

# Economic Analysis of The Egyptian and Jordanian Electric Power Proposals

Antonio Kahwach  
*Mechanical Engineering Student*  
*American University of Beirut*  
Beirut, Lebanon

Hassan Khanafar  
*Mechanical Engineering Student*  
*American University of Beirut*  
Beirut, Lebanon

Jihad Jundi  
*Mechanical Engineering Student*  
*American University of Beirut*  
Beirut, Lebanon

Michael Jabra  
*Mechanical Engineering Student*  
*American University of Beirut*  
Beirut, Lebanon

**Abstract**—This report will study the feasibility of the two proposals that the Lebanese government is working on to increase the amount of electricity provided: the Jordanian Electricity and the Egyptian Natural Gas. After analyzing the gathered information, we find that the price of one KWh that makes the proposals attractive is found by using Benefit Cost Ratio economic tool. The environmental effects of the undergoing these proposals are also studied and found very appealing. Consequently, the proposals are deemed attractive for implementation.

## I. FINAL PROPOSAL AGREEMENTS

The final agreement is as follows:

- Importing electricity from Jordan will cost Lebanon about \$200 million per year [8].
- will entail supplying Lebanon with 150 MW of power between the hours of midnight and 6am, then 250 MW for the remaining 18 hours [3]
- Electricity is expected to be transferred from Jordan towards the Syrian border area of Deraa, then through Damascus. It would arrive in Lebanon at Ksara's substation [4].
- The Syrian government will keep a small portion of the gas sent by Egypt as in-kind payment for transit services to avoid cash transfers that could breach US sanctions, Lebanon's Energy Ministry said [4].
- a \$250 million loan might potentially be given to the Lebanese government [5].
- Lebanon is expecting to receive 60 to 65 million cubic feet of Egyptian gas daily for a minimum of 10 years [2].

## II. JORDANIAN ELECTRICITY

The deal with Jordan will provide Lebanon with up to 250 megawatts of electricity during the day and 150 megawatts at night, equivalent to a total of two additional hours of power. Considering Lebanon is currently in an estimated power shortage of 1,500 MW/day, Jordan's provided energy will not be enough to overcome this shortage; however, it would decrease the present power gap by 15 to 30 percent. Hence,

increasing Lebanon's present daily electric power supply by a significant 35 to 60 percent [7].

In 2020, Jordan produced a surplus of approximately 2,800 GW/hour. Hence, the goal of providing 400 MW/day to Lebanon can be reached according to this data [7].

The price of importing this electricity from Jordan will cost Lebanon \$200 million annually [8]. Lebanon will also need to rehabilitate the National Control Center and EDL main building, which will cost approximately US\$15 million [6].

## III. EGYPTIAN GAS

The deal with Egypt will provide Lebanon with 60 to 65 million cubic feet of Egyptian gas daily. Egypt produces an estimated 7.2 billion cubic feet of natural gas daily, while its average domestic consumption is approximately 5.8 billion cubic feet daily. Hence, it has a surplus of 1.4 billion cubic feet of natural gas, making it capable of exporting the agreed upon amount to Lebanon without affecting its own need [7].

If the plan were to be implemented, Egyptian gas would be transported to Lebanon by pumping it through the Arab Gas Pipeline from north Sinai through Jordan, to the Jordanian-Syrian border, then to the city of Homs, until it reaches the Deir Ammar area in Lebanon. The total length of this pipeline is 1,200 km [9].

However, the Arab Gas Pipeline is currently not in service and in need of maintenance. it is under low pressure and leaks are being inspected according to Tripoli Oil Installations.

It is important to note that Deir Ammar power plant is capable of being operated with natural gas; however, the Egyptian gas pipeline is broken and it would take approximately 6 to 7 weeks to repair the Lebanese side of the pipeline with an estimated cost of \$1 million [7]. Also, \$595.654 million are needed for the project of the Deir

Expenditure	Initial(\$million)	Annual(\$million)
Electricity from Jordan	-	200
Gas from Egypt	-	164.9-178.65 starting 2026
Repairs to Arab Gas Line	1	-
Der Ammar Thermal Power Plant Project	-	148.913 for 4 years starting now
Rehabilitation of the National Control Center and EDL main building	15	-

TABLE I: Expenses

Ammar power plant, which is going to be spanning 4 years. Therefore, we will assume the payment to be equally divided from 2022 till 2025 [10].

It should be taken into account that Deir Ammar thermal plant will begin producing electricity in 2025, hence no natural gas will be bought from Egypt until then.

#### IV. LEBANON'S EXPENSES

Assuming the price of Egyptian gas remains at an average of \$ 7.53 per thousand cubic feet. The expenses for the Lebanese government can be summarized in the the following table:

$$Cost = \$7.53 * 60mil * 365 = \$164.9million/yr \quad (1)$$

Similarly, for 65 cubic feet of natural gas, the cost would be \$ 178.65 million.

Assuming the funds needed for the Der Ammar thermal power plant project and the rehabilitation of the National Control Center and EDL main building are paid initially.

The cost of connecting the Jordanian power line to the grid is not accounted for, and the cost of generating power using Egyptian gas by Lebanon is not included, since Deir Ammar power station is already capable of generating power using gas and no modifications are needed to the plant.

#### V. WORLD BANK LOAN

The loan is a \$250 million loan [5] with a front end fee of 0.25% of the original amount and a commitment fee of 0.25%. Assuming the maturity of the loan is 8 years, the loan interest rate will be 1.07% [1].

#### VI. ENVIRONMENTAL PROBLEMS

Deir Ammar plant switching from the use of diesel to natural gas for energy generation will embark on significant environmental benefits, especially in terms of reducing air pollutant emissions and Green House Gas emissions ,the amount emitted by burning natural gas is 30% less than the amount emitted by burning diesel. Considering that many complaints have been filed against Deir Ammar power plant in the past due to air and marine pollution, the use of natural gas will lead to a significant environmental benefit [11].

To quantitatively analyze how much CO2 is being emitted, it is noted that 0.0551 kg CO2 is produced per cubic foot of natural gas, while 10.18 kg of CO2 is produced per gallon of diesel which is equivalent to 1.361 kg of CO2 per cubic foot of diesel. one cubic foot of natural gas provides 1000 Btu, while one cubic foot of diesel provides 18581.66 Btu. Hence, we obtain a ratio of  $5.51 * 10^{-5}$  CO2/Btu for natural gas and  $7.32 * 10^{-5}$  CO2/Btu for diesel [12]. Therefore, transitioning from the use of diesel to natural gas will result in an approximately 25% decrease in CO2 emissions, making this proposal environmentally appealing.

#### VII. AVAILABILITY OF ELECTRICAL POWER

The power provided by Jordan is 250 MW for 18 hours and 150 MW for 6 hours per day, obtaining a total of 5400 MWh per day, while the equivalent power generated from the natural gas provided from Egypt is 17584 MWh per day if we consider each cubic foot of natural gas producing 1000 Btu [13]. Obtaining a total of approximately 23000 MWh per day or an average of 958 MW over the entire day. Considering Lebanon needs about 3600 MW daily and is only producing 700 MW which is enough for approximately 4.7 hours of electricity per day. This plan will provide almost an additional 6.4 hours of electricity per day in Lebanon if implemented.

#### VIII. CASH FLOWS

The Lebanese Government interest rate is 7.75%. Taking the price of 1 Kwh to be  $P$ . we assume we start receiving electricity from Jordan in 2023, and the Lebanese government start receiving natural gas from Egypt in 2026. The Lebanese government will receive the loan and pay the commitment and the initial front fee to the World Bank in 2022 and pay an annual amount of \$2.675 million from 2023 till 2030, where the loan will reach maturity and \$250 million will be paid. The Lebanese government will also pay for the rehabilitation of the National Control Center, EDL main building and Arab Gas Station in 2022. Annual payment for the Deir Ammar thermal power plant will be made starting now in 2022 until 2025.

#### IX. ECONOMIC ANALYSIS

The Lebanese government receives from 2023 to 2025  $P * 5400(10^3) * 365$  annually and from 2026 to 2030  $P * 23000(10^3) * 365$  annually.

For the economic analysis, the Benefit Cost Ratio economic tool will be used, and it will be evaluated using present worth. Based on Fig. 1, the following can be obtained:

For the world bank:

$$PW(t = 0) = 250 - 2(0.625) - 2.675(P/A, 8, 7.75\%) - 250(P/F, 8, 7.75\%) = \$95.635 \text{ million.}$$

For Jordan:

$$PW(t = 0) = -200(P/A, 8, 7.75\%) = -\$1160 \text{ million.}$$

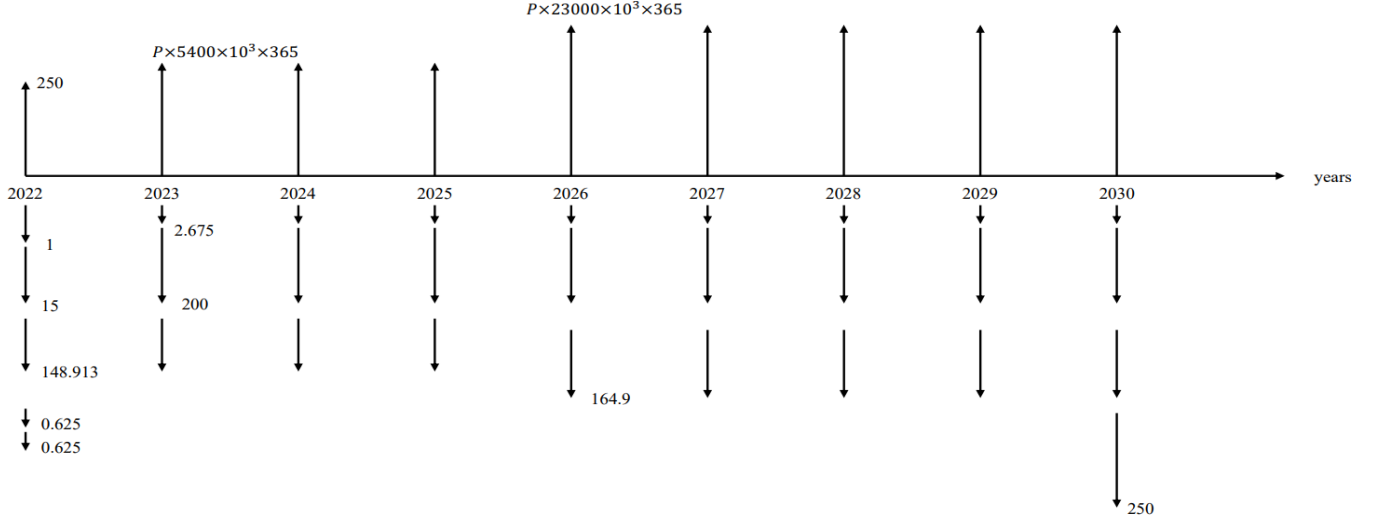


Fig. 1: Cash Flow Diagram

For Egypt:

$$PW(t = 0) = -164.9(P/A, 5, 7.75\%)(P/F, 3, 7.75\%) = -\$529,798 \text{ million.}$$

For the Repair of Arab Gas Line and Rehabilitation of National Control Center and EDL:

$$PW(t = 0) = -\$16 \text{ million.}$$

For the Deir Ammar Thermal Power Plant:

$$PW(t = 0) = -148.913 - 148.913(P/F, 3, 7.75\%) = -\$534.43 \text{ million.}$$

For the cost paid by citizens:

$$PW(t = 0) = P * 5400(10^3) * 365(P/A, 3, 7.75\%) + P * 23000(10^3) * 365(P/A, 5, 7.75\%)(P/F, 3, 7.75\%) = \$P * 3.207(10^{10}) \text{ million.}$$

Considering the world bank present worth as a benefit, the payments to Jordan, Egypt, for repairing the Arab Gas Line, Rehabilitating the National Control Center and EDL, and Funding the Project of the Deir Ammar power plant as costs. The cost of KWh obtained from citizens to the government is considered as a benefit.

#### X. KW-HR PRICE

For this proposal to be worth undergoing under Benefit Cost ratio economic tool, we need  $B/C = 1$  at least. Therefore,

$$B/C = \frac{P*3.207(10^{10})+95.635}{1160+529.789+1+15+534.43} = 1$$

After evaluating the above equality, we obtain that the cost of KWh  $P$  is equal to \$0.07.

#### XI. REFLECTION ON THE PROPOSAL

Considering that the price of KWh is only \$ 0.07 for this proposal to be appealing, which is relatively cheap since the average price of KWh for households is \$0.125 [14]. The environmental effects caused by using Natural Gas and importing electricity from Jordan instead of producing it here are positive. The expected 6.4 extra hours of electricity produced from this proposal are also very appealing. Therefore, undergoing these two proposals is highly advised for the Lebanese government.

#### REFERENCES

- [1] "Lending Rates & Fees." World Bank, <https://treasury.worldbank.org/en/about/unit/treasury/ibrd-financial-products/lending-rates-and-fees>.
- [2] Lebanese wait to fill their gas cylinders in the southern city of Sidon amidst a deepening economic crisis, on Aug. 10, et al. "Egypt Ready to Pump Gas to Lebanon." Al, <https://www.al-monitor.com/originals/2021/12/egypt-ready-pump-gas-lebanon>.
- [3] Person. "Jordan to Sign Deal to Supply Lebanon with Electricity - Energy Minister." Reuters, Thomson Reuters, 19 Jan. 2022, <https://www.reuters.com/world/middle-east/jordan-sign-deal-supply-lebanon-with-electricity-energy-minister-2022-01-19/>.
- [4] Rose, Sunniva, and Khaled Yacoub Oweis. "Jordan to Sign Electricity Deal with Lebanon next Week, Minister Says." The National, The National, 19 Jan. 2022, <https://www.thenationalnews.com/mena/lebanon/2022/01/19/jordan-to-sign-electricity-deal-with-lebanon-next-week-minister-says/>.
- [5] Sewell, Abby. "Jordanian, Syrian and Lebanese Officials Sign Electricity Deal, but Details Remain Unclear." L'Orient Today, L'Orient Today, 26 Jan. 2022, <https://today.lorientlejour.com/article/1288817/jordanian-and-lebanese-officials-sign-deal-to-import-electricity-to-lebanon-via-syria-but-the-plans-details-remain-unclear.html>.

- [6] "Setting Lebanon's Electricity Sector on a Sustainable Growth Path." Lebanese Republic Ministry of Energy and Water, Lebanese Republic Ministry of Energy and Water, [https://energyandwater.gov.lb/mediafiles/articles/doc-100778-2022\\_03\\_31\\_10\\_22\\_46.pdf](https://energyandwater.gov.lb/mediafiles/articles/doc-100778-2022_03_31_10_22_46.pdf).
- [7] "Power to the People? Scrutinizing the U.S.-Arab Effort to Supply Energy to Lebanon via Syria." Washington Institute, <https://www.washingtoninstitute.org/media/5176>.
- [8] France 24. "Lebanon to Sign Electricity Deal with Jordan Next Week: Minister." France 24, France 24, 21 Jan. 2022, <https://www.france24.com/en/live-news/20220121-lebanon-to-sign-electricity-deal-with-jordan-next-week-minister-1>.
- [9] Sewell, Abby. "Jordanian, Syrian and Lebanese Officials Sign Electricity Deal, but Details Remain Unclear." L'Orient Today, L'Orient Today, 26 Jan. 2022, <https://today.lorientlejour.com/article/1288817/jordanian-and-lebanese-officials-sign-deal-to-import-electricity-to-lebanon-via-syria-but-the-plans-details-remain-unclear.html>.
- [10] Carmen, et al. "Deir Ammar Temporary Power Plant, Lebanon." Power Technology, 6 Dec. 2021, <https://www.power-technology.com/marketdata/deir-ammar-temporary-power-plant-lebanon/>.
- [11] Dimaratos, Athanasios, et al. "Assessment of CO<sub>2</sub> and NO<sub>x</sub> Emissions of One Diesel and One Bi-Fuel Gasoline/CNG Euro 6 Vehicles during Real-World Driving and Laboratory Testing." Frontiers, Frontiers, 1 Jan. 1AD
- [12] EPA, Environmental Protection Agency, <https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references>
- [13] "Control Specialties." Control Specialties Inc., <https://www.control-specialties.com/blog/BTUs-IN-NATURAL-GAS-AND-PROPANE/>.
- [14] "Lebanon Electricity Prices, September 2021." GlobalPetrolPrices.com, [https://www.globalpetrolprices.com/Lebanon/electricity\\_prices](https://www.globalpetrolprices.com/Lebanon/electricity_prices)