T.C.
ISTANBUL GEDİK UNIVERSITY
INSTITUTE OF GRADUATE STUDIES

A TECHNICAL AND ECONOMIC FEASIBILITY STUDY FOR THE ESTABLISHMENT OF THERMAL POWER STATION TO MEET DHULUIYA DISTRICT ELECTRIC ENERGY DEMAND FOR THE NEXT DECADE

MASTER'S THESIS

Muayad Meteab SALIM

Engineering Management Department

Engineering Management Master in English Program

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Thesis Advisor: Prof. Dr. Gözde ULUTAGAY

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İSTANBUL GEDİK ÜNİVERSİTESİ
LİSANSÜSTÜ EĞİTİM ENSTİTÜSÜ MÜDÜRLÜĞÜ

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Enstitümüz, Engineering Management Department İngilizce Tezli Yüksek Lisans Programı 191281007 numaralı öğrencisi Muayad Meteab SALIM'in "A Technical and Economic Feasibility Study for the Establishment of Thermal Power Station to Meet Dhuluiya District Electric Energy Demand For the Next Decade" adlı tez çalışması Enstitümüz Yönetim Kurulunun 29.12.2021 tarihinde oluşturulan jüri tarafından *Oy Birliği* ile Yüksek Lisans tezi olarak *Kabul* edilmiştir.

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DECLARATION

I, Muayad Meteab SALIM, do hereby declare that this thesis titled as "A Technical and Economic Feasibility Study for the Establishment of Thermal Power Station to Meet Dhuluiya District Electric Energy Demand For the Next Decade" is original work done by me for the award of the masters degree in the faculty of Engineering Management. I also declare that this thesis or any part of it has not been submitted and presented for any other degree or research paper in any other university or institution. (29/12/2021)

Muayad Meteab SALIM

DEDICATION

To my father, who I always miss and never forget.

To my older brother, who I wish that he is here with me, sharing me this achievement.

To my brothers, sisters and friends, and their support.

To my wife, sons, and my precious daughter and their help.

To all my teachers throughout my study journey who effectively contributed to lighten my way.

To the people who gave me the glass of doubt to start seeking the truth.

All the mentioned come after the most generous person in my life, my virtuous struggling mother.

PREFACE

At the end of my post, I am pleased to thank my mother, family, and brothers as a partner for the continuous support throughout my academic career. I thank all my friends for their support and encouragement. I am pleased to extend my thanks to everyone who advised, guided, or contributed to this research's preparation by teaching me the references and resources required at any stage of the research stages. I especially thank my teacher (Prof. Gozde Ulutagay) for my support and advice. I also thank the university, the head of the department, and the discussion committee members.

December 2021 Muayad Meteab SALIM

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ABBRIVATIONS

TPS : Thermal Power Station
PM : The Particulate Matter
FGD : Flue Gas Desulfurization
CAAA : Clean Air Act Amendments of 1990
LNB : Low-Nox Burners
LEA : Limiting The Excess-Air
OFA : Over-Fire Air
SCR : Selective Catalytic Reduction System
SNCR : Selective Non-Catalytic Reduction System.
CWS : Coal- Water Slurries
COM : Coal-Oil Mixtures

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A TECHNICAL AND ECONOMIC FEASIBILITY STUDY FOR THE ESTABLISHMENT OF THERMAL POWER STATION TO MEET DHULUIYA DISTRICT ELECTRIC ENERGY DEMAND FOR THE NEXT DECADE

ABSTRACT

Energy is the backbone of life and one of the most important sources of advancement and progress in every civilized country. The demand for it is not limited to the demand of individuals, but it can be said that no state activity can take place without electricity. In any case, all productive sectors consume electricity, and this means that the demand for electricity grows with the increase of the population, urbanization, social services, industrial, agricultural and service production activities. Therefore, the demand for electrical energy in flooding continues to increase due to the increase in the number of housing and service units planned to be completed during the coming years as well. On the industrial and agricultural projects that will be implemented during the coming plans. This means that the deficit in the supply of electric power is a cumulative deficit. According to the National Development Plan 2018-2020, the demand in 2019 was 28,723 MW, a deficit of about 50%. This study was conducted to assess the feasibility of establishing a thermal power plant in Dhuluiya district in order to covering the electricity need in next decade. The electricity is one of the most common problems in Iraq due to the continuous failing in providing the adequate amounts of electricity to people, for example, in 2022 the overall need of electricity almost 36253 MW which means there is a deficit in providing electrical power by 22000 MW, that problem was one of the reasons to conduct this study. on the other hand, there was a project included in the Ministry of Planning to establish thermal power plants in some Iraqi regions in 1987 and had an accomplishment of 6% but was stopped because the Gulf war. Dhuluiya is a city located 80 km to the north of the capital, Baghdad, on the eastern bank of the Tigris River, with a population of 55,000, a district belonging to Salah al-Din Governorate. This study showed the general descriptions of these stations and related information, then searched the feasibility by assessing the current population and other consumptions such as the shops, markets, houses, departments and agricultural engines, and the expected growth of these consumptions in the next decade and check them with the power will be provided by this station. On the other hand, evaluate public opinion about this project by means of a questionnaire of a group of people, and then analyzing all these results as shown in the study.

Keywords: *Electrical energy, Electrical energy feasibility, Electric dams*

ÖNÜMÜZDEKİ 10 YIL İÇİN DHULUİYA'DA ELEKTRİK ENERJİSİ İHTİYACINI KARŞILAMAK İÇİN TERMİK SANTRALİ KURULMASINA İLİŞKİN TEKNİK VE EKONOMİK FİZİBİLİTE ÇALIŞMASI

ÖZET

Enerji, yaşamın belkemiğidir ve her uygar ülkede ilerlemenin ve ilerlemenin en önemli kaynaklarından biridir. Buna olan talep, bireylerin talebi ile sınırlı değildir, ancak elektrik olmadan hiçbir devlet faaliyetinin gerçekleşemeyeceği söylenebilir. Her durumda, tüm üretken sektörler elektrik tüketir ve bu, nüfusun artması, kentleşme, sosyal hizmetler, sanayi, tarım ve hizmet üretimi faaliyetleri ile elektrik talebinin artması anlamına gelir. Bu nedenle, önümüzdeki yıllarda da tamamlanması planlanan konut ve hizmet birimlerinin sayısındaki artış nedeniyle taşkınlarda elektrik enerjisine olan talep artmaya devam etmektedir. Önümüzdeki planlarda uygulanacak sanayi ve tarım projeleri hakkında. Bu, elektrik gücü arzındaki açığın kümülatif bir açık olduğu anlamına gelir. 2018-2020 Ulusal Kalkınma Planı'na göre, 2019'daki talep, yaklaşık %50'lik bir açıkla 28.723 MW idi. Bu çalışma, önümüzdeki on yılda elektrik ihtiyacını karşılamak üzere Dhuluiya ilçesinde bir termik santral kurmanın fizibilitesini değerlendirmek amacıyla yapılmıştır. İnsanlara yeterli miktarda elektriğin sağlanamaması nedeniyle elektrik, Irak'taki en yaygın sorunlardan biridir, örneğin, 2022'de toplam elektrik ihtiyacı yaklaşık 36253 MW'dır, bu da elektrik gücü sağlamada bir açık olduğu anlamına gelir. 22000 MW, bu sorun bu çalışmanın yapılmasının nedenlerinden biriydi. Öte yandan 1987 yılında Irak'ın bazı bölgelerine termik santral kurmak için Planlama Bakanlığı'na dahil edilen ve %6'lık bir başarı elde eden ancak Körfez savaşı nedeniyle durdurulan bir proje vardı. Dhuluiye, başkent Bağdat'ın 80 km kuzeyinde, Dicle Nehri'nin doğu kıyısında, Selahaddin Valiliği'ne bağlı 55.000 nüfuslu bir şehirdir. Bu çalışma, bu istasyonların genel tanımlarını ve ilgili bilgileri göstermiş, ardından mevcut nüfusu ve dükkanlar, marketler, evler, bölümler ve tarım motorları gibi diğer tüketimleri ve bu tüketimlerin önümüzdeki on yılda beklenen büyümesini değerlendirerek fizibilitesini araştırmıştır. ve bu istasyonun sağlayacağı güçle kontrol edin. Öte yandan, bir grup insandan oluşan bir anket aracılığıyla bu proje hakkındaki kamuoyunu değerlendirin ve ardından tüm bu sonuçları çalışmada gösterildiği gibi analiz edin.

Anahtar kelimeler: *Elektrik enerjisi, Elektrik enerjisi fizibilitesi,Elektrik barajları*

1. INTRODUCTION

Energy is one of the fundamental factors affecting the status of the economic sustainability and development of any nation. Producing energy is continuing to growing according to three factors; firstly, the continuous changing of power source from wood to coal and after that to oil, gas, and the water flow, secondly the increased electricity usages combined with the huge increasing in population. The global total electrical energy generation projection raises by 87%, from 18.8 trillion kilowatt hours in 2007 to 25.0 trillion kilowatt hours in 2020 and 35.2 trillion kilowatt hours in 2035 (Energy I. Administration, 2010).

However, centuries by centuries the global demand of electrical power is increasing sharply, because the people have been tending to constantly rely on the less efforts ways to achieving their activities and duties, the patterns which need electricity to be done (Ali, nd.). Illustrated that the global power demand is spreading according to the great progress of all kinds of industries and living requirements. In accordance to Spliethoff (2010), the reason for the birth of power plants was increased energy consumption with the demand for more efficiency in power supplies with less economic burdens . The increasing of this need of electricity has leaded to more problems such as producing this power efficiently and covering the economic requirements. According to (Tumbelaka & others, 2016) nowadays' power shortage has caused many concerns about the shape of future electrical production, such as energy demand and efficiency problems. However, many countries have the economic and resources problem facing them producing electricity. The high expenditures of financing the investment and providing fuel is one of the fundamental causes of high expense of electricity, so one of the most effective solutions of the massive growth of the need of energy can be achieved by generating clean and low cost power (Cziesla & others, 2009).

Thus, the economic issue leaded to find other methods to produce electricity with less economic requirements. However, in many developing countries the lack of electricity and the economic and technical failing of facing the local demand for electricity made the authorities look for new technologies to produce the needed electric energy (Koster, 1998). Reported that after the first crisis of the oil in 1973, there was a change in the methodology of producing electricity in Netherlands, for example the energy policy started tending to work on the supply securing, especially replacing the oil by using coal and gas in purpose to avoiding the increasing prices risk. The energy sources which effect the welfare levels in Jordon would in great risk in case of any growth in the costs of crude-oil which are mostly unstable... however, the Jordanian authorities have multiple solutions; advancing the works on discovering and using the local power sources, conducting the economic methods in using electricity with more affective environmental planning on the long-run, and working step by step to locally estimating the cost of economic unit-energy (Jaber & others, 1997). The Thermal Power Stations (TPSs) can solve part of the economic issue because it requires less costs for maintenance and operating. A TPS is a power station which converts thermal energy to electrical energy. However, thermal power plant is different from hydro power plant, where energy (kinetic and potential) of water is converted into electrical energy. For operating a thermal power plant, thermal energy can be obtained by burning fossil fuel, nuclear fuel, solar heat etc. However, the use of fossil fuel is the most common type of it. Additionally, thermal power station can use either gas turbine or steam turbine. Also, use of steam turbine dominates here. However, the thermal stations need less cost for construction and areas of lands than some kinds of renewable energy such as the solar power, nuclear power, gas power, wind power, and the hydro power plants. Due to that their construction is easier and cheaper. Since the TPSs is one of the most common method to produce the electric power, so years by years many countries have contributed in developing this kind of power stations. For example in Russia the thermal power stations is the most used method in electricity generation, they are responsible to generate 67- 70% of the Russian electrical power (Malchik & others, 2016). In many Russian companies the long times that the technicians spent searching for new methods to improve the thermal power stations has lead the implementation of the idea of "fleet service life" which helped the specialists achieving the increasing of the service period of the main operation equipment of these stations by a factor of 1.5- 2.0 (Rezinskikh & Grin, 2010).

2. LITERATURE REVIEW

2.1 Feasibility Study

The feasibility evaluation is the assessment of the viability of a project idea (Glackin, 2013). Simply the basic goal of the feasibility study is to provide an answer to a question "Is the project or the idea achievable and should be performed" (Pauceanu, 2016)? It is fundamentally important for project heads to have a feasibility assessment before project implementation begin (Tito & others, 2018). However, the feasibility assessment provides a based on statistics answer in whether the project should be implemented or not, also it contributes in providing a realistic idea of the future shape of the project, work plan in order to provide a road map project for 3–5years (Pauceanu, 2016). When the feasibility assessment judges the project as a feasible project, it means that the project is able to achieve sufficient future profits, as well as that it is able to meet the expected risks, and finally it can meet the goals of the founders (Ghisi & Schondermark, 2013). However, the feasibility assessment has many benefits such as, avoid the problem of having many failures during the basic planning of the project or idea, as one part of the feasibility study is to test the desired common features of the clients, and so on, this will have a great role in minimizing the defects... Moreover, reducing the excessive use of money and time, as testing desirable features is one of the parts of the feasibility study, feasible projects will not need much time and money to test ideas to satisfy clients, but satisfactory features will be known in advance through the feasibility study... Additionally, give knowledge of the products and potential additional service types, most of the time researching the feasibility of an idea will also provide general knowledge of additional and useful services (Pauceanu, 2016). The test of whether or not feasibility of an idea or project is highly important because it leads to find the best possible solution rather than finding any solution (Inventory & others, 2008). Before embarking on the implementation of most of the projects, architects must provide a feasibility assessment to the client, which can only be actually achieved after obtaining the client's brief. However, the extent of the evaluation depends on the type of feasibility required from the client (Chappell, 2019).

Figure 2.1: The assessment or evaluation of business idea proposed by

Source: (Barreto, 2013)

However, the feasibility test is composed of four basic parts product/service feasibility, industry/market feasibility, organizational/social feasibility, and financial feasibility (Bridge & O'Neill, 2012). According to (Barringer, 2012) during the preparation phase of the project, all parts of the feasibility study must be examined in preparation for the start of the project.

2.2 General Description of Steam Power Plant

Back in 1904, a dry steam engine was built by Prince Piero Ginori Conte in the Tuscany region of Italy and was powered by steam jets from the ground at Larderillo in the same area... However, the dry- steam stations were the first geothermal plants achieving commercial benefit (DiPippo, 2016).

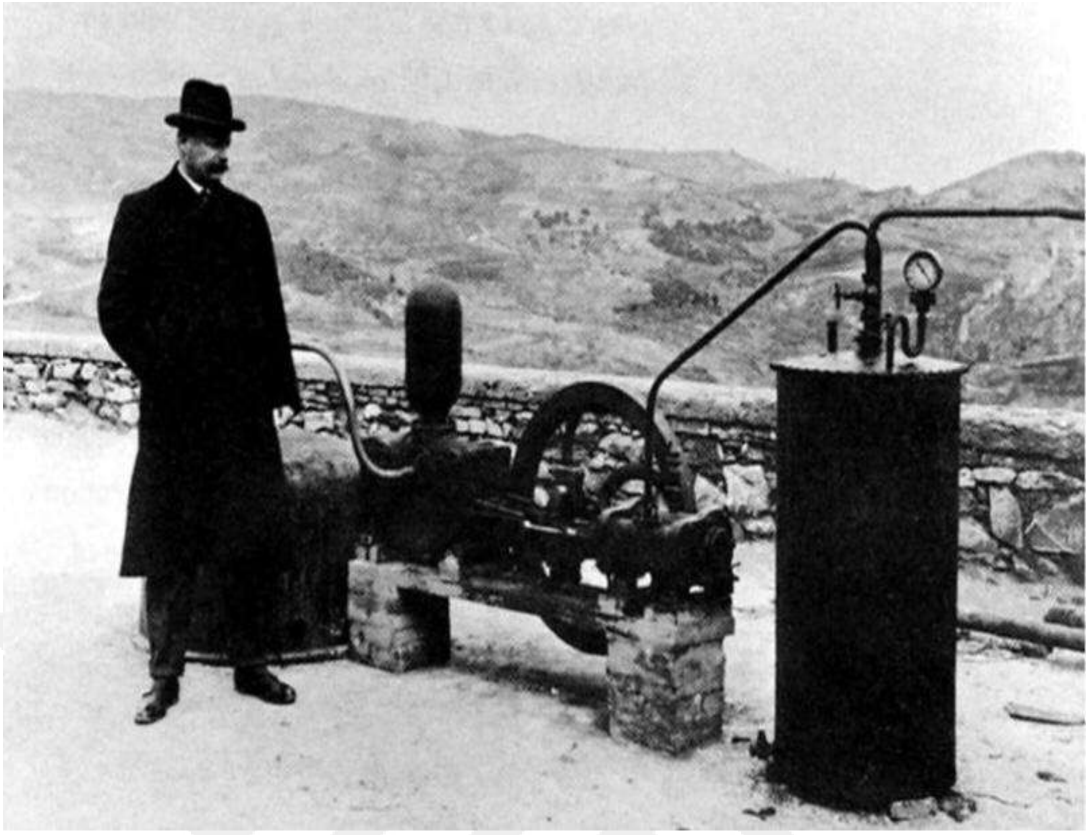
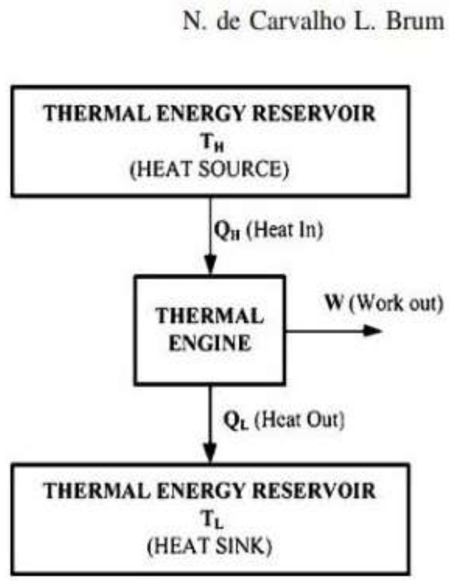


Figure 2.2: The first 15kw geothermal steam engine with its maker Prince Piero Ginori Conti

Sourece: (DiPippo, 2016).

Riznic (2017) said that, the steam generators work as heat energy exchangers with a giant shell and tube, and contain thousands of tubes, the steam production process is done by transferring thermal energy from the primary reactor to the secondary side, and then the turbine generators will be run in order to produce electrical energy. The biggest part of thermal stations existing uses the heat energy produced by reactions of combustion and its used fuels which are, pulverized coal, natural gas or fuel oil for more than a century… further, in all cases the operation of thermal station can be presented by the basic diagram in (Brum, 2012) Fig. 2.3.



$$\eta_{\max} = 1 - \frac{T_L}{T_H}$$

Figure 2.3: The basic presentation of operation process in thermal plants

Source: (Brum, 2012).

The main ingredients of the steam power plant are:

- Steam generator (also termed as boiler)
- Steam turbine
- A generator (also known as alternator)
- Condenser
- Heaters
- Pumps
- Fans
- Other auxiliaries

However, the steam generator burns the fossil fuels (coal, fuel oil, and natural gas) to convert the chemical energy in them to heat energy... after that, the cold water absorbs the heat emitted from the combustion, which will convert the water to a high- temperature and pressure steam in the steam generator... Latterly, the heat energy of the steam converts to mechanical energy and then to electrical power in the turbine and the generator... The furnace gets the air in purpose of combustion of the fuels... the gas passing over heating components gets the cooling process in different places, then it is discharged to outside environment through a stack... The released thermal power by combustion process is absorbed in various heat transfer surfaces—superheater, reheater, and economizer, to rise the working fluid's temperature and in the air heater to warm the ambient air before entering into the furnace... Rankine cycle is the basic cycle in steam power plants, which includes these processes:

1. Steam generation in a boiler at constant pressure
2. Isentropic expansion in a steam turbine
3. Condensation in a condenser at constant pressure
4. Pressurizing condensate to boiler pressure by isentropic compression (Sarkar, 2017).

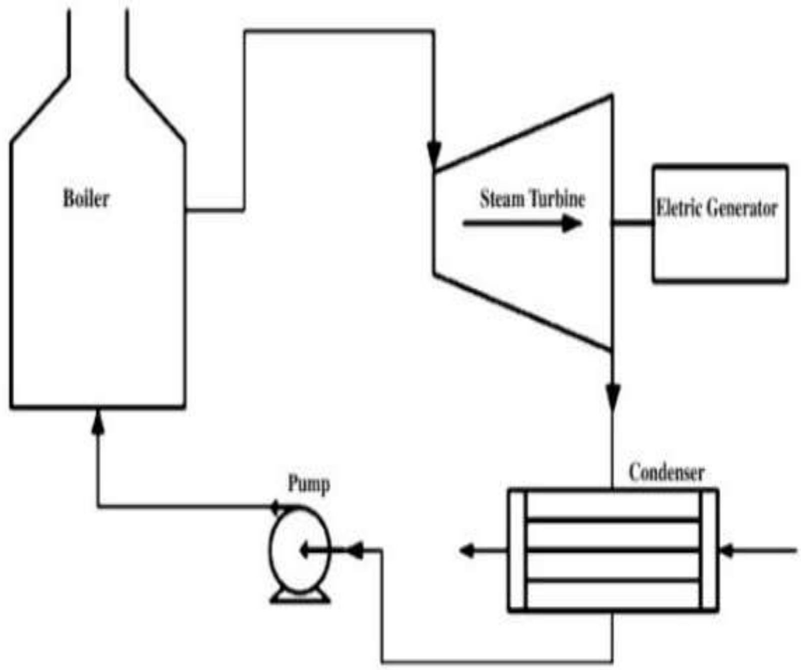


Figure 2.4: The Basic Rankine Cycle

Source: (Brum, 2012)

2.3 The Environmental Impact

In thermal power plants, the inputs to the electricity generation process are air, water and chemicals, which, if not properly controlled, are capable of causing serious impacts on the environment, impacts that can greatly affect the local air quality… As a feature common to all large projects, thermal power plant installations cause environmental impacts, from its early stages until the project's closure… In thermal power plants, there are the three types of solid, liquid and gas waste that are produced continuously and permanently, and are the cause of the most serious environmental impacts… The ability of the environment to absorb waste and the volume and type of waste are the main factors that determine the amount of environmental impact (Santos & Matai, 2012). In addition to that Sarkar (2015) illustrated that the environmental pollution emitted from the electrical energy stations which depend on the fossil fuel include:

- Particulate matter
- Sulfur oxides (SOx)
- Nitrogen oxides (NOX)
- Carbon dioxide (CO2)
- Carbon monoxide CO

2.4 Environmental Pollution Control

Explained a control explained how to control each type of pollution as follows (Sarkar, 2015)**:**

1. The Particulate matter: the particulate matter (PM) can be controlled by two kinds of devices; the mechanical separating device or the electrical separating device... However, the mechanical device consists of:

- Gravity settling
- Cyclone separation
- Scrubbers
- Fabric filters etc.

On the other hand, the electrical device controls the emissions by the electrostatic precipitation... However, the electrostatic precipitator more used than the mechanical separating devices, but both of them are able to successfully collect fine particles from 10 μ down to 0.05 μ size, also it has high level of efficiency in collecting many types of pollutants...

2. Methods of controlling sulfur oxides emissions: Methods of controlling sulfur oxides emissions: There are two methods available to achieve the reduction of sulfur oxide emissions from electric power plants in order to control pollution from these stations, and these two methods are:

- Switching to low-sulfur fuels

- Implementation of Flue Gas Desulfurization (FGD) system.

However, at first the low-sulfur fuel (coal) was more attractive. Then the new type of charcoal led to many problems due to it being lower grade charcoal, higher ash content and lower heating value. This is how it caused many technical problems and they are:

- Improper heat transfers between different places, which led, incidentally, to the production of unacceptable steam from boilers.
- Bad performance of pulverizer
- ID and FD fans are recently becoming unable to supply the air required to ensure complete combustion, because coal with lower heating value requires more air
- The high levels of flow of the flue-gas led to higher gas side erosion
- The ability of the current ash- handling system became inadequate for the full evacuation of the produced ash.

However, the fuel change has been shown to be suitable for retrofit projects. Overall, the (FGD) system has proven to be more successful in process of controlling SOx emissions. To explain, this system is implemented through groups of pulverized coal-fired boilers, since the SO2 gas is acidic, so the process needs alkaline chemicals such as; limestone (CaCO3), hydrated lime {Ca(OH)2}, magnesium hydroxide {Mg(OH)2}, etc. In order to remove the SO2 from flue gases. on the other hand, the process can use the natural alkaline which is the sea water to remove the SO2, because it contains high concentrations of the natural alkaline ions such as sodium, magnesium, potassium, calcium, carbonates, bicarbonates, chloride and sulphite. However, SO2 control process is achieved by seawater scrubbing, which has shown to achieve a 90% in SO2 reduction.

3. Methods of NOx pollution control: According to the US Clean Air Act Amendments of 1990 (CAAA), the NOX (about 90%-95% is NO, and the remaining is NO2) can be controlled by several techniques:

- Low-nox burners (LNB)
- Adopting fuel biasing
- Implementing the technique of limiting the excess-air (LEA) in the combustion process

- Application of over-fire air (OFA)
- Injecting the flame with steam or water
- Implementing of a recirculating flue gas

However, these processes aim to slow the mixing of air with fuel by redistribute them, which will lead to reduce the levels of O2 in the critical NOx formation areas, and reducing the amount of fuel that is burned in the peak of flame temperature. On the other hand, there are the back-end controls techniques such as:

- Selective catalytic reduction (SCR) system
- Selective non-catalytic reduction (SNCR) system.

Moreover, there are studies are being conducted to test the availability of using the fly ash in the construction industries such as (Malchik & others, 2016; Fediuk & Yushin, 2015) etc. illustrated that the chemical and mineral state of ash and slag is highly similar to natural mineral raw materials, which means that one of the beneficial solutions to the negative impact problem caused by thermal power plants is the use of fly ash and slag in the construction and agricultural. Furthermore, Fediuk & Yushin, 2015) reported that laboratory experiments have clarified the basic features of the leaked ash, as well as the possibility of using fly ash in the production of mineral and polymeric building materials.

2.5 Power Station Location Selection

During its construction and operation, a power plant influences the world around it. Such impacts are transient and permanent in nature. On the ground and in the air, a power plant takes up space, uses water supplies and, in most instances, releases pollution into the air. It may also impact the current or potential uses of adjacent and surrounding land as well.

Therefore, every location prior to the construction of the power plant must be evaluated. The study should take account of all the factors and sub-factors that influence the selection of sites for power plants.

2.5.1 Thermal power plants criteria for site selection

Thermal power station site selection criteria can be determined by the following limitations:

1- Locations of TPPs are avoided within 25 km of the outer periphery of the following: metropolitan cities, national parks and wildlife sanctuaries, and ecologically sensitive areas such as tropical forests, biosphere reserves, major lakes and coastal areas rich in coral formation.

2- Sites should be selected in such a way that the chimneys of the power plants do not come into the range of the airport of the closest airport.

3- These locations should be selected which are situated at least 500 m away from the flood plains of the river system.

4- The location of the sites is avoided in the region (say 10 km) of areas of archaeological, geographical, cultural/religious/tourist significance and protection facilities.

5- Forest or prime agricultural land shall be avoided for the establishment of thermal power houses or for the disposal of ash.

2.5.2 Factor affecting selection of location of thermal power plant

The factor affecting selection of location of thermal power plant can are listed in table 2.1. which includes main and sub factors for the selection criteria (Choudhary & Shankar, 2012).

Table 2.1: Factor affecting selection of location of thermal power plant

Main factor	**Sub-factors**
Economic effect	Cost of land acquisition Cost of investment Cost of service and repairs Pay-back time Future constraints on growth Possibility to extend the platform
Social problems	Creation of jobs Acceptance to the public Amount of relocations Distance from the public domain
Accessibility	Accessibility of road/rail/airport Accessibility of transmission grid Consumption stage of electricity Accessibility in urban areas

2.6 Thermal Power Plants Fuel

Thermal power plants are one of the most fundamental, and common electrical plants. The majority of these plants use the coal as a source of heat. According to (Breeze, 2014) worldwide, the most abundant source of electricity is the coal, it is the source of almost 40% of global electricity. However, the coal fired is one of the causes of the environmental pollution, due to that many studies were conducted in order to find new sources of fuel that can serve the purpose of generating electricity, as well as produce less contamination.

2.6.1 Coal- water slurries

A massive source of abundant types of fuel have been created by the waste coal products, through several cleaning systems in the USA about 40% of 1 billion ton of the yearly produced coal are treated This process aims to remove inorganic matter, pyritic sulfur, trace minerals, and other contaminants (Leonard, 1979; Speight, 1989). In the 1980s, and in order to find an oil alternative, the research .focusing was on Coal- water slurries (CWS) formulations development with increased concentrations of coal, these developed formulations have aimed to develop an item which is handled much like #6 heavy fuel oil. About 70-75% of these CWS products were typical solid concentrations (Stultz & Kitto, 1992), According to (Morrison & others, 1997) in the high density CWS the concentrations of coal fines had a growth from 40 % in the coal-oil mixtures (COM) to 65-70% in CWS products. However, the development of CWS has been carried out for the sake of many benefits; Firstly, to provide a useful way to use the tough fines for dewatering in coal preparation plants, as a useful benefit in the cleaning process of coal waste bunkers, which means less safety risks in coal mining, and secondly, it can provide an economic benefit as CWS is a low-cost fuel, thirdly, they provide an environmental benefit as CWS can be used as a methodology to reduce NOx emissions (Morrison & others, 1997; Battista, 2002; Battista & others, 1997). For more than a century, CWS technology is still in constant development, with pulverized charcoal being mixed with both water and oil ... However, the first patent for achieving the coal- oil mixtures COM was granted to Smith and Munsell in 1879 for its achievement of addition a new source of oil as well as contribute to reducing liquid fuel costs (Trass & Gandolfi, 1999).

2.6.2 Biomass

The vast majority of energy requirements are provided by the fossil fuels usage ... However, the massive amounts of fossil fuel use play an important role in the depletion of fossil fuels, as well as have a fundamental contribution to global warming because they cause large amounts of greenhouse gas emissions (Zinla & others, 2021). As a result, in order to provide the environmental safety, as well as to keep natural resources for next generations, there is a global shift to the use of alternative power resources (Lim & others, 2012). For example, in West Africa, the authorities have started investment projects in the renewable energy sector (Zinla & others, 2021).. According to (Titiloye & others 2013), this part of the African continent contains large amounts of agricultural waste, which is waste that can be used as sources of renewable energy (Koua & others, 2015). Illustrated that in Cote ˆ d'Ivoire every year the agricultural industry waste, crops and plantations produce almost 4.3 million tons of oil equivalent. However, (Cziesla & others, 2009) said that this country has a mass production of these crops, as it occupies the seventh ranking in the world for Robusta coffee production, as well as the cocoa beans, green coffee, and rice. Due to that, these areas have massive amounts of wastes that are produces after harvesting; usually these wastes are either left to be burned in the environment, or to decompose in the fields' ground... However, these wastes can be an important source of electricity generation (Zinla, 2021). According to (Iakov, 2012) generating the electrical power from biomass combustion is an over developed technology. This technology can be a promising method in electricity generation in Cote ˆ d'Ivoire, as it benefits from the cacao, rice and coffee wastes by burning them to produce electrical energy by the thermochemical conversion processes... on the other hand, it plays a fundamental role in both reduce the negative environmental impact produced by the greenhouse gasses emissions, as well as it contributes in processing the agricultural activities wastes (Zinla, 2021). Thermochemical conversion is defined as it is the usage of certain tools to convert of biomass to electricity through thermal processes such as the combustion (Cai & others, 2017; Saidur & others, 2011).

3. METHODOLOGY

1. Causes of the study: Due to the widespread problem of electricity in Iraq in general, and especially in Salah El- Dean province and its cities. However, because of the wide dependence on electricity on massive aspects of life such as trade, agriculture and official departments work this problem leaded to a major effect on the general life in Iraq generally and in Dhuluiya in special. And because of the long period of time without a solution to this problem this study was conducted in order to offer a solution proposal to the authorities as well as this study was conducted as one of the requirements of getting the master degree.
2. Parts of the study:

a. In the first place there is an introduction to show the basic information of global need to electricity, as well as information of the gradual development of electricity shapes and ways of generation.

b. After that there is the literature review where the researcher introduced basic information about the visibility study, then was the history and general description of thermal power plants, their environmental impact, and ways of reduction of them, finally the studies that shown the kinds of less contamination fuels.

c. The researcher also talked about the factors that affect the location selection.

d. Then was a questionnaire that sent to a group of people from the city concerned with the study to check the people’s opinions with the solution proposal.

e. Finally, after explaining the methodology of study, come the researcher’s conclusions and recommendations.

3. To explain and measure the dependency on electricity in the city which the study conducted about, the numbers and kinds of electricity consumers (these data are obtained from Directorate of Dhuluiya Municipality) are shown here:

a. Residential homes: 14,000 houses.

b. Shops: 400 – 500.

c. Population: according to the last statistic (2020 statistic) 75000

d. Government Departments: 25 departments as shown below:

- Police Directorate
- National Security
- Intelligence
- Civil Defense
- Directorate of Education
- Irrigation Directorate: in table 3.1, illustrate the numbers and classification of irrigation Pumps motors depending on “horsepower”.
- Department of Agriculture
- Municipal
- Electricity Directorate
- The district office
- Communications Directorate
- Directorate of Water and Sewage
- Dhuluiya Hospital
- Primary health care sector
- Six health centers
- Veterinary Center
- College of the Great Imam
- Social Welfare Directorate
- Agricultural Equipment Directorate
- Compensation Directorate
- Dhuluiya Court
- Supply Center
- Civil Status Directorate
- Sunni Endowment
- Dhuluiya Notary Department

Table 3.1: Classification and numbers of used Pump motors depending on "horsepower".

"Horsepower" of the used Pump motor in city	The number
7.5 hp	27
10 hp	49
15 hp	112
20 hp	66
25 hp	214
30 hp	36
40 hp	17
50 hp	22
75 hp	28
150 hp	16
100 hp	26
125 hp	3
60 hp	1
135 hp	2

4. Methodology of the study: An integrated study of the technical matters related to the establishment of this project was prepared by collcting the necessary data for the study from the concerned departments, explaining the general features of these plants and processes related to it such as the fuel, and contamination contro and so on, as well as comunicating a group of the city's community in order to collect the general opinion about this project. And then studying these data and analyzing them for the purpose of obtaining accurate results to evaluate the technical side of the project. The technical study of the project also includes estimating the local consumption of the region in which the project will be established. The population growth rate and the average daily consumption of electric energy for each person will be calculated for the purpose of guessing the amount of local consumption for the next decade. All the data mentioned was documented and scheduled in an engineering way in order to benefit from it in studying the technical feasibility of the proposed project. As for the study of the operational cost, the data of the Baiji Thermal Power Station will be approved, as it is the same design for the proposed

station in this study, in addition to the fact that this station has integrated data for both the cost of manpower, periodic maintenance and emergency. The proposed feasibility study also includes the topic of providing fuel for the proposed plant. The data that is available at the Samara Thermal Power Station could be relied upon as being the closest to the Dhuluiya district, geographically and administratively. Therefore, it can be used and included in the study and scheduling it in an engineering way that adopts modern technologies.

3.1 The Basic Feasibility Study and Project Information

The aim from this work is present a success study for establishment of thermal power station with suitable capacity can cover the energy demand of Al- Dhuluiya city for ten years more. Before the analyizing of questionnair we have to explaine some characterstics of the proposed station in table (3.2).

Table 3.2: Project details

Project name	**Dhuluiya Thermal Power Station**
The concept	Establishment of thermal power station with total capacity of “number” which is equal to “number” according to the note of the department of steam and electromechanical stations and engineering affairs numbered 6 in 18/1/2019 with the order of planning department of planning and studies numbered T D /3/6061 in 28/11/2018
Details	Etablishment of thermal power station that works by the crude oil, known that the Oil Ministry is able to provide the station with crude oil.

3.2 The Questionnaire

To check the possiblity and acceptance of the proposed project a questionnaire used, the questionnaire contains many questıons grouped ınto five axises: personal information axis, education and specialization axis, service evaluation axis, the proposed project axis, and project financing. Each axis contains some questions.

3.2.1 The presentation of questions of questionnaire

3.2.1.1 Personal information axis

This axis contains the following questions:

- Gender
- Age

3.2.1.2 Education and specialization axis

- Education level
- Specialization.

3.2.1.3 Service evaluation axis

This axis contains the following questions:

Q1- Your opinion on the reality of electricity in the city (processing hours)?

Q2- Your opinion about the electricity quality in the city (voltage level)?

Q3- Can the necessary needs be met with the current electric power level?

3.2.1.4 The proposed project

This axis contains the following questions:

Q4- Will the adoption of privatization in the production of electrical energy reduce the hours of energy absence?

Q5- Do you support the establishment of an electric power production station in the district?

Q6- Can the environmental impacts associated with the construction of the thermal station in the district be overcome?

Q7- The establishment of the power station leads to a reduction in the unemployment rate and helps in developing the private sector?

Q8- The value of the sums paid by the citizen in the event of the adoption of privatization approximates the amounts that the citizen pays for private generators?

3.2.1.5 The finance of proposed project

This axis contains the following questions:

Q9- The thermal power plant construction project can be presented as an investment opportunity, as it is economically feasible?

Q10- The security situation in the district helps to attract investors and thus there is no security problem?

Q11- The project site chosen is considered the best in terms of fuel economy and connection to the national electricity grid?

The questionnaire will be discussed in chapter four.

4. STATISTICS AND ANALYSIS OF QUESTIONAR

A questionnaire was conducted to conduct a statistical study on the opinions related to the proposed station, the results of 136 people were collected, with different the genders, ages, specializations and academic levels.

At the beginning of this chapter, a descriptive analysis of the questions which was including in the questionnaire will be covered, which through it is possible to give an idea of the feasibility of establishing the proposed station.

4.1 Analysis of Questionaire

The used statistical processing:

- Frequencies and percentages.
- Average and standard deviation.

4.1.1 Frequencies and percentages

In this subsection the percentages of the majors and the academic levels of the persons those participated in the questionnaire, these will be represented as shown in tables (4.1) and (4.2).

Table 4.1: The academic specialization of the persons who participated in the questionnaire

Specialization	Frequency	Percent	Valid Percent	Cumulative Percent
Mechanical engineering	4	2.9	2.9	2.9
Electrical engineering	7	5.1	5.1	8.1
Civil engineering	8	5.9	5.9	14.0
Computer engineering	1	.7	.7	14.7
Management and economy	86	63.2	63.2	77.9
Medical specialties	7	5.1	5.1	83.1
Other	23	16.9	16.9	100.0
Total	136	100.0	100.0	

Table 4.2: Distribution of students participating in the questionnaire according to their academic level.

Education	Frequency	Percent	Valid Percent	Cumulative Percent
High school	6	4.4	4.4	4.4
Diploma	3	2.2	2.2	6.6
Bachelor	37	27.2	27.2	33.8
Master	70	51.5	51.5	85.3
PhD	20	14.7	14.7	100.0
Total	136	100.0	100.0	

By extrapolating the tables (4.1) and (4.2), it becomes clear - between the participating in the questionnaire - that the percentage of specialists in electrical engineering (5.1%) and the percentage of specialists next to mechanical engineering (2.9%), while the percentage of specialists in the economic side is (63.2%), and the percentage of specialist in the civil engineering reaches to (5.9%) as these disciplines cover a large part of the disciplines that must be consulted when proposing such a project, where their percentage of them reaches to (77.1%) approximately.

4.1.2 Analyze of Important Questionnaire Questions

When looking on the answers of first question, it will be found about 40 people out of 136 expressed that they were not satisfied with the reality of electricity in the city, while the number of those who showed their complete dissatisfaction increased to 89 people and this is appear from the figures 4.1 and table 4.3.

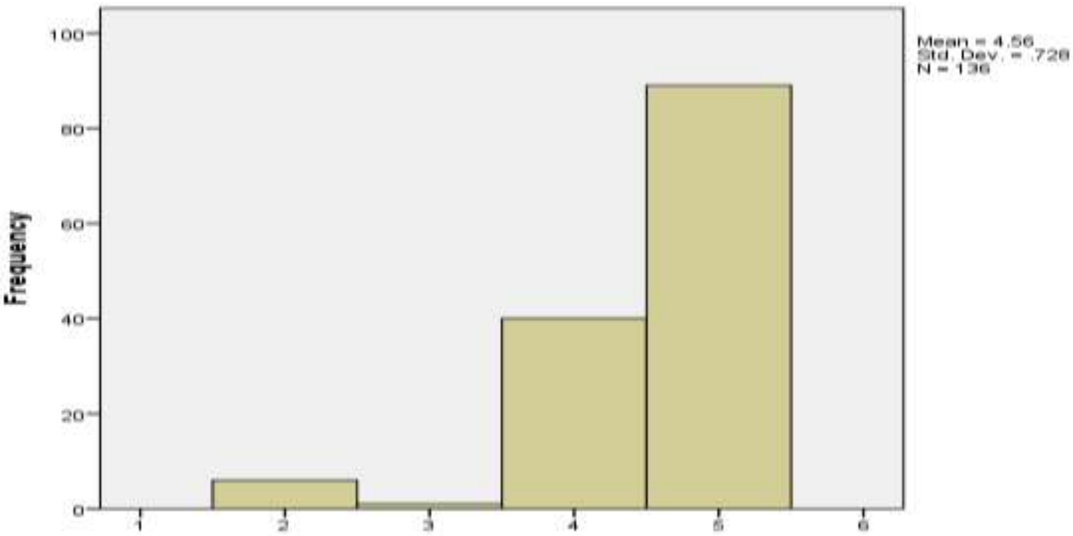


Figure 4.1: The block diagram of the responses of the first question

Table 4.3: The numbers of responses to the first question

Q1	Frequency	Percent	Valid Percent	Cumulative Percent
Agree	6	4.4	4.4	4.4
Neutral	1	.7	.7	5.1
disagree	40	29.4	29.4	34.6
strongly disagree	89	65.4	65.4	100.0
Total	136	100.0	100.0	

More than 42 people also showed their approval for the construction of an electrical station in the city, while the number of those who expressed their strong approval for the project was (89) out of (136) people, as shown in figures 4.2 and table 4.4.

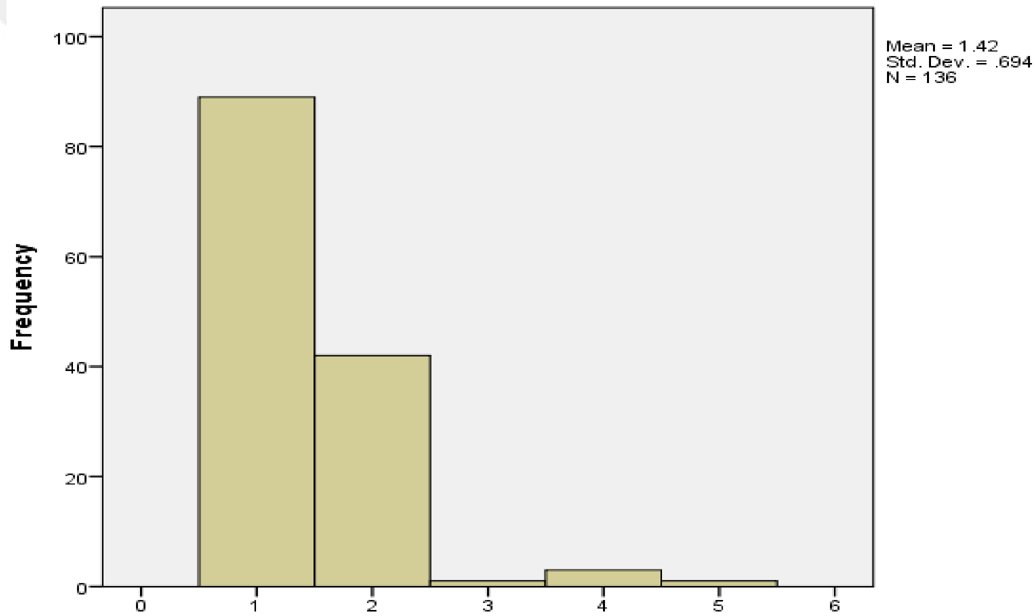


Figure 4.2: The block diagram of the responses of the fifth question

Table 4.4: The numbers of responses to the fifth question

Q5	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly agree	89	65.4	65.4	65.4
Agree	42	30.9	30.9	96.3
don’t know	1	.7	.7	97.1
disagree	3	2.2	2.2	99.3
strongly disagree	1	.7	.7	100.0
Total	136	100.0	100.0	

When looking on the answers of sixth question, it will be found about 82 people out of 136 expressed that they were sure that it can the environmental impacts associated with the construction of the thermal station in the district be overcome, and this is appearing from the figures 4.3 and table 4.5.

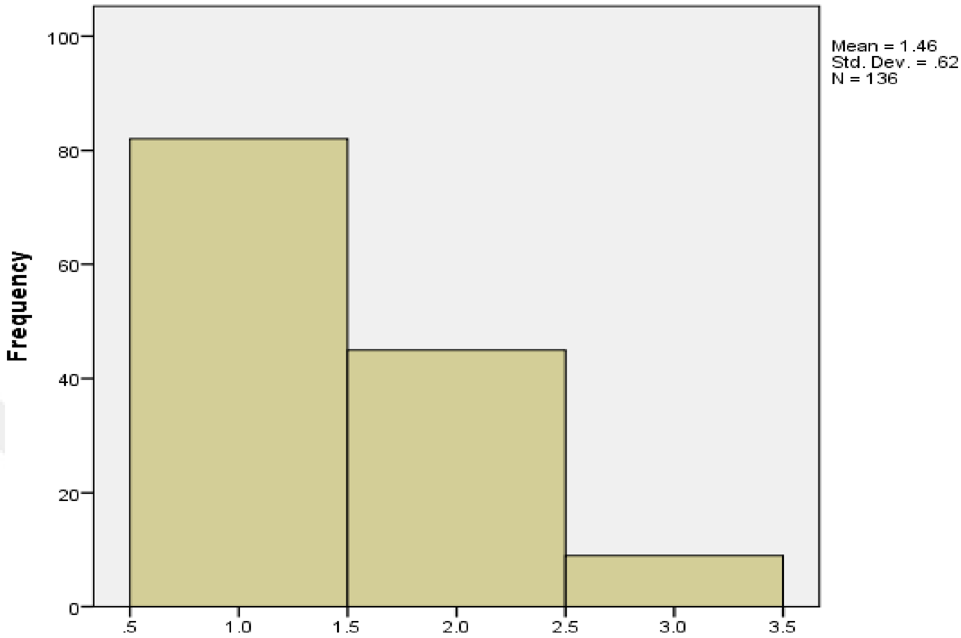


Figure 4.3: The block diagram of the responses of the sixth question

Table 4.5: The numbers of responses to the first question

Q6	Frequency	Percent	Valid Percent	Cumulative Percent
Of course	82	60.3	60.3	60.3
Don’t know	45	33.1	33.1	93.4
No it not possible	9	6.6	6.6	100.0
Total	136	100.0	100.0	

Also, by looking at the descriptive analysis of the questionnaire related to question 11, we note that 101 persons considered the chosen project site to be the best in terms of fuel economy and connection to the national electricity network, and almost the same number of them showed their strong agreement, these can be shown in figure 4.4 and table 4.6.

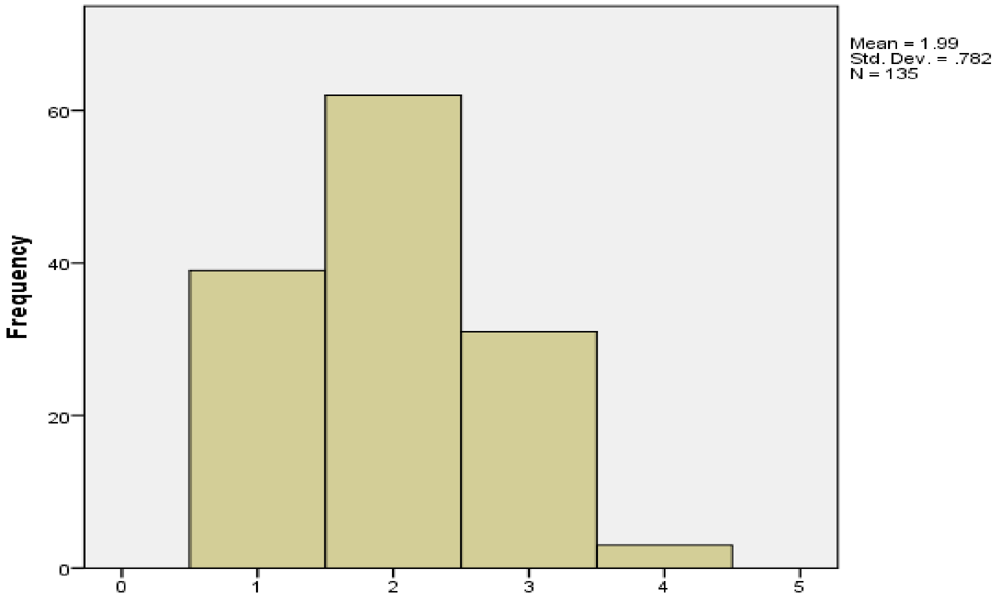


Figure 4.4: The block diagram of the responses of the eleventh question

Table 4.6: The numbers of responses to the eleventh question

Q11		Frequency	Percent	Valid Percent	Cumulative Percent
	Strongly agree	39	28.7	28.9	28.9
	Agree	62	45.6	45.9	74.8
	Don't know	31	22.8	23.0	97.8
	Disagree	3	2.2	2.2	100.0
	Total	135	99.3	100.0	
Missing	System	1	.7		
Total		136	100.0		

4.1.3 Moving average (main) and standard deviation

At last, it's important to be know the number of persons who support the establishment of an electric power production station in the district, who thought there's ability to overcome environmental impacts associated with the construction of the thermal station in the district, and whose thought that the project site chosen is the best in terms of fuel economy and connection to the national electricity grid via the table 4.7.

Table 4.7: The positive answers of the most important three questions in the questionnaire

Question	Positive answer	Negative answer	Other	Main	Standard deviation	General opinion
Q1/ Your opinion on the reality of electricity in the judiciary (processing hours)	6	129	1	4.56	0.728	n. Answer
Q5/ Do you support the establishment of an electric power production station in the district?	131	4	1	1.42	0.694	p. Answer
Q6/ Can the environmental impacts associated with the construction of the thermal station in the district be overcome?	82	9	45	1.46	0.62	p. Answer
Q11/ The project site chosen is considered the best in terms of fuel economy and connection to the national electricity grid	101	3	31	1.99	0.782	p. Answer

It is clear from the table 4.7, that the general opinion about the proposed station was positive answer which support the establishment of the proposal station, while which of the four questions had the largest share of positive answers, it can be clarified in figure 4.5.

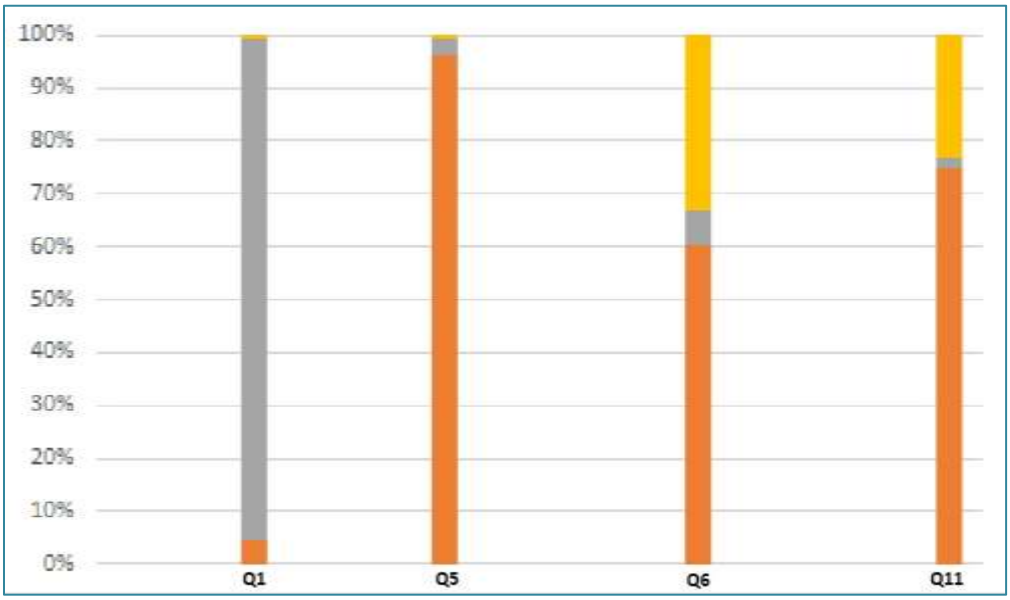


Figure 4.5: Which of the four questions had the largest share of positive answers?

5. THE ECONOMIC FEASIBILITY STUDY

According to the rates of increase in the population, the increase factor approved in the Central Statistical Organization in the Iraqi Ministry of Planning and Development Cooperation is 2.8%. Based on this evidence, the potential population increase will be as illustrated in table 5.1:

Table 5.1: The increase of population between 2020 and 2030

Year	Population
2020	75,000
2021	77,100
2022	79,258
2023	81,477
2024	83,758
2025	86,103
2026	88,513
2027	90,991
2028	93,538
2029	96,157
2030	98,849

However, the volume of electrical energy consumption in the city at the present time will be distributed to the following places of consumption:

- Residential homes: 14,000 houses.
- Shops: 400- 500
- Population: according to the last statistic (2020 statistic) 75000
- Government Departments: 25 departments as shown here:
- Police Directorate
- National Security
- Intelligence
- Civil Defense
- Directorate of Education
- Irrigation Directorate
- Department of Agriculture

- Municipal
- Electricity Directorate
- The district office
- Communications Directorate
- Directorate of Water and Sewage
- Dhuluiya Hospital
- Primary health care sector
- Six health centers
- Veterinary Center
- College of the Great Imam
- Social Welfare Directorate
- Agricultural Equipments Directorate
- Compensation Directorate
- Dhuluiya Court
- Supply Center
- Civil Status Directorate
- Sunni Endowment
- Dhuluiya Notary Department.

Table 5.2: Classification and numbers of used Pump motors depending on "horsepower"

"Horsepower" of the used Pump motor in city	The number
7.5 hp	27
10 hp	49
15 hp	112
20 hp	66
25 hp	214
30 hp	36
40 hp	17
50 hp	22
75 hp	28
150 hp	16
100 hp	26
125 hp	3
60 hp	1
135 hp	2

However, according to the data of the International Bank, the average amount of energy per person in Iraq is 1.3 kWh. That means as equation 1:

$$C = N_P * A_{v_p} \quad \textbf{(5.1)}$$

Where:

C = The needed capacity of the station.

Np = number of populations.

A_{v_p}= the average of energy per person.

Then:

$C = N_P * A_{v_p}$=98850*1.3= 128,505 KW

Which is equal to 128.51 MW approximately. However, because the nearest design of a thermal power plant is 150MW, so this capacity will be approved.

5.1 The Feasibility Study Math

Depending on the exchange rate which is equal to 1,450 dinars per 1dollar, the estimated cost of 1kw\h according the Iraqi Ministry of Electricity is 120 dinars s equation (5.2)

$$N_{mw} = N_{kw} * 1000 \quad \textbf{(5.2)}$$

Where:

N_{mw} = number of megawatts in hour.

N_{kw} = number of kilowatts in hour.

Then:

1MW\h = 120*1000= 120,000 dinars =120,000/1450= 82.7 dollars for MW\h

The number of hours in the year is 365*24= 8760 hours

The yearly cost of 1 MW can be illustrated as equation 5.3:

$$C_y = N_{mw} * \ N_y \quad \textbf{(5.3)}$$

Where:

C_y = the cost of megawatts per year.

N_y = number of hours per one year.

Then:

82.7*8760= 724,452 dollars for MW\year

- The highest cost of operating and maintenance contracts for thermal plants is estimated at 0.5 cents per kilowatt hour for a simple cycle and $ 5 per megawatt hour, according to a feasibility study prepared by the Iraqi Ministry of Electricity in 2006.
- When assuming that the station needs 50 employees for operation and maintenance purposes (engineers, technicians, workers, drivers, administrators, accountants), the monthly employee wages cost is $ 53,800 and $ 645,600 annually. They are as shown in table 5.3:

Table 5.3: Number of potential employees and their salaries

Employee	**Number**	**Monthly salary (dollars)**	**Annually salary (dollar)**
Engineers	10	1,300	13,000
Technicians	23	1,100	25,300
Administrator and accountant	9	1,100	9,900
Others	8	700	5,600
Total	50	53,800	645,600

- The estimated fuel consumption for producing a kilowatt hour is 0.235 liters for liquid fuel and 0.235 cubic meters for gas
- The selling price of a barrel of crude oil of 159 liters inside Iraq is estimated at $ 5.48, or 3.67 cents per liter, heavy fuel 8.46 cents per liter, gas oil 33.84 cents per liter, and natural gas 4.23 cents per cubic meter
- The estimated number of operating hours for the plant annually is 7680 hours/year and maintenance are 1080 hours / year.
- Then the fuel cost per cent / kW can be calculated as equation 5.4:

$$C_f = C_{l^*} C_C \quad \textbf{(5.4)}$$

Where:

C_f = the fuel cost per cent / kW.

C_l = the estimated fuel consumption for producing a kilowatt hour.

C_C = the price of estimated fuel consumption for producing a kilowatt hour.

Then:

Natural gas: 0.235 * 4.23 = 0.99 cent / kW

Gas oil: 0.235 * 33.84 = 7.95 cent / kW

Crude oil: 0.235 * 3.67 = 0.86 cent / kW

Heavy fuel 0.235 * 8.46 = 1.98 cent / kW

- The project life span is 25 years.

The feasibility study math will be designed according to the breakeven and the cash flow, and will be separated into three statuses:

- According to the estimated cost about 724,452 dollars per MW which means 108,667,800 dollars per 150 MW\year
- According to the estimated cost of (+10%) of the estimated cost in point 1 about 796,897 dollars per MW\H which means 119,534,550 dollars per 150 MW\year
- According to the estimated cost of (-10%) of the estimated cost in point 1 about 652,007 dollars per MW\H which means 97,801,050dollars per 150 MW\year.

Then the electrical power generation cost according to the different types of fuel can be shown as equation 5.5:

$$C_{Ot} = C_0 + C_f \quad \textbf{(5.5)}$$

Where:

C_{Ot} = electrical power generation cost.

C_0 = the operating and maintenance cost.

C_f = the fuel cost.

Then:

1. Operating by natural gas: the electrical power generation cost = 0.5+0.99 = 1.49 cents per unit (kWh) which is equal to 14.9 cents per unit (mWh) = 14.9*150*7680 = 17,146,800 dollars per 150 mw\year
2. Operating by Gas oil: the electrical power generation cost = 0.5+7.95= 8.45 cents per unit (kWh) which is equal to 84.5 cents per unit (mWh) = 84.5*150*7680 = 97,344,000 dollars per 150 mw\year.
3. Operating by crude oil: the electrical power generation cost = 0.5+0.86= 1.36 cents per unit (kWh) which is equal to 13.6 cents per unit (mWh) = 13.6*150*7680 = 15,667,200 dollars per 150 mw\year.
4. Operating by heavy fuel: the electrical power generation cost = 0.5+1.98= 2.48 cents per unit (kWh) which is equal to 24.8 cents per unit (mWh) = 24.8*150*7680 = 28,569,600 dollars per 150 mw\year.

Yearly power selling price can be calculated as equation 5.6:

$$P_{py} = P_{s^*}\ A_{mw}\ {}_*N_y \quad \textbf{(5.6)}$$

Where:

P_{py} = yearly power selling price (cash flow).

P_s = power selling price in Iraq per hour.

A_{mw} = the amount of produces MWs.

Then:

30.76*150*7680 = 35,435,520 dollars for (150MW\year) which presents yearly power selling price.

The cost of operation was illustrated in table 5.4.

Table 5.4: Costs of operation and maintenance and energy selling prices

Details	**The costs (dollars\MWh)**	**Operating costs per (150MW\ Year) dollars**
Operating by natural gas	14.9	17,146,800
Operating by gas oil	84.5	97,344,000
Operating by crude oil	13.6	15,667,200
Operating by heavy oil	24.8	28,569,600
Power selling prices (150 MW)	30.76	35,435,520

5.2 Project Cash Flow Report

5.2.1 Project cash flow according to the approximate qualitative price about (724,452 dollars\MW)

5.2.1.1 Project cash flow when operating the station by the natural gas

a. The estimated cost of establishing the project is estimated at 108,667,800 dollars.

b. Yearly cash flow = power selling price, can be calculated by equation 6, then:

c. 150*30.76* 7680 = 35,435,520 dollars per year

d. Cash outflows (variable) can be explained by equation 5.7:

$$Y = C_0 + E_w + S + X \tag{5.7}$$

Where:

Y = cash outflows.

C_0 = costs of operation and maintenance on gas.

E_w = employee wages.

S = service supplies.

X = other disbursements

Then:

Cash outflows = 10,714 + 16,071 + 645,600 + 17,146,800 = 17,819,185 dollars annually.

a. Profit (annual) cash flows is calculated by using the equations 5.8:

$$R_n = P_{py} - Y \quad \textbf{(5.8)}$$

Where:

R_n = Profit (annual) cash flows.

Then:

Profit (annual) cash flows = 35,435,520 - 17,819,185 = 17,616,335 dollars annually.

According to this data the project reaches the breakeven in 6 years and 2 months.

5.2.1.2 Project cash flow when operating the station by the crude oil

a. The estimated cost of establishing the project is estimated at 108,667,800 dollars
b. Yearly cash flow = power selling price, by applying the equation 6:
c. 150*30.76* 7680 = 35,435,520 dollars per year
d. Cash outflows (variable) can be calculated by applying equation 7:
e. 10,714 + 16,071 + 645,600 + 15,667,200 = 16,339,585 dollars annually
f. By using equation 8, profit (annual) cash flows will be: 35,435,520 - 16,339,585 = 19,095,935 dollars annually

According to this data the project reaches the breakeven in 5 years and 7 months.

5.2.1.3 Project cash flow when operating the station by the gas oil

a. The estimated cost of establishing the project is estimated at 108,667,800 dollars
b. Yearly cash flow = power selling price power selling price, by applying the equation 6: 150*30.76* 7680 = 35,435,520 dollars per year
c. Cash outflows (variable) can be calculated by applying equation 7: 10,714 + 16,071 + 645,600 + 97,344,000 = 98,016,385 dollars annually
d. By using equation 8, profit (annual) cash flows will be: 35,435,520 - 98,016,385 = -62,580,865 dollars annually

e. According to this data the project will not reach the breakeven and it is in a continuous lose.

5.2.1.4 Project cash flow when operating the station by the heavy fuel

a. The estimated cost of establishing the project is estimated at 108,667,800 dollars

b. Yearly cash flow = power selling price power selling price, by applying the equation 6: = 150*30.76* 7680 = 35,435,520 dollars per year

c. Cash outflows (variable) can be calculated by applying equation 7: 10,714 + 16,071 + 645,600 + 28,569,600 = 29,241,985 dollars annually

d. By using equation 8, profit (annual) cash flows will be: 35,435,520 - 29,241,985 = 6,193,535 dollars annually

e. According to this data the project will reach the breakeven in 17 years and 5 months

5.2.2 Project cash flow according to the approximate qualitative price about (796,897 dollars\MW)

5.2.2.1 Project cash flow when operating the station by the natural gas

a. The estimated cost of establishing the project is estimated at 119,534,550 dollars

b. Yearly cash flow = power selling price, can be calculated by equation 6, then: 150*30.76* 7680 = 35,435,520 dollars per year

c. Cash outflows (variable) can be calculated by applying equation 7: 10,714 + 16,071 + 645,600 + 17,146,800 = 17,819,185 dollars annually

d. By using equation 8, profit (annual) cash flows will be: 35,435,520 - 17,819,185 = 17,616,335 dollars annually

e. According to this data the project reaches the breakeven in 6 years and 8 months.

5.2.2.2 Project cash flow when operating the station by the crude oil

a. The estimated cost of establishing the project is estimated at 119,534,550 dollars

b. Yearly cash flow = power selling price, can be calculated by equation 6, then: 150*30.76* 7680 = 35,435,520 dollars per year

c. Cash outflows (variable) can be calculated by applying equation 7: 10,714 + 16,071 + 645,600 + 15,667,200 = 16,339,585 dollars annually

d. By using equation 8, profit (annual) cash flows: 35,435,520- 16,339,585 = 19,095,935 dollars annually

e. According to this data the project reaches the breakeven in 6 years and 2 months.

5.2.2.3 Project cash flow when operating the station by the gas oil

a. The estimated cost of establishing the project is estimated at 119,534,550 dollars

b. Yearly cash flow = power selling price, can be calculated by equation 6, then: 150*30.76* 7680 = 35,435,520 dollars per year

c. Cash outflows (variable) can be calculated by applying equation 7: 10,714 + 16,071 + 645,600 + 97,344,000 = 98,016,385 dollars annually

d. By using equation 8, profit (annual) cash flows: 35,435,520- 97,344,000 = -62,580,865 dollars annually

e. According to this data the project will not reach the breakeven and it is in a continuous lose.

5.2.2.4 Project cash flow when operating the station by the heavy fuel

a. The estimated cost of establishing the project is estimated at 119,534,550 dollars

b. Yearly cash flow = power selling price, can be calculated by equation 6, then: 150*30.76* 7680 = 35,435,520 dollars per year

c. Cash outflows (variable) can be calculated by applying equation 7: 10,714 + 16,071 + 645,600 + 28,569,600 = 29,241,985 dollars annually

d. By using equation 8, profit (annual) cash flows: 35,435,520- 29,241,985 = 6,193,535 dollars annually

e. According to this data the project will reach the breakeven in 19 years and 3 months

5.2.3 Project cash flow according to the approximate qualitative price about (652,007 dollars\MW)

5.2.3.1 Project cash flow when operating the station by the natural gas

a. The estimated cost of establishing the project is estimated at 97,801,050 dollars

b. Yearly cash flow = power selling price, can be calculated by equation 6, then: 150*30.76* 7680 = 35,435,520 dollars per year

c. Cash outflows (variable) can be calculated by applying equation 7: 10,714 + 16,071 + 645,600 + 17,146,800 = 17,819,185 dollars annually

d. By using equation 8, profit (annual) cash flows: 35,435,520-17,819,185 = 17,616,335 dollars annually

e. According to this data the project reaches the breakeven in 5 years and 5 months.

5.2.3.2 Project cash flow when operating the station by the crude oil

a. The estimated cost of establishing the project is estimated at 97,801,050 dollars

b. Yearly cash flow = power selling price, can be calculated by equation 6, then: 150*30.76* 7680 = 35,435,520 dollars per year

c. Cash outflows (variable) can be calculated by applying equation 7: 10,714 + 16,071 + 645,600 + 15,667,200 = 16,339,585 dollars annually

d. By using equation 8, profit (annual) cash flows: 35,435,520-16,339,585 = 19,095,935 dollars annually

e. According to this data the project reaches the breakeven in 5 years and 1 months.

5.2.3.3 Project cash flow when operating the station by the gas oil

a. The estimated cost of establishing the project is estimated at 97,801,050 dollars

b. Yearly cash flow = power selling price, can be calculated by equation 6, then: 150*30.76* 7680 = 35,435,520 dollars per year

c. Cash outflows (variable) can be calculated by applying equation 7: 10,714 + 16,071 + 645,600 + 97,344,000 = 98,016,385 dollars annually

d. By using equation 8, profit (annual) cash flows: 35,435,520- 98,016,385 = -62,580,865 dollars annually

e. According to this data the project will not reach the breakeven and it is in a continuous lose.

5.2.3.4 Project cash flow when operating the station by the heavy fuel

a. The estimated cost of establishing the project is estimated at 97,801,050 dollars

b. Yearly cash flow = power selling price, can be calculated by equation 6, then: 150*30.76* 7680 = 35,435,520 dollars per year

c. Cash outflows (variable) can be calculated by applying equation 7: 10,714 + 16,071 + 645,600 + 28,569,600 = 29,241,985 dollars annually

d. By using equation 8, profit (annual) cash flows: 35,435,520- 29,241,985 = 6,193,535 dollars annually

According to this data the project will reach the breakeven in 15 years and 8 months.

5.3 The Investment in the Private Sector

5.3.1 The Concept of Investment

Investment can be denoted as investing money or allocating it in the available investment fields or opportunities, which the investor believes are appropriate and acceptable opportunities and achieve the return that he desires with the least level of risk. There is a reciprocal relationship between return and risk, as the return increases as the risk increases and decreases by decreasing it. The investment is either in proposed (new) economic projects or takes the form of investment expansions in existing companies, such as adding additional new production lines to the existing lines and whatever the type of this investment. New investment projects or additions that need a feasibility study to be accepted by the concerned departments. And investment is an addition to assets (fixed capital) (Himick & Coulier, 2016; Ricciardi, 2004).

This is considered an increase in investment growth and expansion, as the real investment by business organizations is the real growth in fixed capital. As companies that are trying to launch a new product need additional machinery and equipment, and all of these elements are real investment elements in addition to stock and commodity requirements that fall within the working capital and aims to increase wealth not only at the level of companies but at the state level. As the macroeconomic environment and that companies are the micro-economy of the macro economy, in addition to real investment, there is financial investment, such as investing in loans (buying government bonds or buying stocks) (Freeman & Perez, 1988; Dixit & Pindyck, 1995).

5.3.2 Investment Environment

Investment needs an investment environment in which the ingredients for the investor's success in making a good choice of available investment opportunities are available, and the most prominent of these ingredients are:

- Political, economic and security stability.
- The investor feels safe and stable.
- Encouraging financial and legal legislation that facilitates the investment process.
- Encouraging tax policies that include tax exemptions for a certain period, after which the income derived from investment is subject to tax.
- Providing suitable investment opportunities in light of an economy characterized by prosperity and economic growth.
- Existence of savings and awareness of savings and investment, considering savings as a source of financing for investment.

- The existence of financial markets in which it is easy to trade (securities) shares and bonds (Moore & Schmitz, 2008; Bardy & others, 2012; Pyhrr & others, 1999).

investment may be the employment of net output in order to achieve an increase in wealth without changing its social character and distribution, therefore, Socialist theorists believe that investment, which derives its source from the economic surplus, leads to the renewal of old productive capacities of society and the expansion of its production apparatus in various sectors such as agriculture, industry, trade and others (Nee, 1991; Robinson, 1979; Luxemburg, 2015).

5.3.3 The Importance of Investment

The importance of investment is summarized in the following points:

- Increase income.
- Creating job opportunities (Bank, 2013).

Supporting the economic and social development process

Increasing production and supporting the trade balance and balance of payments

Developed countries have paid great attention to investment by issuing laws and legislation encouraging investment necessary for the movement of visionaries of money. In developing countries, investment did not give enough attention despite the scarcity of capital in the country. This scarcity of capital may be due to the following reasons:

- Low growth rates of national income
- High consumption rates
- High population growth rates
- Irrational use of available capital (McCombie & Thirlwall, 2016).

5.3.4 The Advantages of Investment

Investment has many advantages from these advantages:

- Investment is not represented in the flow of capital only, but only what is accompanied by productive arts and modern products, as well as administrative and organizational skills and technical expertise lacking in developing countries, and these investments allow the participation of local capital and local labor to different degrees and the resulting benefits (Means, 2017).

- Investment may be a source of cash, when the project activity is based on production and export, where the investor has a greater ability to market the products.
- These investments open the way for the national capital and encourage it to participate in production (Shaw et al, 2013).
- The investments represent an addition to the production capacity in the host countries, in addition to the fact that part of the profits of those investments are reinvested (Kusek & Silva, 2018).
- Investment motivates national expertise not to migrate abroad, as it provides opportunities and work conditions that this expertise seek outside the country (Deininger & Byerlee, 2012).
- Based on what has been submitted that the private investment can lead to the development of projects, and because the estimated quantitative costs of the total costs of the proposed project are among the most important elements of establishing projects and obtaining official and fundamental approvals for them. Therefore, estimated quantitative study was conducted in comparison with a similar project to the one that was proposed in this work.

The capacity of the proposed station was decided to be 150MW. However, the way of the mathematical calculations and determining the costs was done as in the works of feasibility studies in the Iraqi Ministry of Planning.

In the feasibility study of the establishment of a thermal power station in Al Anbar Province (The station to be compared with proposed station) with a capacity of 1400MW its cost was determined to be 1,120,000,000 dollars. The economic feasibility study has been calculated and estimated by Feasibility Study Department in the Ministry of Planning designed. In the ministry department they require a table to summarize the expenditures according to the thermal power station departments and needs. The entire plant cost is 108,667,800 dollars and was divided as shown in the sample table 5, and the percentage was determined by comparing the cost of this plant to the cost of the 1400 MW plant percentages.

Table 5.5: Summarizing of expenditures according to AL-Anbar thermal power station departments and needs

No.	**Details**		**Cost in dollars**	**Paragraph percentage of the project cost**
1	Engineering designs		30,800,000	2.75%
2	The machines and the Equipment		72,800,000	65%
3	Constructing		134,400,000	12%
4	Implementation			
	4 - 1	Mechanical works	123,200,000	11%
	4 - 2	Electrical work and control	95,200,000	8.5%
5	Training		80,400,000	0.75%
	Total		1,120,000,000	100%

The technique of the department was followed in this research for proposed station and the estimated quantitative cost can be explained as shown in table 5.6.

Table 5.6: The details of the investment cost

Details	Cost in dollars	Paragraph percentage of the project cost
Engineering designs	2,988,364.5	2.75%
Machines and equipment	70,634,070	65%
Constructing	13,040,136	12%
Mechanical works	11,953,458	11%
Electrical works	9,236,763	8.5%
Training	815,0085	0.75%
Total	108,667,800	100%

It's explained from the table 6, the estimated quantitative cost of every requirement after the total estimated cost was calculated which equals (108,667,800), the estimated cost of every requirement then will be:

108,667,800 * Paragraph percentage of the project cost

Where:

Engineering designs = 108,667,800 * 2.75% = 2,988,364.5

Machines and equipment = 108,667,800 * 65% = 70,634,070

Constructing = 108,667,800 * 12% = 13,040,136

Mechanical works = 108,667,800 * 11% = 11,953,458

Electrical works = 108,667,800 * 8.5% = 9,236,763

Training = 108,667,800 * 0.75% = 815,0085

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

- When the estimated cost is equal to (-10%) from the estimated main cost of the project, the time to reach the breakeven will decrease by one year and three months when operating by the natural gas, and six months when operating by the crude oil and almost two years when operating by heavy fuel.
- When the estimated cost is equal to (+10%) from the estimated main cost of the project, the time to reach the breakeven will increase by six months when operating by the natural gas, and almost seven months when operating by the crude oil and almost two years when operating by heavy fuel.
- When operating the station by natural gas the project will reach the breakeven in 5-7 years affected by the estimated cost of the whole project.
- When operating the station by crude oil the project will reach the breakeven in 5-6 years affected by the estimated cost of the whole project.
- When operating the station by heavy oil the project will reach the breakeven in 15-19 years affected by the estimated cost of the whole project
- When operating the station by gas oil the project will not reach the breakeven and it is in a continuous lose.
- 113 of specialists related to the proposed project participated in the questionnaire, add to 26 persons of other specializations and different level academics. 131 answers were consistent with the idea of establishing the project, while 4 answers disagree with the idea, and one neutral answer.
- The fifth question (Do you support the establishment of an electric power production station in the district?) received the largest percentage of answers, which absolutely support the idea of establishing the project, as the percentage of support reached more than 95%. As for the eleventh question (The project site chosen is considered the best in terms of fuel economy and

connection to the national electricity grid?), the percentage of answers that agree with its content amounted to more than 77%. Which means the project establishment and the location are supported by the survey participants.

6.2 Recommendations and Future Works

- In view of the above, the operation of the Dhuluiya thermal plant is recommended based on using of first-class crude oil fuel, then natural gas, then heavy fuel in the event that the energy sale price is 30.76 cents per kilowatt hour, because it is economically feasible, then will reach the breakeven point and achieves profits for the project.
- It is evident from the above study, it can’t be recommended to operate the plant by gas oil, because there is no ability to reach the economic feasibility.
- It is recommended to resort to the private sector when there is no government capacity to provide services to citizens, provided that there is a realistic study and an objective vision of the projects.
- It’s recommended propose new projects instead of these old projects which spend too much years in work under difficult and different conditions, this may be more effective and more financially feasible than projects on which billions are spent without benefit for citizens.

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