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The Challenges faced by the Iraqi electricity sector: Reform program and proposed solutions

Ammar Mohammed Kadhim

Planning & studies Office, Iraqi Ministry of Electricity.

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ABSTRACT

The electricity crisis in Iraq presents a complicated challenge that extends beyond technical, administrative, and strategic dimensions, impacting the nation's economic and political landscapes. This research explores the roots of the crisis, emphasizing the need for comprehensive planning, enhanced leadership, and coordinated efforts within the state administration.

This study proposes two alternative sources of financial support to revitalize the electricity sector. Firstly, the utilization of loans from local banks provides a viable economic and political solution, reducing costs associated with importing energy and alleviating the energy deficit. The second proposal suggests establishing a development investment fund, attracting local capital investments with competitive interest rates. These funds, reinvested in high-return projects, promise to augment the Ministry's revenues, and contribute to economic growth.

To illustrate the viability of the proposals presented in this paper, a 1400 MW thermal power station is examined, comparing the cost of production (kWh) when financed by local banks against the cost of importing energy or purchasing from investors. Additionally, the study advocates for a rehabilitation program to increase unforeseen capabilities through maintenance campaigns, project acceleration, and a focus on the electric power transmission sector's development.

In conclusion, the implementation of these proposals offers a transformative approach to address the electricity crisis in Iraq. Beyond immediate financial benefits, these initiatives contribute to economic growth, energy sustainability, and improved GDP income. The study emphasizes the necessity of a coordinated rehabilitation program and enhanced infrastructure development to realize a more resilient and efficient electrical system.

1. Introduction

In electricity power system, the energy supply and demand levels can change rapidly and unexpectedly due to many issues, such as power generation units forced outages, transmission and distribution line outages and unexpected load changes with high demand growth as a result to consumer behavior such as response to economic variation and high style life.

The electricity system in Iraq faces a main problem, which is the inability to meet load demand. The electricity crisis in Iraq is not intractable at the technical, administrative, or strategic level, nor is it limited to the performance of the electricity sector. Instead, its causes are known and diagnosed. Confronting the challenges of this crisis requires thoughtful planning, simultaneously developing the leadership and coordination work of the state administration with its institutions and among them and reconsidering

* Corresponding author E-mail address: ammarmohkadhim@gmail.com

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its view of the national energy security strategy.

In May 2003, electricity production was less than 10 percent of the already inadequate pre-war level. The continuation of the electricity crisis had one of the most serious adverse effects on the national economy and became a major political issue [1]. The activities and projects of the Ministry of Electricity have faced weakness in their implementation and completion, as well as a decrease in the operational capabilities available for power generation plants due to the absence of visions of the executive authority and the failure to adopt simultaneous planning and coordination. It lacks an integrated work method between the sectorial and institutional executive authority [2]. The lack of annual financial allocations to the Ministry and the problematic economic fluctuations that the country is experiencing constitute a serious challenge facing the Ministry’s plan, which aims to increase the supply of electrical energy in light of the current deficit, which constitutes approximately 30% of the total energy demand. In addition, reliance on purchasing energy from investors, importing it from neighboring countries, and buying gas, but the costs of purchasing and importing energy and gas constitute very high annual amounts that exhaust all the financial allocations of the Ministry, which affects the failure to secure financial allocations to establish projects for electric power stations affiliated with the Ministry, which also reflects negatively on a budget of the country in general. This research deals with two proposals to secure financial allocations to finance the construction of electric power station projects from sources other than investment, namely by relying on loans from local banks, as these two proposals have positive dimensions from an economic and political perspective for the ministry in particular and for the country in general, as it will contribute from a financial perspective. Reducing the costs resulting from importing and purchasing energy and lowering the energy deficit will achieve increased growth in the country’s economic cycle and improve the GDP income [3]. Through this study, it was proposed to provide two sources of financial financing to reform the electricity sector. It was select a thermal power station(steam) with a capacity of 1400 MW, as an example, to compare the cost of producing (kWh), including the costs of building and operating these units, which are financed according to the first proposal from local banks, with the cost of importing energy from neighboring countries and purchasing Energy from investors (IPP). The second proposal includes establishing a development investment fund that will attract local capital investments by providing an additional return represented by a specific interest rate that is estimated in a competitive framework with the market and then reinvesting these amounts in implementing projects with high returns that contribute to raising the ministry’s revenues. From energy sales, the annual interest rate specified for these deposits will be paid through a certain percentage of the collection revenues collected, and an integrated economic cycle will be achieved.

In literature review the important studies addressed the characteristics of reform the electrical power system, in order to identify an appropriate solution technique for their system problems. These studies and research exist to address the issues of energy supply planning which is emerged as a result of fluctuating production (supplier) and consumption (consumer). Some of these studies have been developed to determine the optimal overall solutions for energy production and supply planning to meet time-varying demand, by selecting a mix of different energy sources with minimum total cost. Other studies analyze the impact of investment decisions by the regulator and private firms in a liberalized electricity market.

The [4] explicit the impact of using the economic theory for reformed power systems and theory for optimal investment on new power generation under uncertainty. As well as give an explanation of by using dynamic investment models can identify profit maximizing investment strategies which stem from the optimal decentralized investment decisions under different regulations and market designs. [5] Studied the problem of long-term planning of electric power systems, focusing on determining the operational capabilities of fossil fuel-based power generation systems. He concluded that it is not possible to rely on the traditional source of energy to meet our energy needs except for many years in the future. [6] Developed an optimal model to represent specific components of an energy supply system and consumption entities. This would enable the analysis of the reaction to a sudden drop in power caused by the wind speed. Furthermore, the strategies used for the operation system were improved, by reducing the rebound effect and ensuring a better frequency stabilization and restoration. [7] used models to build a market dynamic that has been analyzed through simulations. The simulation model of the strategic behavior, which is formulated for the agents, is used as a tool for analyzing the market outcomes when competitive agents (power producers) interact through the market place. [8] compared a Nash equilibrium analysis and agent-based modelling for assessing the market dynamics of energy supply. A Q-learning algorithm, which was initially designed for learning through interaction with a Markov Decision Process, was proposed. The suppliers submitted their bids to the market place in order to maximize their payoffs, where reinforcement learning as a behavioral agent model was applied. [9] examined the complex decision making and optimization environment in an electricity system in order to clarify the impact of the deregulation of the energy market on decision making and optimization in utilities.[10] presented an Independent Supply Operator (ISO) model for coordinating transmission expansion-planning with competitive generation capacity-planning in electricity markets. As result to uncertainties in energy generation and load, optimal decision-making in energy markets is a complicated and challenging task [11]. applied an agent-based model to solve the problem of short-term strategic bidding of traditional Generation Companies It is clear from these studies, in electrical power system, the investment decisions of energy suppliers were constantly changing with any new challenges that emerged with increasing the demand, such as independent power producers take part in electricity market. Accordingly, new methodologies and models have been developed to make optimal investment decisions in electric energy production. In this research, as a result of the issue of shortages in energy supplies, the optimal strategies for achieving energy sufficiency were presented after diagnosing the problem. Through analysis and comparison, results were obtained that provide a reliable source of financial allocations necessary to reform the electricity sector.

A historical overview of the electricity energy supply structure and demand behavior in Iraq is presented in the next section. The challenges of reforming the electricity sector are addressed in section 3. The 4 section offers the scene by analyzing the reform plan in light of the decline in financial allocations to the electricity sector and its impact on energy supplies in Iraq. The conclusion and recommendation are discussed in the last section.

2. A historical overview of the Iraqi electrical energy system and demand behavior

The Iraqi electricity supply started to grow rapidly between 1967 and 1990 to face the rapid demand by building several power plants and establishing an electricity network due to the fast-growing economy that brought prosperity and stability to Iraq in this period (Electricity, 1990).

After the year 2003, the rapid demand with the improvement of the standard of living, the introduction of air conditioning and heating equipment, and the lack of control over the devices and the extent of their compliance with the required specifications [12]. in addition to the significant fragmentation of housing, the spread of slums in all governorates of Iraq, and the weakness of collection, this led to a demand for electrical energy on a frequent and unnecessary basis, and with non-linear consumption rates, as well as distorted,

Resulting in a heavy energy burden. Therefore, the gap between supply and demand widened, as shown in Fig. 1.

The year 2014 was critical for the Iraqi electricity sector. It was expected to include the most significant increase in power generation capacity in its history, with 24-hour electrical power supplies increasing by the end of 2014. However, the disruption of the security situation in some cities as a result of ISIS events constituted a solid blow to the ministry's plan [13]. Moreover, there has been a significant impact on the plan to launch investment projects for international companies to enhance the electricity generation capacity in Iraq to meet future demand, as many large projects that could have illuminated the entire Iraq have been delayed, as shown in Fig.2.

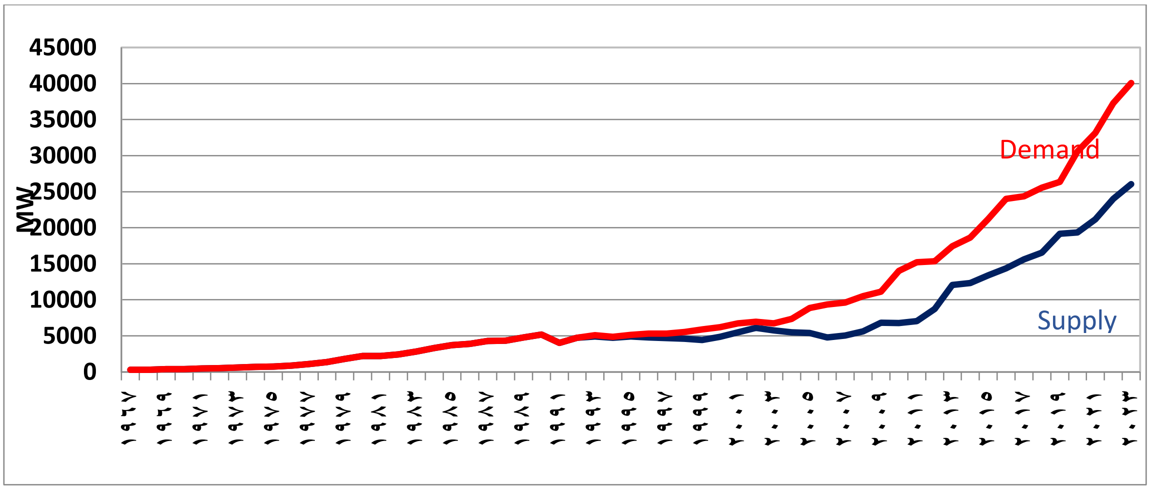

Figure 1. The Peak load (MW) Supply and Demand for the Years (1967 - 2023)

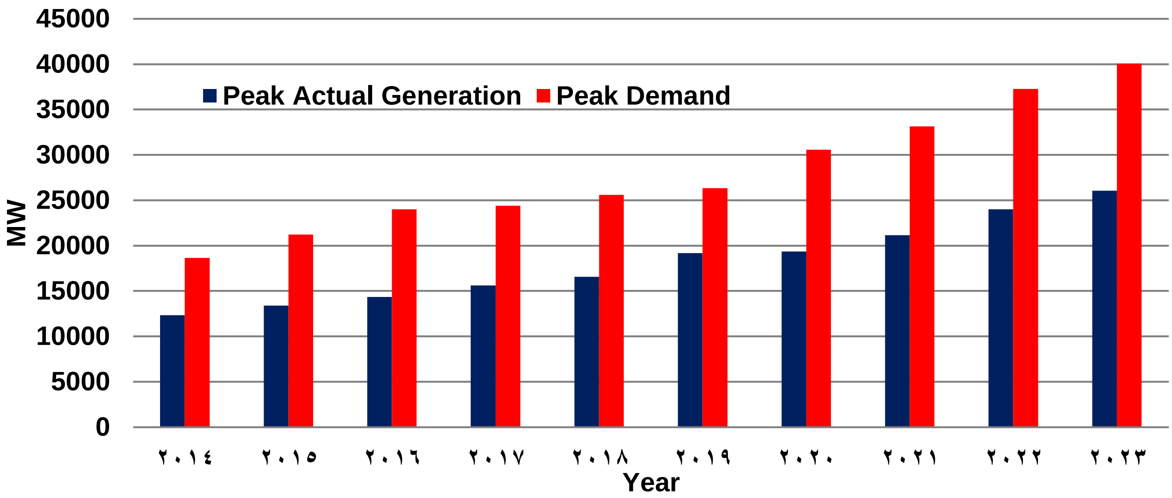

Fig.2 The Peak Generation and Peak Demand for the Years (2014 - 2023)

3. The Challenges of Reforming the Electricity Sector

The main challenge for the Iraqi electrical power system is the loss of the ability to meet the load demand and the decrease in the percentage of available energy production from power stations. The energy installation from different power station types is shown in Fig.3. Due to several factors, including the decrease in available operational capabilities due to (i) The failure to complete the correct annual maintenance programs and rehabilitation work for the electrical system, the actual energy supply from these power stations is clear low in Fig.4 when comparison to installation capacity. Then (ii) Lack of sufficient financial allocations to complete investment projects affected the delay in installing and operating the complementary part of the highly efficient combined cycle gas stations, whose efficiency reaches 60% and with added capacities of 7,500 MW, without additional fuel. In addition to converting these allocations into operational allocations for purchasing energy from investors costs approximately $3 billion annually, (iv) The Ministry of Oil did not fulfill its obligations when preparing the fuel plan parallel to the program of implementation stages of the central electricity plan, due to its "reluctance and delay" in completing the particular infrastructure to provide the types of fuel required to operate electrical power production stations,(v) Burning more associated natural gas as evident in Fig. 5, due to failure to plan oil policy, with high amounts allocated to purchasing gas from neighbor countries, as fixed in the fuel plan, (vi) Bottlenecks in transporting the production loads of investment production stations whose locations were chosen ill-considered and imposed according to the requirements of investment companies, which caused high short-cycle levels in the regional national network due to the presence of large capacities of investment stations in small geographical locations.

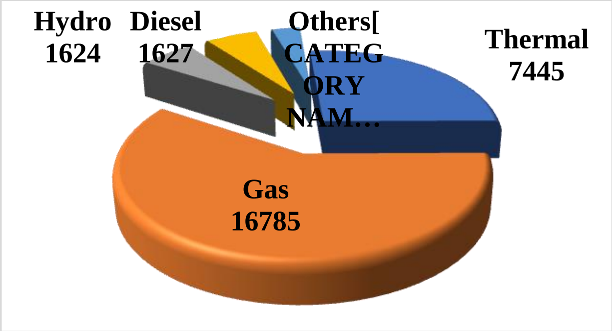

Fig.3 Install Capacities of Power Generation

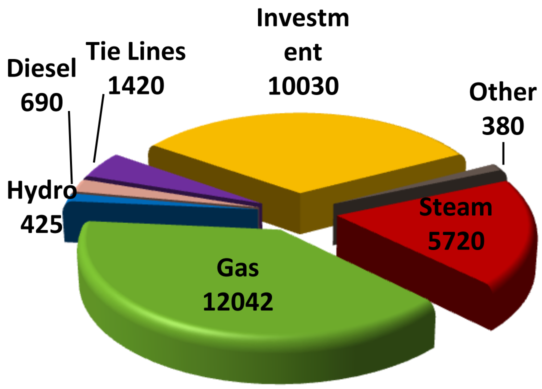

Fig.4 Available Capacities of Power Generation

Fig.5 Burning Associated Natural Gas

4. The reform plan in light of the decline in financial allocations to the electricity sector and its impact on energy supplies in Iraq.

Reforming the reality of the electrical network in its current state will reduce the percentage of the deficit between energy supply and demand for it. Still, it requires providing large financial allocations simultaneously with the rise in production costs annually and the decrease in revenues achieved as a result of the reasons mentioned, as well as the necessity of completing the projects outlined in the ministry's plans, so it has become necessary to search for other funding sources, to provide the essential funding for the required development and rehabilitation projects. The Ministry of Electricity is constantly developing ambitious plans to reform, rehabilitate and expand the national electrical power network. However, these plans often face a big issue with the lack or absence of financial allocations for the Ministry's investment budget, as the Ministry relies on financing its projects on the amount allocations to it within the country's general budget. This period was characterized by turmoil over previous years due to oil price fluctuations and the budget's 90% dependence on oil sales.

The Ministry's second resource, revenues from sales of electrical energy to consumers, is also declining, as administrative losses significantly affect this resource, as the amount of energy produced reached approximately (140) million (MWh) for the year 2022. An increase representing approximately (15%) of the energy produced in 2019 was approximately (122) million MWh. However, the amount of energy sold from the distribution networks to consumer types was approximately (55) million MWh only due to the administrative and technical losses in the network, which are estimated at around (60%) completely, divided into (40%) administrative losses and (20%) technical losses.

4.1 The first proposal for this study

The proposal is to establish a development investment fund that will attract local capital investments by providing an additional return represented by a specific interest rate that is estimated in a competitive framework with the market and then reinvesting these amounts in implementing projects with high returns that contribute to raising the Ministry's revenues from energy sales. The annual interest rate specified for these deposits will be paid through a certain percentage of the collection revenues collected, and an integrated economic cycle will be achieved, as shown in Fig (6).

In order to clarify the extent of the expected benefit when implementing this proposal, it was adopted to identify the network and smart meter project for the city of Baghdad as a targeted project to be financed by this fund, as this project aims to reduce technical and administrative losses in distribution networks, thus achieving high collection revenues for the amount of energy sold to all Consumer types.

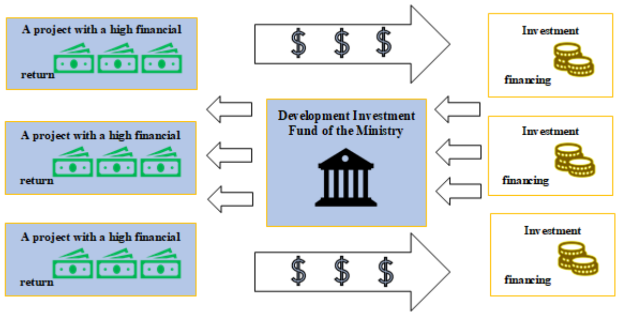

Fig. 6: An illustrative diagram of the proposed investment fund's working mechanism

The Baghdad distribution network was chosen as a geographical target to study data on consumers within this network and estimate the percentages of losses in it currently, based on the amount of electrical energy received and sold within the subs of this company, as shown in Table. (1)

In order to estimate the amounts of energy sold without administrative waste, the amount of energy received from the distribution networks was identified, as shown in Table (1), according to the types of consumers and the consumption categories within each category. The percentages of items and consumption categories appear as shown in Tables (1, 2, 3, 4) in Appendix No. 1, as (3) scenarios were assumed for estimating annual energy sales revenues in light of the percentages of technical and administrative losses in energy distribution networks after proceeding with the project. Reform and rehabilitation of the energy distribution sector, where revenues were estimated according to the amount of energy received, shown in Table (1) in light of the total percentage of technical and administrative losses in each case, where the first scenario includes a percentage of technical losses (10%) and administrative losses (30%). In contrast, the second scenario consists of a percentage of technical losses (7%) and administrative losses (15%), while the third scenario includes a percentage of technical losses (5%) and administrative losses (5%) as well.

In Appendix the Table (4) shows the variables based on which the financial analysis of the project was carried out. The value of the capital invested in the Development Investment Fund was assumed to be equal to the value of the investment cost of the network and smart meters project**.**
By reviewing Table (5) in the Appendix and adopting a payment period for the instalment of the invested capital payment of only one year, it is clear that the amount of the invested capital will be recovered within (7) years according to the data of the first scenario (technical losses (10%), administrative (30%) (one year of grace + (6) years of repayment). As for the second scenario (technical losses (7%), administrative losses (15%), the amount of capital invested in it is recovered within (5) years (one year of grace + (4) years of repayment), in addition to the third scenario (technical losses (5%), administrative losses (5%)), in which the amount of capital invested in it is recovered within (4) years (one year of grace + (3) years of payment), either If the grace period for repaying the invested capital is (3) years, then the recovery period according to the first scenario will be (9) years, the second scenario (7) years, and the third scenario (6) years, as shown in Fig. (1,2,3) in Appendix.

Table 1 shows the data of sub-distribution networks the Rusafa, Karkh, and Al-Sadr for 2022.

Sub	No. of consumer	Energy received MWh	Energy sold MWh	Loss %
Rusafa	331,209	7,376,512	3,106,951	58%
Al-Karkh	533,944	14,174,822	5,459,999	61%
Alsadr	377,206	9,296,727	2,871,822	69%
Total	1,242,359	30,848,061	11,438,772	63%

4.2 The second proposal for this study

A second proposal is to finance projects of utmost importance through borrowing from local banks. The same mechanism is applied in dealing with international banks, where the interest rate on the loaned capital is determined. This will stimulate the role of local banks in increasing local investments and reducing dependence on foreign investments, and politically, it will achieve stable electrical energy security.
The following are the requirements for implementing this proposal:

1- The decision granting the Central Bank the authority to lend to public energy production companies (self-financing) to implement these stations, provided that the loan is repaid annually from the energy purchase amounts (operating budget).
2- If it is not possible to implement Paragraph (1) for any legal reason, we suggest issuing a decision to establish a fund to finance thermal station projects using the (EPC-F) method, with an interest not exceeding (2%), and adopting the exact payment mechanism in Paragraph (1) above.
3- It suggests benefits from the Iraqi Banks Association Fund with the

Central Bank of Iraq (Tamkeen Initiative) [6] while proposing a mechanism for coordination between the Tamkeen Fund, the Iraqi Association of Banks, and all government agencies and institutions concerned.

To apply this proposal by calculating the loan value and interest according to the details and analysis of the construction cost (KW) with the following assumptions: -

- The capacity of the thermal station is (1400) MW.
- Adopting international prices for the average construction and turnkey cost (one million dollars per MWh) within three years.
- Interest rate (6%).
- Adopting a repayment period of 7 years.
- Productive life is up to 20 years.

The value of the annual payment amount to the bank, calculating interest during the construction period, is in Table (2):

Table (2) Annual loan payment value

Period payment	Annual payment based on an interest rate of 6%
1	275,867,928
2	275,867,928
3	275,867,928
4	275,867,928
5	275,867,928
6	275,867,928
7	275,867,928
Total payment	1,931,075,495

Table (3) Assumptions for estimating the energy produced and the station's operational costs.

Number of units and capacity of station	**MW٣٥٠×٤**
Total capacity of the station	MW١٤٠٠
Availability factor	%٨٩
Annual total hours	h ٧٧٩٦
Annual maintenance hours	h ٩٦٤
Performance factor	%٩٠
Annual energy produced	MWh ٩,٨٢٣,٤٦٤
Operation and maintenance costs, excluding fuel costs	5 $/MWh

From the data in Table (3), it is clear that the operation and maintenance expenses of the station are approximately $49 million annually, excluding the cost of fuel. An increase rate of (3%) has been estimated annually in the cost of operation and maintenance of the station to maintain the energy level produced. Fig. (7) shows a comparison of the annual costs between importing energy, purchasing it from investors, or building the station according to the proposal to finance the project with a loan from the Central Bank to the self-financing public company, as the annual operating costs of the project, including the amount of the loan payment and interest, are approximately $325 million. For (7) years, then it decreases after the end of the loan payment to a limit of $59 million, compared to the allocations for importing or purchasing energy, which range from $548 billion annually to purchase energy from the investor (steam station) to $1.177 billion annually. To import energy from neighboring countries and $450 billion to purchase energy from investment stations (combined cycle).

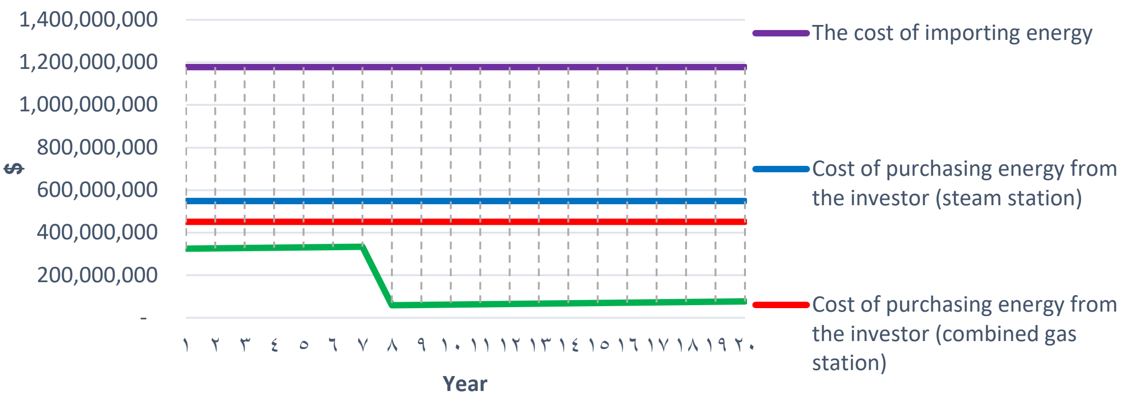

Fig.7 A comparison of the annual costs of importing energy, purchasing it from an investor, or building a steam station financed through a local loan.

Fig.(8) shows a comparison of the total costs paid at the end of the year (20) between cases of importing energy or purchasing it from investment power stations(thermal investment plants or combined gas power stations) with the proposal to finance the project by relying on a local loan with an interest rate of (6%).

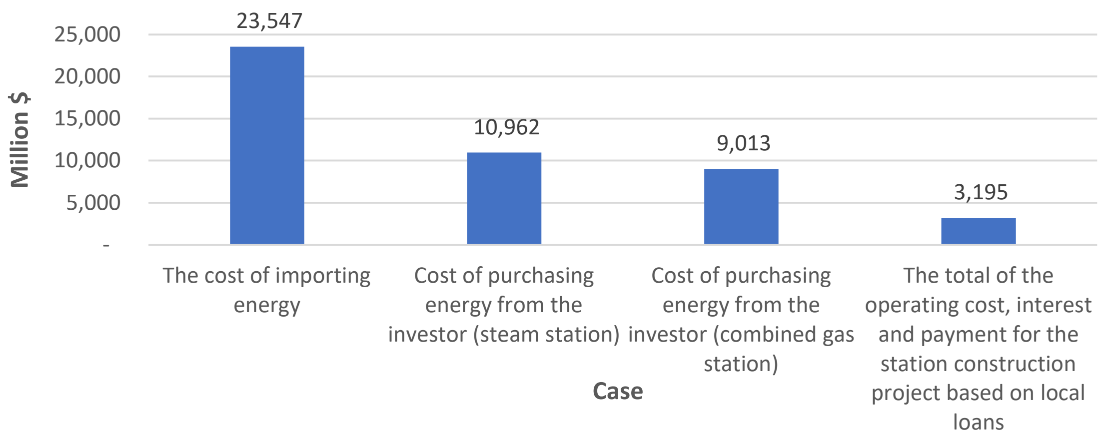

Fig. (8) Comparison of the total amounts paid for four cases

According to these results, it is clear that there is economic feasibility in continuing with this proposal to implement important projects, thus reducing the amount of energy deficit, improving the ministry's infrastructure, reducing operational expenses in the short and long term, and achieving stability in the supply of electrical energy.

5. Conclusion

The main goal of the ministry of electricity is to supply the consumer with reliable energy service (no energy shortage). This requires preparing an overall rehabilitation program for the electrical power system to increase the available capabilities by carrying out a maintenance and rehabilitation campaign for electricity generation plants to increase the energy production. Then, accelerating the completion of the suspended projects whose implementation work has been resumed as a plan to increase energy savings over the next two years. Furthermore, it requires developing the electric power transmission sector in a way that is commensurate with the expansion of production capabilities and the removal of bottlenecks determined by the flow of electrical loads through adhering to the data of the load flow program and the stability of the electrical network. Accordingly, two appropriate proposals were presented to secure the necessary financial allocations to implement the comprehensive repair and rehabilitation process of the electrical system.

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Table 1 (Estimation of energy sales revenues (ID) according to the amount of energy received (technical losses (10%) and administrative losses (30%)

Classify	Consumption categories	Percentage of units sold	Percentage of energy sold out of annual total energy	Percentage of energy sold out of annual total energy	Price (ID/KWh)	The revenue from selling energy without technical losses
Residential	1-500	12.20%	8.30%	1,535,855	10	15,358,545,435
	501-1000	34.96%	23.79%	4,402,705	10	44,027,048,679
	1001-1500	38.14%	25.95%	4,802,579	10	48,025,787,203
	1501-2000	5.06%	3.44%	637,580	35	22,315,302,102
	2001-3000	5.04%	3.43%	634,478	35	22,206,743,283
	3001-4000	1.52%	1.04%	191,874	80	15,349,905,851
	٤٠٠٠ -More	3.07%	2.09%	386,685	120	46,402,214,286
	Total	**100.00%**	**68.03%**	**12,591,756**		**213,685,546,839**
Commercial	1-1000	34.50%	2.17%	401,105	60	24,066,304,516
	1001-2000	15.32%	0.96%	178,129	80	14,250,342,378
	2001-3000	6.88%	0.43%	80,034	120	9,604,044,430
	3001-4000	3.91%	0.25%	45,485	120	5,458,181,285
	٤٠٠٠ -More	39.38%	2.47%	457,763	120	54,931,546,295
	Total	**100.00%**	**6.28%**	**1,162,516**		**108,310,418,904**
Industrial	0.4 K.V	13.15%	1.68%	310,124	60	18,607,466,579
	11 K.V	45.09%	5.74%	1,063,191	60	63,791,449,389
	33 K.V	11.54%	1.47%	272,136	60	16,328,146,576
	132 K.V	30.22%	3.85%	712,614	60	42,756,854,151
	Total	**100.00%**	**12.74%**	**2,358,065**		**141,483,916,695**
Government	1-5000	10.17%	1.17%	215,905	120	25,908,540,579
	5001-10000	5.88%	0.67%	124,930	120	14,991,598,793
	10001-20000	10.16%	1.17%	215,785	120	25,894,207,539
	20001-40000	7.82%	0.90%	166,084	120	19,930,078,823
	٤٠٠٠ -More	65.96%	7.57%	1,400,573	120	168,068,729,036
	Total	**100.00%**	**11.47%**	**2,123,276**		**254,793,154,770**
Agricultural	**Total**	**100.00%**	**1.48%**	**273,224**	**60**	**16,393,423,806**
Total				**18,508,837**		**734,666,461,014**

Table (2) Estimation of energy sales revenues (ID) according to the amount of energy received (technical losses (7%) and administrative losses (15%))

Classify	Consumption categories	Percentage of units sold	Percentage of energy sold out of annual total energy	Percentage of energy sold out of annual total energy	Price (ID/KWh)	The revenue from selling energy without technical losses
Residential	1-500	12.20%	8.30%	1,996,611	10	19,966,109,065
	501-1000	34.96%	23.79%	5,723,516	10	57,235,163,283
	1001-1500	38.14%	25.95%	6,243,352	10	62,433,523,364
	1501-2000	5.06%	3.44%	828,854	35	29,009,892,732
	2001-3000	5.04%	3.43%	824,822	35	28,868,766,268
	3001-4000	1.52%	1.04%	249,436	80	19,954,877,606
	٤٠٠٠-More	3.07%	2.09%	502,691	120	60,322,878,572
	Total	**100.00%**	**68.03%**	**16,369,282**		**277,791,210,891**
Commercial	1-1000	34.50%	2.17%	521,437	60	31,286,195,871
	1001-2000	15.32%	0.96%	231,568	80	18,525,445,092
	2001-3000	6.88%	0.43%	104,044	120	12,485,257,759
	3001-4000	3.91%	0.25%	59,130	120	7,095,635,670
	٤٠٠٠ -More	39.38%	2.47%	595,092	120	71,411,010,184
	Total	**100.00%**	**6.28%**	**1,511,271**		**140,803,544,576**
Industrial	0.4 K.V	13.15%	1.68%	403,162	60	24,189,706,553
	11 K.V	45.09%	5.74%	1,382,148	60	82,928,884,206
	33 K.V	11.54%	1.47%	353,777	60	21,226,590,548
	132 K.V	30.22%	3.85%	926,399	60	55,583,910,396
	Total	**100.00%**	**12.74%**	**3,065,485**		**183,929,091,703**
Government	1-5000	10.17%	1.17%	280,676	120	33,681,102,753
	5001-10000	5.88%	0.67%	162,409	120	19,489,078,431
	10001-20000	10.16%	1.17%	280,521	120	33,662,469,801
	20001-40000	7.82%	0.90%	215,909	120	25,909,102,470
	٤٠٠٠ -More	65.96%	7.57%	1,820,745	120	218,489,347,746
	Total	**100.00%**	**11.47%**	**2,760,259**		**331,231,101,201**
Agriculture	**Total**	**100.00%**	**1.48%**	**355,191**	**60**	**21,311,450,947**
Total				**24,061,488**		**955,066,399,319**

Table (3) Estimation of energy sales revenues (dinars) according to the amount of energy received (technical losses (5%) and administrative losses (5%))

Classify	Consumption categories	Percentage of units sold	Percentage of energy sold out of annual total energy	Percentage of energy sold out of annual total energy	Price (ID/KWh)	The revenue from selling energy without technical losses
Residential	1-500	12.20%	8.30%	2,303,782	10	23,037,818,152
	501-1000	34.96%	23.79%	6,604,057	10	66,040,573,018
	1001-1500	38.14%	25.95%	7,203,868	10	72,038,680,805
	1501-2000	5.06%	3.44%	956,370	35	33,472,953,153
	2001-3000	5.04%	3.43%	951,718	35	33,310,114,925
	3001-4000	1.52%	1.04%	287,811	80	23,024,858,776
	٤٠٠٠ -More	3.07%	2.09%	580,028	120	69,603,321,429
	Total	**100.00%**	**68.03%**	**18,887,633**		**320,528,320,259**
Commercial	1-1000	34.50%	2.17%	601,658	60	36,099,456,774
	1001-2000	15.32%	0.96%	267,194	80	21,375,513,567
	2001-3000	6.88%	0.43%	120,051	120	14,406,066,645
	3001-4000	3.91%	0.25%	68,227	120	8,187,271,927
	٤٠٠٠ -More	39.38%	2.47%	686,644	120	82,397,319,443
	Total	**100.00%**	**6.28%**	**1,743,774**		**162,465,628,357**
Industrial	0.4 K.V	13.15%	1.68%	465,187	60	27,911,199,869
	11 K.V	45.09%	5.74%	1,594,786	60	95,687,174,084
	33 K.V	11.54%	1.47%	408,204	60	24,492,219,863
	132 K.V	30.22%	3.85%	1,068,921	60	64,135,281,227
	Total	**100.00%**	**12.74%**	**3,537,098**		**212,225,875,042**
Government	1-5000	10.17%	1.17%	323,857	120	38,862,810,869
	5001-10000	5.88%	0.67%	187,395	120	22,487,398,190
	10001-20000	10.16%	1.17%	323,678	120	38,841,311,308
	20001-40000	7.82%	0.90%	249,126	120	29,895,118,235
	٤٠٠٠ -More	65.96%	7.57%	2,100,859	120	252,103,093,553
	Total	**100.00%**	**11.47%**	**3,184,914**		**382,189,732,155**
Agriculture	**Total**	**100.00%**	**1.48%**	**409,836**	**60**	**24,590,135,709**
Total				**27,763,255**		**1,101,999,691,521**

Table (4) Variables based on which the project's financial analysis was conducted

The value of the capital invested in the fund($)	**462,213,272**
Interest rate	8%
The value of the annual interest rate	36,977,062
The investment cost of the project	462,213,272
The percentage of the collection returned to the fund	20%
Period of payments(year)	3
Exchange rate	1320
Energy sales revenue ($) according to scenario 1	**556,565,501**
The value of the collection percentage belonging to the fund ($) according to the first scenario	**111,313,100**
Energy sales revenue ($) according to scenario 2	**723,535,151**
The value of the collection percentage belonging to the fund ($) according to the second scenario	**144,707,030**
Energy sales revenue ($) according to scenario 4 (technical %5, administrative %5)	**834,848,251**
The value of the collection percentage belonging to the fund ($) according to the third scenario	**166,969,650**

Table. (5): Summary of the project's financial analysis, with a grace period of only one or three years

Scenario	**The fund's annual revenue from collection ($)**	**The investment cost of the project ($)**	**The value of the interest rate on the capital invested in the fund (%٨)**	**The payments for recovering the remaining invested capital after paying the interest rate**	**The recovery period for the amount of capital invested in the financing fund is based on a grace period of (1) year**	**The recovery period for the amount of capital invested in the financing fund is based on a grace period of (3) year**
First scenario (10% technical losses, 30% non-technical losses)	111,313,100	٤٦٢,٢١٣,٢٧٢	36,977,062	٧٤,٣٣٦,٠٣٨	٧.٢	٩.٢
First scenario (7% technical losses, 15% non-technical losses)	144,707,030	٤٦٢,٢١٣,٢٧٢	36,977,062	١٠٧,٧٢٩,٩٦٨	٥.٣	٧.٣
First scenario (5% technical losses, 5% non-technical losses)	166,969,650	٤٦٢,٢١٣,٢٧٢	36,977,062	١٢٩,٩٩٢,٥٨٨	٤.٦	٦.٦

Fig. (1) Net payment of the value of invested capital according to the first scenario technical losses 10%, administrative losses 30%

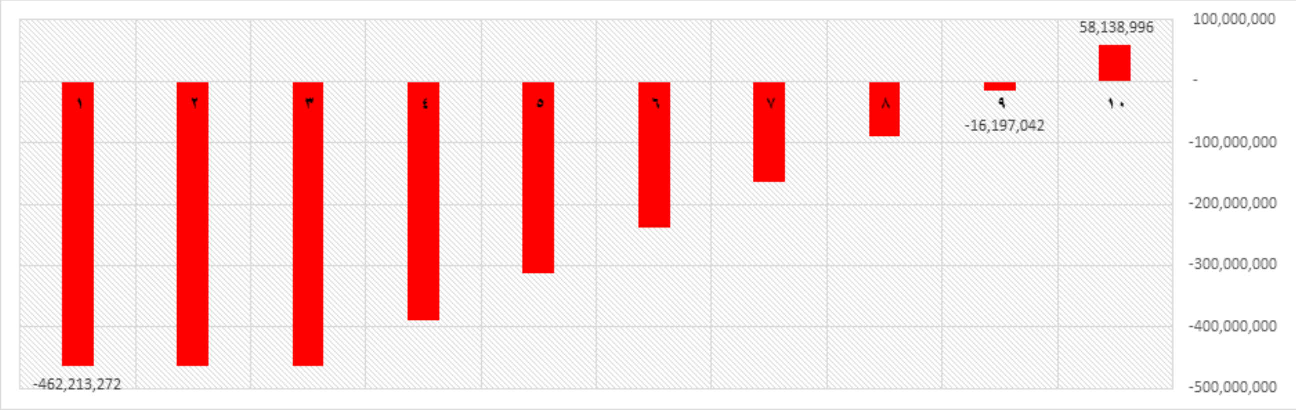

Fig. (2) Net repayment of the value of invested capital according to the second scenario technical losses 7%, administrative losses 15%

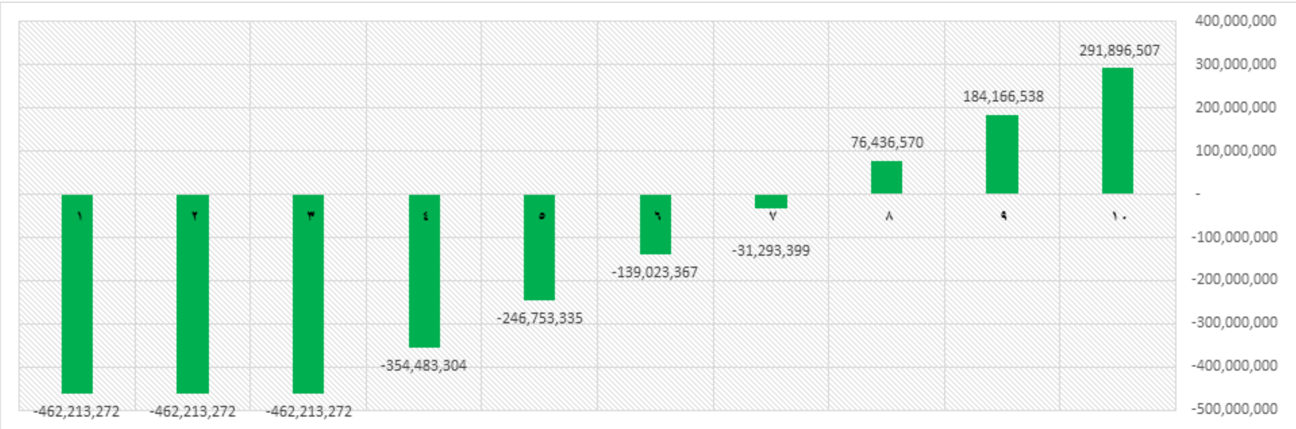

Fig. (3) Net payment of the value of invested capital according to the first scenario technical losses 5%, administrative losses 5%