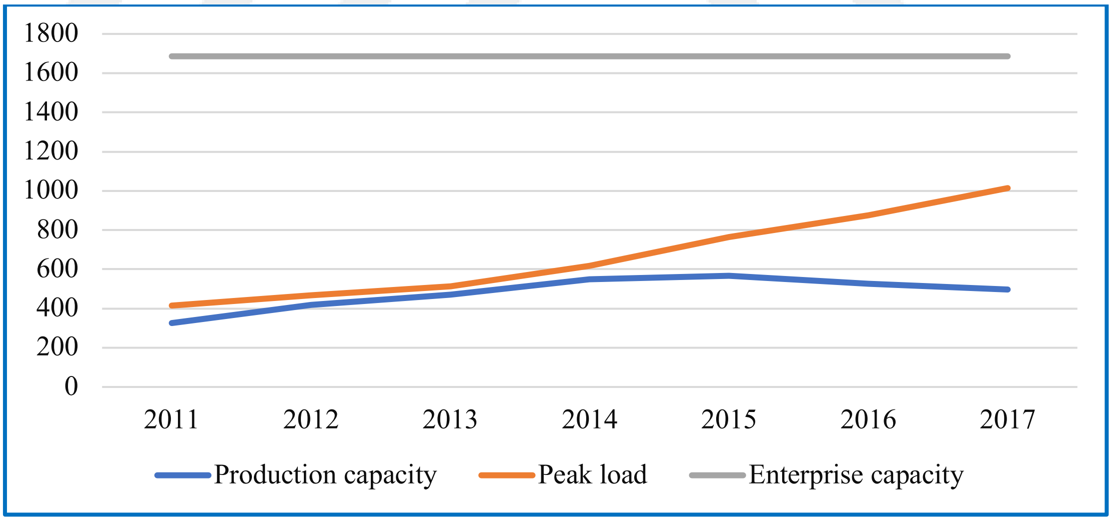

Figure 3.7. Peak Load and Production Capacity.

Source: Depending on Table 3.12.

Moreover, a positive sign that the peak load has exceeded 50% no limit for required for productivity, but high in Duhok, fewer during (2014, 2013, and 2012), the ratio of the peak load of the actual production amounted to 875 in 2017 explains high real output, nonetheless, from the table (3.12) increase sufficient demand and production decreased from the year 2015 with production years 2016, 2017 respectively reached (526, 497.71) MW/h, as shown in Figure 3.7.

3.3.7. The Imports of Electricity from Neighboring Countries

The revelation of electricity in Iraq to various crises and problems such as the wars with neighboring countries. The imposition of the economic embargo on it in the nineties affected the electricity supply. Likewise, the occupation by the United States in 2003 caused the intensification of internal conflicts and the spread of corruption. There are other reasons related to the same sector, for instance, the decrease in operational efficiency due to the obsolescence of most of the stations operating in Iraq, the reduced maintenance, operation of the transmission and distribution networks.

However, electricity is fluctuating between high, low, and the shortage is met by imports from neighboring countries, mainly from Turkey and Iran, because it is known that electricity cannot be transported as long distances as in the case of goods and services. So, the annual electricity rate generated locally was around 277.6 MW in 2004. While electricity locally generated had very slightly gone down in 2005, but it increased again in 2006 and 2007, recorded by 148.9 MW in 2007. It increased in 2008, reached 227.8 MW, then increased significantly in 2009, 2010, and 2011 reached 1516 MW, at a growth of 446.1% compared to 2004, as shown in Table 3.13 below.

Table 3.13. Produced Electricity by Sources During 2004-2010 (MW)

Source	Locally Generated	Turkey	Iran	Federal Government	Total
2004	277.6	79.4	0	0	357
2005	227	121.4	0	0	348.5
2006	197.8	156.1	0	133.6	487.5
2007	148.9	144.5	0	193.4	486.8
2008	227.5	102.7	4.4	165	499.9
2009	577.5	137.4	5.4	92.7	812.8
2010	882	146	5	13	1046
2011	1516	4.67	6.82	92.08	1435.41

Source: (KRG, 2018).

However, electricity imported from Turkey during the period 2004-2009 similarly experienced variations, growing from 79.4 MW in 2004, to 156.1 MW in 2006. So, these amounts went steadily down, which reached 4.67 MW in 2011. Furthermore, electricity imported from Iran in 2008 emanated to 4.4 MW, increasing to 56.82 MW in 2011. Additionally, the KRI's electricity share provided by the Iraqi federal government was 133.6 MW in 2006. It increased to 193.4 MW in 2007 and then deteriorated to 13 MW in 2010. The latter amount represents 1.2% of the quantity produced in 2010 (1046 MW), as shown in Figure 3.8.

It covers the size of the shortage in electricity production in order to meet the needs of economic and social service activities. Iraq also resorted to importing electricity at a rate of (774.8) MW through the Turkish and Iranian lines and the barges in 2010 against (648.6) MW in 2009. The volume of imports increased by 19%. The import rate of electric power of (1011.1) MW in 2014 through the Iranian line and barges was lower when compared to 2013 of (1053.3) MW. It means that the volume of imports decreased by 4.0%, despite this decrease in the import rate but it is still significant.

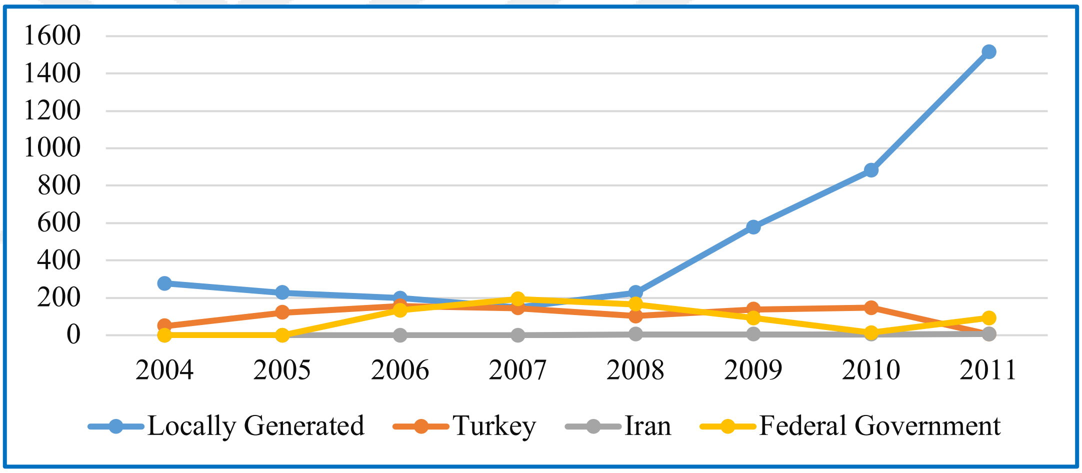

Figure 3.8. Produced Electricity by Sources During 2004-2010 (MW)

It should mention that even in the light of Iraq's import of electricity from neighboring countries to meet the shortage in domestic production, but this import will not suffice to meet all domestic demand for electricity. Nonetheless, it contributed to meet part of that demand. For instance, the shortage reached 3732.8 MW in 2010, while the energy import rate did not exceed (774.8) MW for the same year, which means that the demand for electricity by (2958) MW. It is satisfied, and demand of (2383.2) MW was not satisfied when comparing the shortage with the volume except for 2014, demand remains unsatisfied, and this has a negative impact on the Iraqi economy and its citizens at the same time.

3.3.8. Monthly Change of Electricity Consumption

To examine the seasonal factors, we have compared the monthly change in electricity consumption. The electrical load varies from month to month, with changing production and consumption. From Table 3.14, monthly change of electricity consumption varies from month to month, rising to the highest in February, starting (10.92%) of total consumption in 2017, while a decreased quantity for the lowest level in October by (6.11%) of total consumption and this disparity is due to the impact of climate change and the particular temperatures.

Table 3.14. Monthly Change of Electricity Consumption in Duhok During 2017

Monthly	Jan	Feb	Mar	Apr	Ma	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Tot
The amount of energy consumed MWH	1656	1686	1531	1398	1039.9	1063	1148	1173	1064	943	1210	1534	15446
Percentage%	10.7	10.9	9.91	9.06	6.73	6.88	7.43	7.59	6.89	6.1	7.83	9.93	100

Source: (KRG, 2017).

The winter season of December, January, February, and March was the first place in the amount of electricity consumed. While it is (10.92%) in February, and (9.91%) in March, it accounted for (41.48%) of the total consumption and the percentage of use (9.93%) in December, so, (10.72%) in January. The low temperatures in this season ranged between (-7 ° C and -15%° C), and it impacts the increase in consumption for the human need to use electric heating devices to temper heat the weather. The summer season of May, June, July, and August are the second largest in the amount of energy consumed, accounting for 28.63% of the total consumption during the year for high temperatures ranging between 40 ° C and 46 ° C. (50 ° C).

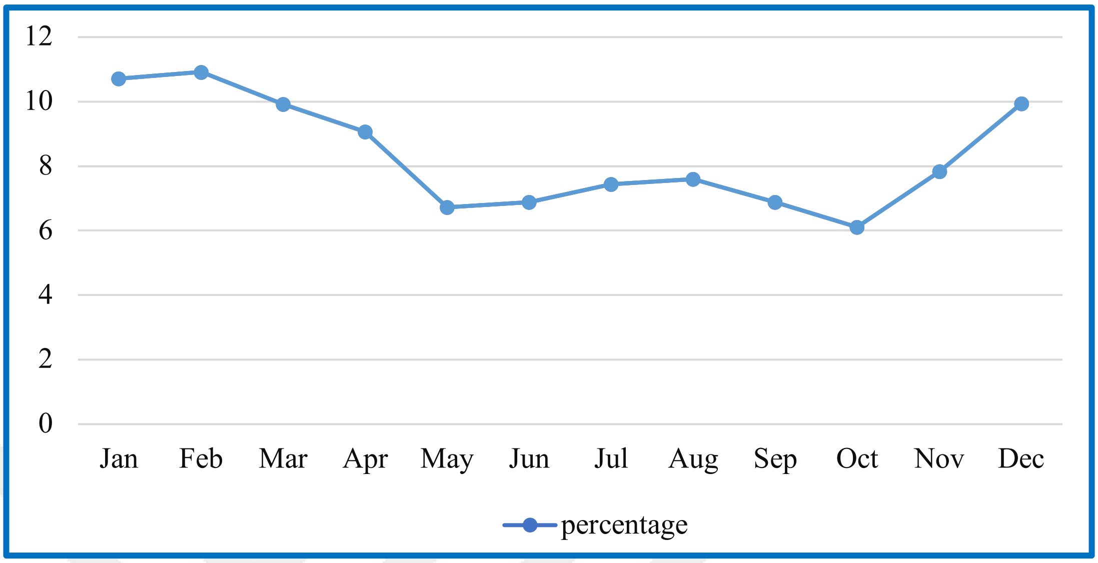

Figure 3.9. Monthly Change of Electricity Consumption
Source: Depending on Table 3.13.

As for the fall season, it is the percentage of consumption (6.89%) in September and (6.11%) in October (7.83%) in November, and thus it represents the third place in the amount of electricity consumption by 20.83%. The spring season ranked fourth in the amount of energy consumed, which accounted for 9.05% of total consumption and 9.05% in April — evidenced by the moderate temperature, which reached 25 ° C in April, or cooling. The climate is the most apparent factor in the difference in consumption quantities during the seasons.

3.4. ELECTRICAL POWER LOSSES

As the results are shown in Table 3.15, a considerable electricity loss recorded in the distribution network due to technical reasons related to the process of transferring heat from the transmission network to the distribution stations according to the technical characteristics of the carrier wire of the electrical power. Such as the type of material made of the fence, resistance to the passage of electric current, the cutoff area, and the high temperature, which works on the discharge of electrical lines when expanding and diluting. So administrative reasons, as a waste of large amounts of energy to bypass citizens on the distribution network through the creation of links to steal electricity in addition to the random construction by those who avoid the empty areas.

Table 3.15. The Amount of Electrical Power Losses During (2011-2017)

Periods	The Energy Displayed MW	Energy Sold MW	Wasted Energy MW
2011	**3889**	**1793**	**2096**
2012	**5009**	**2350**	**2659**
2013	**5659**	**2729**	**2930**
2014	**6573**	**2984**	**3589**
2015	**6802**	**3067**	**3735**
2016	**6315**	**2809**	**3506**
2017	**5974**	**2605**	**3369**

Source: (KRG, 2017)

The gradual increase in the amount of energy lost over the period (2011-2017) and increasing by (51-56) % annually, the maximum amount lost in 2015 was (55) % of the total energy received from the network. Lost power quantities continued to rise during the period (2011-2017). However, their proportions of the total energy received from the system took to increase gradually from 51% in 2013 to 56% in 2017, and the reason goes back to the displaced and refugees to areas. Although directed employees in Duhok distribution network to reduce the problem of high energy loss in the province, in general, their proportion is high compared to what is allowed, an shown in Figure 3.10.

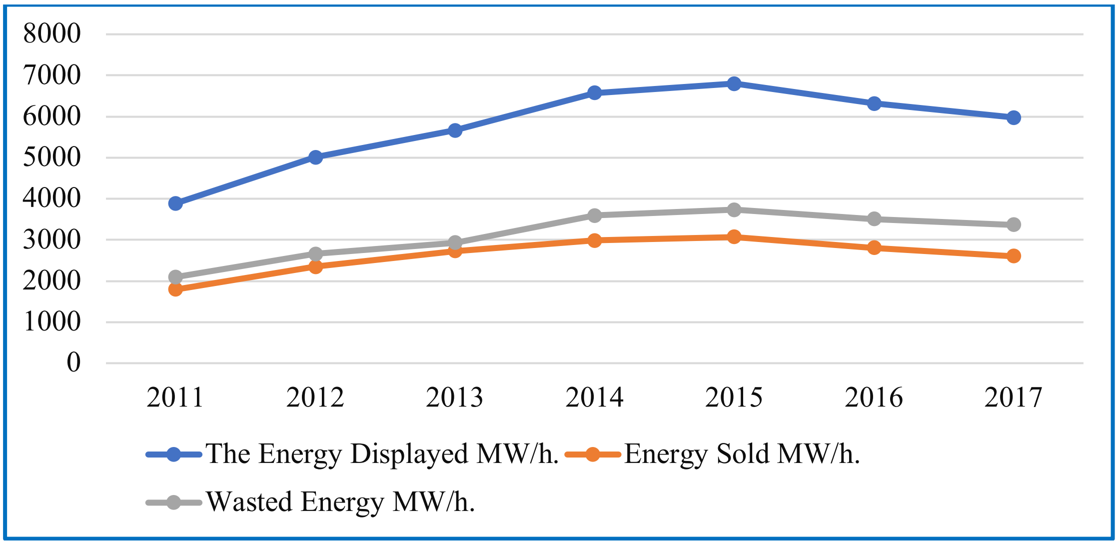

Figure 3.10. The Amount of Electrical Power Losses During (2011-2017)

Source: Depending on the Table 3. 15.

3.5. BALANCES AMONG ELECTRICITY SUPPLY AND DEMAND AND ACTUAL DEMAND

To find out whether there are balances among electricity supply, demand, and actual demand during (1995-2017), we have examined the data of the electricity supply, demand, and actual demand. Thus, the results revealed that consumption exceeds the production in the province over the period (1995-2017) in quantities ranging between a minimum of (77) megawatt-hours and (1686) megawatt-hours per hour. The generation plant in Duhok connected to the regional distribution network, so a large part of the production is needed to meet demand.

Table 3.16. The Average Balance of Supply, Demand and Maximum Demand for Electricity in the Duhok During (1995-2017)

Periods	**Supplied Load (AV)**	**Demand Load (AV)**	**Demand Load (Max)**
1995	**45**	**50**	**77**
1996	**69**	**75**	**94**
1997	**66**	**78**	**97**
1998	**53**	**80**	**100**
1999	**26**	**100**	**132**
2000	**19**	**105**	**134**
2001	**38**	**110**	**142**
2002	**66**	**120**	**152**
2003	**73**	**129**	**196**
2004	**99**	**136**	**231**
2005	**138**	**217**	**353**
2006	**169**	**258**	**421**
2007	**160**	**341**	**555**
2008	**127**	**429**	**596**
2009	**152**	**464**	**601**
2010	**227**	**402**	**655**
2011	**326**	**415**	**698**
2012	**418**	**467**	**858**
2013	**472**	**515**	**1037**
2014	**548**	**617**	**1240**
2015	**567**	**763**	**1418**
2016	**526**	**875**	**1643**
2017	**498**	**1014**	**1686**
Total	**212**	**337**	**1686**

Source: (KRG, 2017).

While the hours of processing in the Duhok province recorded at the average of (10) hours per day are much lower than most provinces of the KRI, it reaches in some to 14 hours per day. The large quantities of electrical energy produced in the region do not reflect positively on them. The first is provided an additional percentage of them to meet the demand of the part for electrical energy. Despite the massive output of electrical energy in the region of Duhok, but what equipped with the area for power is not commensurate with the actual need, it has to be given a concession of this product compared to other provinces.

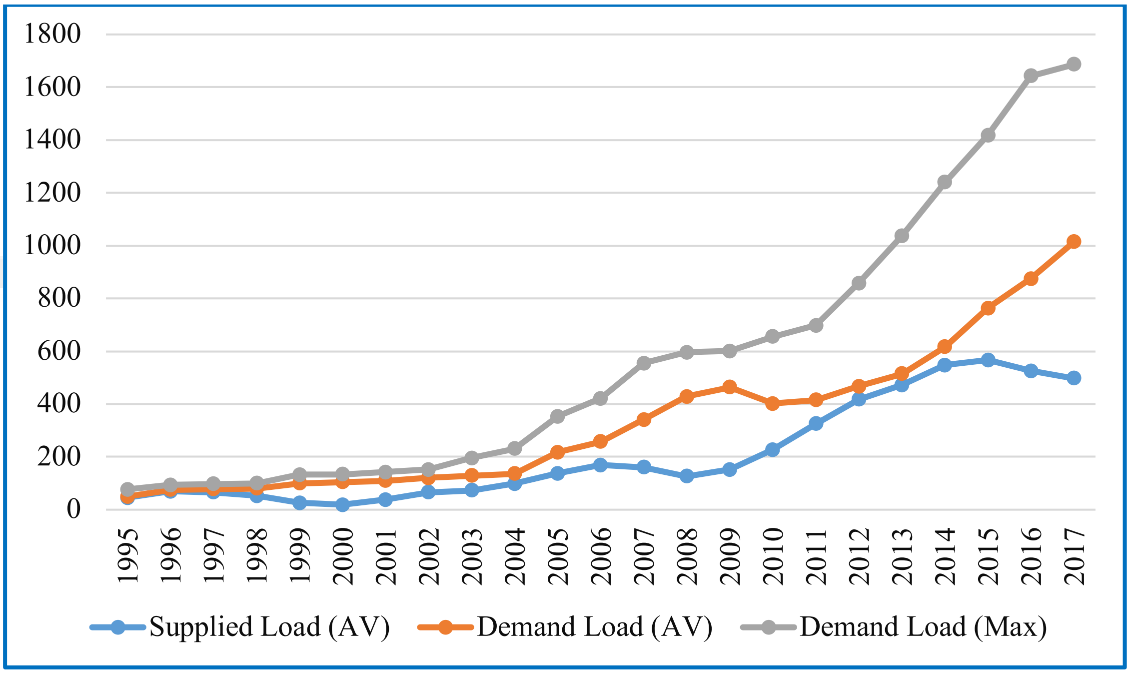

Figure 3.11. The Average Balance of Supply, Demand and Maximum Demand for Electricity in the Duhok During (1995-2017)

3.6. THE KRI ELECTRICITY CONSUMPTION AND GDP GROWTH RATES

From Table 3.17, and Figure 3.12 below, we can realize that the KRI electricity consumption growth rate connected to the GDP growth rate during the periods 2004-2013. However, from 2014 to 2017, respectively, the growth rate of electricity consumption was higher than that of the GDP growth rate.

Table 3.17. Electricity Consumption and GDP Growth Rates During (2004-2017)

Periods	**Electricity Consumption Growth Rate MW/h**	**GDP Growth Rate (billion $)**
2004	327.3	2
2005	348.4	3
2006	487.5	6
2007	486.8	9
2008	499.9	16
2009	812.8	20
2010	1046	22
2011	1291.8	25
2012	1379.1	26
2013	1472.9	29
2014	1560	28
2015	1652.4	28
2016	1722.9	27
2017	1795.6	26

Source: (KRG, 2018) and (KRG, 2017)

The figures show that from 2004 to 2013, the GDP growth rate of KRI has improved from 1.7 billion $ in 2004 to 29 billion $ in 2013. Due to the increase of KRI share in Iraqi public budget, as the results of the increase in the price of crude oil, and development the private sector in the region, however, from 2014 to 2017 GDP has declined since of violence of ISIS and cutting the KRI share in the Iraqi budget (Srhnk, 2011).

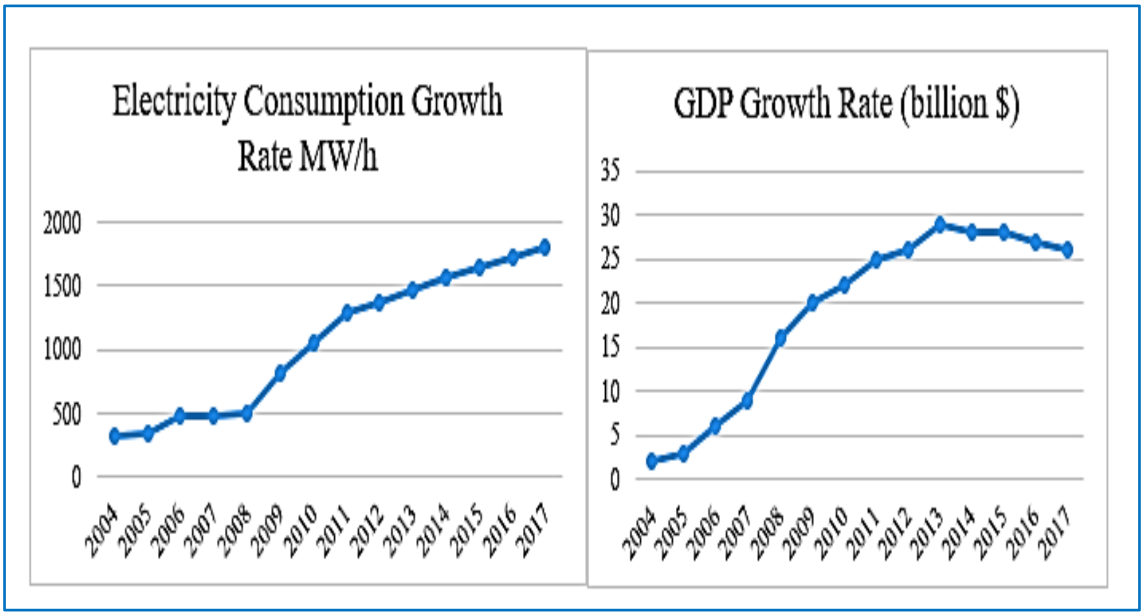

Figure 3.12. Electricity Consumption and GDP Growth Rates During (2004-2017)
Source: (KRG, 2018) and (KRG, 2017).

Though, based on the data published by the KRG’s Ministry of Electricity, total electricity sold was (1046) MW in 2010, the number of subscribers namely (households, commercial sector, industry, agriculture, and government sector) was 739,049; thus, a subscriber's consumption of energy was around 1.414 kW. To be more accurate, when dividing the total quantity of sold electricity by the total KRI’s population, we obtain the per capita share of about 0.223 KW for 2009. According to KRI’s ministry of electricity statistics for 2010, the estimated demand is around 0.341 KW. So, this means that the actual demand for electricity is almost double the produced and sold amount, which itself procedures one of the challenges.

4. CONCLUSIONS AND RECOMMENDATIONS

4.1. Conclusions

The primary purpose of this study is to examine the role of energy in regional development: a case study for Duhok. The electricity sector is one of the critical economic and social sectors since it plays a significant role in stimulating economic activity and social stability.

So, the results found that generates electricity peak load was 1686 MW, in Duhok province, but the actual supply increased rate (212) MW during previous years and real demand (337) MW. The actual production of electric energy in this province is not equal to almost with maximum load. Average hours of daily processing (8-12) hours a day are much lower than in most other regions supplying hours. The generators have a crucial role in keeping the electricity on conservation (12-14) an hour a day in Duhok.

The average supply fluctuated between (19) and (69) MW/h, and the highest average demand was between (50) MW/h, and (120) MW/h from 1995 to 2002. Moreover, it was the maximum demand from (77) MW/h to (153) MW/h. From 2003 to 2017, the KRG has adopted the energy in the Duhok province and after the falling of the regime. The starch of several stations, including small stations (Kashi station and Baadri and Duhok and Aqrah), where the processing power of Duhok and surroundings. The average supply increased between (73) and (548) MW/h. In between 2003 and 2014. Moreover, the increase in the demand average was (129) and (617) MW/h. Besides, it was the maximum demand (169) (1240) MW/h. The electricity provided for refugees and IDPs in KRG for 2014, supplied average in 2015, was (567) MW/h and demand average (763) MW/h. It was a demand maximum (1418). The supply was in the lowest processing for 2016. It reached (526) MW/h; also, the demand rate was (875) MW/h, and the demand rate reached a maximum of (1643). The supply was in the lowest process in 2017. It reached (498) MW/h, and the demand was (1014) MW/h, and the demand reached a maximum of (1686).

It was a gross supply (212) MW/h of 1995-2017 and average demand (337) Mika Watt/hour with a maximum total rate demand (1686) Mika Watt/hour as per. From 1999 to 2010, it was not sufficient production to processing power by 25%, but an increase in

2011, where doubled the year 2010 the proportion of participants (13.543%) and in the year 2011 amounted (22.758%). It increased the height to the year 2014 at (25.889%), moreover, in the years that followed by a decline in the year 2017 as (14.770%).

The domestic sector represents the most significant consumer electric energy sector that sold electric energy prices low amount with high quantities of consumption. It rises from (6.750ID) (5.72$) per kilowatt-hour to (540.250ID), (457.84$) per kilowatt-hour. In the commercial sector, electricity is sold at prices (130) thousand dinars (110$) (kW/hour). Agricultural prices are different from energy prices traded in the commercial sector lump and constant rate (150) thousand dinars ($ 127) (kW/hour) and (30) thousand dinars (kW/h). Either in the industrial sector is different, so use (400v) price (120) a thousand dinars ($ 102) (11kv to 132kv) for the price of 100 thousand dinars ($85) (kWh).

The increasing rate of consumption of electricity in the province at a rate of 22.5% annually for the period 2003-2017 during the production rate of 14% per annum in the increase. The result of the electricity consumption of 2011-2017 the percentage of the residential sector reached (79.39), the government sector (9,51), the business sector (8,37), modern industry (1,45), and the agricultural sector (1.28). Winter considered the peak in the rest of the season in consumption and 41.5% of the total annual use in the summer, approximately 20.6% of the total annual expenditure. Duhok Centre ranked first in consumption and by 29.62% of the total, followed by ZAKHO in second was 18%, followed by SEMEL in third place was 14.67%, then SHEIKHAN in fourth place at 11.8%, followed by fifth-ranked AQRAH 9.9 percentage amounted 3%, then spend BARDARSH by 8.5%, and finally AMAIDY with seventh and 7.4%.

Further, the KRI electricity consumption growth rate connected to the GDP growth rate during the periods 2004-2013. However, from 2014 to 2017, respectively, the growth rate of electricity consumption was higher than that of the GDP growth rate. The results show that from 2004 to 2013, the GDP growth rate of KRI has improved from 1.7 billion $ in 2004 to 29 billion $ in 2013. Due to the increase of KRI share in Iraqi public budget, as the results of the increase in the price of crude oil, and develop the private sector in the region, however, from 2014 to 2017 GDP has declined since of violence of ISIS and cutting the KRI share in the Iraqi budget.

The expose of electricity in Iraq to various crises and problems such as the wars waged by Iraq with neighbouring countries. The imposition of the economic embargo on it in the nineties, which affected the electricity supply. Also, to the occupation by the United States in 2003, besides the intensification of internal conflicts and the spread of corruption in most. There are other reasons related to the same sector, for instance, the decrease in operational efficiency due to the obsolescence of most of the stations operating in Iraq besides the reduced maintenance, operation of the transmission and distribution networks. However, electricity is fluctuating between high, low, and the shortage is met by imports from neighbouring countries, mainly from Turkey and Iran, because it is known that electricity cannot be transported as long distances as in the case of goods and services.

However, electricity imported from Turkey during the period 2004-2009 similarly experienced variations, growing from 79.4 MW in 2004, to 156.1 MW in 2006. So, these amounts went steadily down, which reached 4.67 MW in 2011. Also, electricity imported from Iran in 2008 emanated to 4.4 MW, increasing to 56.82 MW in 2011. Furthermore, the KRI's electricity share provided by the Iraqi federal government was 133.6 MW in 2006. It increased to 193.4 MW in 2007 and then deteriorated to 13 MW in 2010. The latter amount represents 1.2% of the quantity produced in 2010 (1046 MW).

While, to cover the size of the shortage in electricity production- which was just mentioned - in order to meet the needs of economic and social service activities, Iraq also resorted to importing electricity at a rate of (774.8) MW through the Turkish and Iranian lines and through the barges in 2010 against (648.6) MW in 2009, i.e., the volume of imports increased by 19%. The import rate of electric power of (1011.1) MW in 2014 through the Iranian line and barges was lower when compared to 2013 of (1053.3) MW, which means that the volume of imports decreased by 4.0%, despite this decrease in the import rate but it is still significant. It should mention that even in the light of Iraq's import of electricity from neighboring countries to meet the shortage in domestic production, but this import will not suffice to meet all domestic demand for electricity.

Nonetheless, it contributed to meet part of that demand. For instance, the shortage reached 3732.8 MW in 2010, while the energy import rate did not exceed (774.8) MW for the same year, which means that the demand for electricity by (2958) MW. It is satisfied, and demand of (2383.2) MW was not satisfied when comparing the shortage with the volume except for 2014, demand remains unsatisfied, and this has a negative impact on the Iraqi economy and its citizens at the same time.

4.2. Recommendations

Electricity providers in KRI cities support the regional economy for most of its sectors. On the one hand, electricity is one of the costs of production. On the other hand, to provide welfare to the KRI people as the electricity is one of the reasons and means that increase the welfare and development of the social life of individuals in terms of heating, cooling, recreation, operation of machines, household appliances. The authorities should work in two directions:

First: Attention to increase production through several means is to rehabilitate and maintain the existing electrical system production, transport, distribution, and accelerate the implementation of production units under implementation - if available -, and the establishment of new production units in strategic areas economically and socially. The second is the interest in reducing demand through several means through adopting programs to educate citizens on the positive benefit of rationalization when using electric power at the individual and country level. For all the above, it cannot be reached to safety unless there is an appropriate investment climate in terms of security stability, political, administrative, and others.

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APPENDIX

Appendix 1 : Curriculum Vitae (CV)

<table>
<tr><th colspan="3">PERSONAL INFORMATION</th></tr>
<tr><td>Name and Surname</td><td colspan="2">Abdulazeez Dndar ABDULAZEEZ</td></tr>
<tr><td>Date of Birth</td><td colspan="2">06/08/1975</td></tr>
<tr><td>Address</td><td colspan="2">Duhok- Iraq</td></tr>
<tr><td>Phone (Iraq)</td><td colspan="2">+964 7504641509</td></tr>
<tr><td>E-mail</td><td colspan="2">azizzawity@gmial.com</td></tr>
<tr><th colspan="3">EDUCATION AND TRAINING</th></tr>
<tr><td>Degree</td><td>Institution</td><td>Graduate</td></tr>
<tr><td>Bachelor of Science</td><td>Nawroz University, College of Administration and Economics, Department of Economics</td><td>2011</td></tr>
<tr><td>Master of Science</td><td>Siirt University, Faculty of Economics and Administration, Siirt (TURKEY)</td><td>2019</td></tr>
<tr><th colspan="3">PERSONEL SKILS</th></tr>
<tr><td rowspan="2">Languages</td><td colspan="2">Kurdish Native Language</td></tr>
<tr><td colspan="2">Arabic Perfect/ English Good</td></tr>
</table>