



Iraq's electrical energy shortage and potential solutions

Abdal-Razak Shehab Hadi^{1*} Adnan Alamili² Ali Abdyasser³ Kadhum³ Mohammed Chessab Mahdi⁴

Electrical engineering, faculty of engineering, University of Kufa, Holy Alnajaf, P.O. Box 21, Iraq

²Electrical engineering, faculty of engineering, University of Kufa, Holy Alnajaf, P.O. Box 21, Iraq

³Electric Technical Dept, Kufa Technical Institute, Al-Furat Al-Awsat Technical University, Iraq

⁴IT Dept., Technical Collage of Management, Al-Furat Al-Awsat Technical University, Kufa, Najaf, Iraq,

¹ abdulrazzaq.aljuburi@uokufa.edu.iq

² adnan.alaamili@uokufa.edu.iq

³ Kin.ali1@atu.edu.iq

Abstract

Iraq suffers from a major shortage in the supply of electric power for several reasons, such as wars, the economic sanctions, in addition to obsolescence of generation stations. The demand increases by 10% annually, which aggravates the problem and increases the size of the gap between supplied energy and demanded energy. The treatments taken by successive administrations since 2003 until now do not meet ambition, and they cannot address the shortage for several reasons, the most important of which are administrative corruption and poor planning. Suitable and available options have been reviewed to fill the shortage in electric power and keep pace with the increasing demand for it. The most important of them was the investment of clean energy represented by natural gas, which is one of the energy resources available in Iraq, through the establishment of large gas fired generation plants, in addition to using two types of renewable energy, namely solar and wind energy, to provide their resources in Iraq.

Keywords: Gas-fired stations, Renewable Energy in Iraq, Solar, wind.

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1. Introduction

The electricity sector plays a vital role in developing the economy of post-war countries such as Iraq, Afghanistan, and Syria. Iraq has gone through exceptional circumstances, such as wars and economic sanctions, during the past forty years, which led to the reduction of energy production to very low levels. [1] The main reason for reducing energy production is the bombing of infrastructure during the

second Gulf War 1991, where about 75 percent of the 9,300 MW produced in Iraq was destroyed, leaving only 2,300 MW left. The United Nations launched the Oil-for-Food and Drug Program in 1996, limited oil exports were allowed by this agreement. This program did not include maintenance and development of infrastructure, electricity and water projects. [2] The situation worsened after the invasion led by USA in March 2003. As a result,



energy supply to consumers has become very limited. Electricity production in mid-2003 was less than 10 percent of the already insufficient level before the war. Despite being restored to pre-war levels, a limited planning system and administrative corruption hindered the revival of the electricity sector. [3]

After 2003, the problem worsened, especially with the increase in demand for electrical energy, due to the high level of Iraqi per capita income and the large increase in the population. The Iraqi government has built some power plants, but they have not matched the inherited power shortage and increased demand. [4]

Table1. Electric energy shortage in Iraq 2010-2019 [5]

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Required	12251	14392	14945	15220	16385	15703	17750	21115	22470	24031
Supplied	6492	6480	7540	9538	8097	10477	11787	12617	14140	16372
Shortage	5759	7912	7405	5682	8288	5226	5963	8498	10330	7659
Shortage %	47	55	49.5	37.3	50.6	33.3	33.6	40.2	46	31.8

Figure 1 shows the value of the actual need for electric power in Iraq for the years 2010 to 2019 and the value of the electric energy actually equipped for the same period.

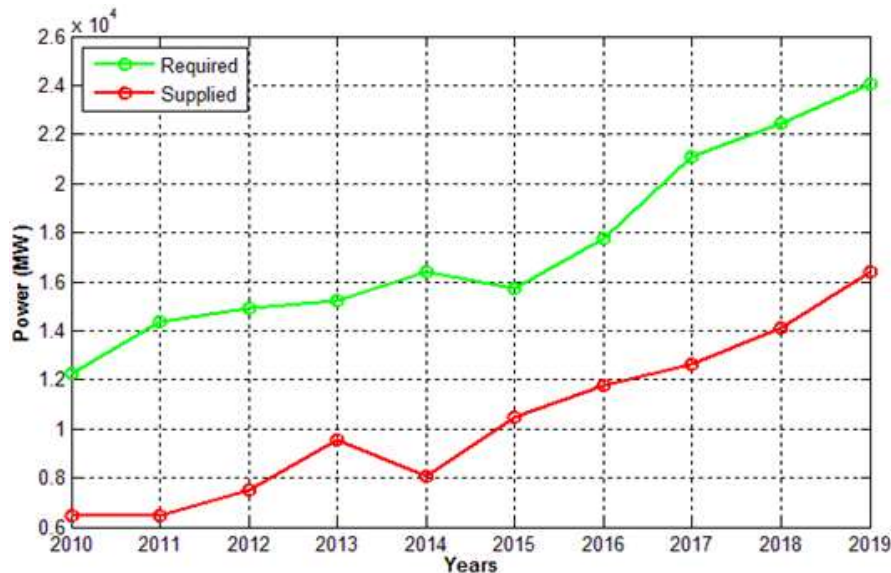


Figure 1 Actual need and supplied electric power from 2010 to 2019

2. The reality of Iraqi Electric power generation System

Iraqi Electric power generation system made up of generation units ranging from 1.7 to 300 MW per unit. The types of the generation units are thermal stations, hydro based stations, gas turbine stations, diesel engine stations in addition to small diesel generators used for peak loads. [5]



The total installed generation capacity and actual production rate for all stations for 10 years (2010-2019) is explained in Table (2).

Table 2. Generation unit's capacity and actual production [5]

years	Number of generation units			Total design capacities	Actual production rate
	Stations units	Diesel	Total		
2010	209	253	462	15007	5583
2011	225	253	478	16854	6153
2012	208	591	799	15888	5253
2013	240	599	839	21577	6669
2014	245	307	552	22511	7736
2015	274	307	581	26690	9239
2016	276	307	583	26800	10502
2017	280	307	587	27472	11962
2018	280	307	587	27472	14212
2019	280	307	587	27472	19045

Due to a number of factors including fuel shortages, aging, poor operation, efficiency deterioration, and maintenance strategies, two thirds of Iraq's generation capacity is non-operational or operating below capacity levels. [1]

When reviewing the types of generating station units according to the

type of fuel, we find that the units powered by natural gas fuel constitute the backbone of the generation system in Iraq, where the design capacity of these units is 63% of the total design capacity of units of generation stations in Iraq. [5]

Table (3) shows the number of units of the generating stations, the type of fuel, and their design capacity.

Table 3. Number of units, types of fuel, and capacity [5]

Types of fuel	No of units	Design capacity	Percentage
Steam	31	7305	29.381 %
Gas	198	15694	63.122 %
Hydroelectric	29	1864	7.497 %
Total	258	24863	100 %

Iraq is not self-sufficient gas producer and need to import gas from neighbor countries. The electric power generation system suffers from important problems like poor maintenance, high temperatures in most months of the year (more than 55 C), lack of high quality fuel, tariff collection system is inefficient.

3. Potential solutions options

There are a number of options available to address the shortage of

electric power in Iraq and to meet the growing demand for it. The first section of these options relates to the distribution network and reducing its losses, developing, and expanding it to meet the increasing demand for energy. The second part relates to expansion the generation sector through using natural gas in efficient power plants, and increase in the proportion of renewable energy in total generation energy. In this work, we will address the second section, which is



related to the generation sector, to focus on the options available and appropriate to address the shortage in energy supplies and keep pace with the increased demand.

3.1 Gas-fired power plant option

Natural gas is an important fossil energy source due to the advantages that it characterizes, as it is a raw material for many industries and fuel for it, especially for generating electric energy, as well as the low percentage of pollutants when burned. [1]

There has been a significant increase in global demand for natural gas and the expansion of its uses as a result of the technological development that led to lower production and export costs, and its use in the field of energy generation and raising its efficiency and reducing production costs in line with environmental laws that encourage its use as a clean source of energy. [6]

Iraq produces and uses natural gas much less than most countries in the region. Although Iraq has large quantities of free natural gas and associated gas, the bulk of the associated gas is flared. Gas flaring is a serious environmental problem. It contributes to greenhouse gas emissions that cause global warming.

About 70% of all natural gas that is produced in Iraq is flared, instead of captured and invested. This gas, if invested, is sufficient to provide electricity to more than 17 million Iraqi families. [7]

Increasing oil production, mean increasing the gas flaring. There are efforts being made in this regard. Progress has been made by capturing and processing about 10 billion cubic meters of gas annually, but this effort must be accelerated, as Iraq can produce 50 billion cubic meters annually, especially when considering the increasing need for gas in power generation. [8]

Gas-fired stations in Iraq began by small units, quick starting units, and portable gas units which were operating to cover the peak loads. Because of the development of

gas stations technology and their high efficiency, medium and large-sized gas stations were adopted as the main energy producing stations, and not merely for the purposes of covering peak loads.

There is a clear increase in the number of gas-fired units, so that the design capacity of gas-fired units has become 63% of the total design capacity of the total units in 2019. Table 2 explain the percentage of gas fired units.

The increase in the number of gas-fired stations through the establishment of new plants with large design capacity in locations close to the sources of gas production is one of the main solutions to fill the shortage in the production of electric energy.

Oil and gas fields are spread all over areas of Iraq, which facilitates the establishment of gas-fired generation stations in various locations in Iraq without the need to transport gas over long distances.

3.2 Renewable energy option

Renewable energy sources consist of traditional and non-traditional sources. Traditional renewables include biomass and large hydroelectric plants, while non-traditional renewables include solar energy, wind energy, and geothermal energy. [9]

The development of renewable energy sources is important as these sources help greatly to reduce carbon dioxide emissions to the atmosphere, also increasing the proportion of renewable energy from total produced energy increases the energy sustainability of the systems and also helps reduce dependence on fossil fuels. [10]

Solar energy and wind energy are among the resources available in Iraq. Most areas of Iraq are sunny for most of the year, while some areas enjoy with winds energy that can be used to rotate wind turbines.

3.2.1 Solar energy

Solar energy source, are increasingly attractive field to most electricity systems.



This is especially true in Iraq, because the solar resources are excellent, and can be provide an opportunity to improve the cost and reliability of electricity. The cost of producing energy using solar cells has decreased quickly around the world and is expected to continue to decrease. [11]

The cost of energy production using solar cells is equal to the cost of production it from oil-fired stations and can be lower if the solar energy market is developed in Iraq, while the cost of energy production using solar cells is more than the cost of production it using gas-fired stations and will be less if the price of gas is at 2 \$ per million British thermal units (MBtu) or

more. [12]

Due to the high quality of solar resources in Iraq, in addition to the fact that most regions of Iraq enjoy about 300 sunny days per year, therefore, the generation of electric energy from solar energy becomes available and appropriate in Iraq.

In figure 2, Global Horizontal Irradiation map provides a summary of the estimated solar energy available for power generation and other energy applications in Iraq, while Photovoltaic Power Potential map provides a summary of estimated solar photovoltaic (PV) power generation potential in Iraq.

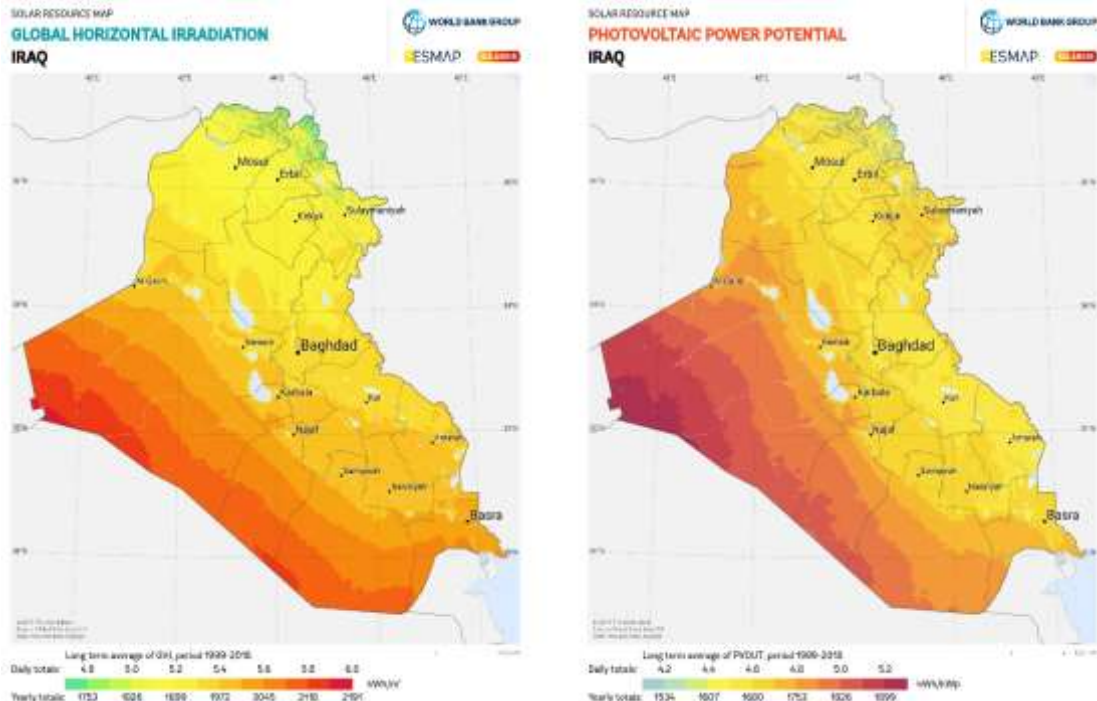


Figure 2. Iraq global horizontal irradiation & photovoltaic power potential [13]

The energy production projects using solar cells have not been widely developed yet in Iraq, and therefore the costs of building new projects are unclear, even though the cost of the solar panels is very well known, but can be capitalized from the experience of international developers in achieving low costs in Iraq.

3.2.2 Wind energy

Wind energy could be an attractive option

for Iraq. Although wind resources are not as solar energy resources in Iraq, but new technological developments such as low speed wind turbines and the designs of the digital wind farm are increasing available areas for development.

The most important areas where wind energy is available are the sedimentary plain in the center and south of the country, where the average wind speed is more than eight meters per second, as



well as Wasit governorate, specifically in the Shihabi region and Sheikh Saad and Al-Hay region, in addition to Ali Al-Gharbe

region in Dhi-Qar governorate in the south. Figure 3 explain wind energy availability areas in Iraq

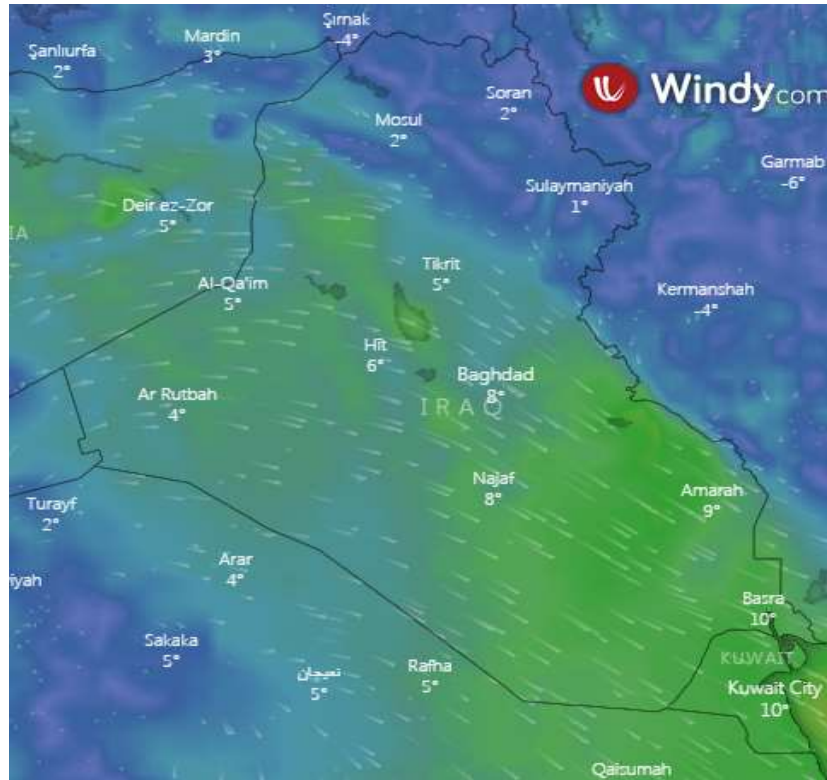


Figure 3.Wind energy availability areas in Iraq [14]

The industry of electric energy production using wind energy has not been widely developed in Iraq, and therefore the process of building new projects to produce electric energy using wind energy cost more.

The cost of electric energy production using wind energy compete well the cost of its production from oil-fired stations and offers a good way to increase types of the energy sources.

Using wind energy to generate electric energy is important to increase the portion of renewable energy in total energy, especially that the energy generated using solar panels is available during daylight hours only unless the batteries are included.

4. Conclusions

1- Iraq suffers from a major shortage in

the supply of electric power for several reasons, such as wars, the economic sanctions, in addition to obsolescence of generation stations. This shortage of electrical power supply will become more severe if the factories and industrial facilities that are suspended are operated. These factories and industrial facilities stopped for a number of reasons, including shortage of electric power supply. The demand increases by 10% annually, which aggravates the problem and increases the size of the gap between supplied energy and demanded energy.

2- The treatments taken by successive administrations since 2003 until now do not meet ambition, and they cannot address the shortage for several reasons, the most important of which are administrative corruption

and poor planning.

- 3- Iraq has large and diversified energy resources, such as oil and gas. The fields of oil and gas are spread in most of the Iraqi provinces, so it is possible to build large electrical stations that operate with gas and be close to private gas sources and that is in line with environmental laws which encourage to use a clean source of energy.
- 4- Iraq has a sunny climate (about 300 sunny days per year), so it can be invested this climate in producing solar energy using solar panels. It is possible to sponsor home solar generation projects and connect them to the public grid, in addition to the construction of large solar energy fields in desert areas of Iraq.
- 5- Northwest winds blow to Iraq in most days of the year, especially in the sedimentary plain in the center and south of the country, with an average speed of 8 meters per second. This is consistent with the requirements of wind turbines to generate energy. Therefore, it is possible to increase the proportions of renewable energy in the generation mixture by investing wind energy, in order to include two sources of renewable energy, solar energy and wind energy.

Declarations

Availability of data and materials, all data generated or analyzed during this study are contributed by team of Iraqi Ministry of Electricity's engineers.

Competing interests

The authors declare they have no competing interests.

Authors' contributions

All authors read and approved the final manuscript.

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