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TECHNICAL CHALLENGES FACING ELECTRICAL POWER SECTOR IN JORDAN

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Abstract

Electricity energy sector in Jordan faces many problems represented by its dependency on oil and gas as source of such energies, losses and inefficient in production and distribution. This paper presents most of problems faces electrical energy sector in Jordan, its causes, its effects and suggested solutions. Problems and challenges and suggested solutions are summarized in seven main areas: First: Sources of electricity generated, second: growth of electricity demand, third: Electricity generating alternative resources, fourth: electricity networks connection and import, fifth: cost analysis, sixth: promising solutions and finally government laws and regulations.

Keywords: *Electricity, Challenges, Jordan, Demand, Energy.*

1. INTRODUCTION

Energy use has increased rapidly over the last decade, placing the Kingdom under severe economic strain. However, this increase has not been followed by effective public awareness efforts or robust legislation controlling national building standards. This circumstance necessitates the use of energy-saving strategies, particularly the standardization of energy-efficient devices, as well as changes in consumer behavior. This method not only decreases energy resource prices, increases energy independence, and reduces energy-related greenhouse gas (GHG) emissions, but it also offers up new opportunities for technological innovation. As a result of increased energy consumption and per capita energy intensity during the last decade, Jordan imports the majority of its energy resources (oil, coal, and natural gas). When compared to 2016, primary and final energy consumption increased by 4.1 and 5.1%, respectively. Furthermore, the overall cost of energy utilized in 2017 was around 2.429 billion JOD, an increase from 1.924 billion JOD the previous year. As energy imports and consumption rise, Jordan will need to employ cutting-edge technology to attain energy independence. The main challenges for electrical energy in Jordan are slow implementation of EE plans, a lack of public awareness of the benefits of EE, an inaccessible database and a lack of clear information, a lack of oversight in implementing Jordanian building codes, the need for new articles to the EE Applications Law, and insufficient funding for EE projects for low-income households (Khashman et al., 2016). Furthermore, power loss and cheating are serious problems. Jordan's long-term growth is reliant on the energy sector. However, it is a necessary infrastructure for Jordanian society to function; on the other hand, high primary energy prices put a significant strain on the Jordanian economy. This load is mostly the result of a reliance on energy imports such as oil and gas, as well as price and supply quantity variations. Between 2000 and 2021, there was a continuous increase in power demands, with an average increase in consumption of 6.8%. Table 1 shows the Jordan-yearly Electricity consumption (Billion kWh) for the years 2000-2021.

Table 1 Jordan-Yearly Electricity consumption (Billion kWh) [Source: Ministry of Energy (2021)].

Year	Yearly Electricity consumption (Billion kWh)
2000	6.1
2001	6.59
2002	7.09
2003	6.86
2004	6.86
2005	7.09
2006	7.96
2007	8.39
2008	9.85
2009	9.58
2010	10.4
2011	10.4
2012	11.3
2013	13.54
2014	13.54
2015	14.00
2016	14.56
2017	16.00
2018	16.82
2019	16.82
2020	16.82
2021	17.00

Jordan's electricity consumption is rapidly increasing, with an average yearly increase of 7.4 percent from 3,000 MW in 2012 to 15,000 MW in 2040. 2011, Worley Parsons. According to a 2014 announcement by Jordan's Energy Minister, Jordan's power consumption is predicted to treble by 2030. NEPCO, on the other hand, revises its forecast, forecasting slower growth and electricity consumption of 4,300 MW by 2020 and 8,130 MW by 2030 (Abu-Rumman, 2020; NEPCO Statistics, 2015).

In Jordan, approximately 39% of primary energy is used for power generation, with the majority of this energy coming from natural gas and oil (EDAMA, 2019). According to NEPCO, imported natural gas accounted for 93 percent of energy generation in 2018. Jordan Times (Jordan, 2020). The remaining energy was generated via crude oil, solar, and hydropower. Until the 2003 Iraq War, the vast majority of electricity was generated using crude oil acquired at below-market prices from Iraq. As a result, Egyptian natural gas gradually replaced Iraqi crude oil. The situation remained unchanged until 2010, when Egypt's interruptions forced natural gas deliveries to Jordan to halt, leaving the country to rely on crude oil. In 2015, energy generation shifted back to less expensive natural gas (Sandri et al., 2020).

2. LITERATURE REVIEW

The escalating cost of electricity presents a significant challenge for consumers worldwide, with particular severity in Jordan. Energy, as an indispensable prerequisite for social, economic, and urban development, has garnered substantial scholarly attention across various nations (Erős et al., 2022; Jaber, Badran, and Abu-Shikhah, 2003;

Loska, Wiechuła and Korus, 2004). Global population growth has contributed to an increased demand for energy resources (Leong Cheng et al., 2022; Al-Hamamre et al., 2017; Shahbaz, Chaudhary and Ozturk, 2017), leading to a surge in energy consumption in urbanized regions like Jordan (Zhao and Zhang, 2018; Kazim, 2007; Al-Mulali and Ozturk, 2015; Shahbaz and Lean, 2012). Scholars contend that Jordan's rapid development, in part, stems from its longstanding acceptance of refugees, which has notably augmented the nation's electricity consumption (Jaber, Marahleh and Dalabeeh, 2019; El Hanandeh, 2014; Meaton and Alnsour, 2012). Moreover, projections anticipate a substantial rise in fossil fuel demand driven by population growth (Baz et al., 2021; Baz et al., 2017).

Despite possessing abundant oil shale resources, Jordan remains reliant on petroleum imports from neighboring countries (Jordan News, 2022; Hrayshat, 2007), contributing to significant greenhouse gas emissions per capita due to continued dependence on fossil fuels (Trading Economics, 2021).

Jordan's electricity sector has been a focal point of extensive research efforts. Sandri et al. (2020) emphasized the formidable challenges posed by Jordan's dearth of natural resources, coupled with regional instability and conflict, in securing energy resources. Through desk research and expert interviews, their study evaluated the current state of Jordan's energy sector, identifying key obstacles and outlining future objectives. This endeavor enriches discussions on ensuring the environmental, economic, social, and political sustainability of Jordan's energy sector. Jordan's energy security, historically intertwined with its relations with neighboring nations, exposes it to international shocks and political events. Despite reform initiatives, energy security remains pivotal due to extensive energy imports and limited success in diversifying the energy mix, with approximately 94% of energy imported, constituting about 10% of GDP. The escalating domestic demand, growing at a rate of 3% annually, underscores the urgency of developing a more sustainable energy industry. Addressing these challenges necessitates investments in renewable energy, enhanced energy efficiency measures, and collaborative partnerships with other countries. The pivotal role of governance in effective implementation of these initiatives was highlighted by experts. Establishing a shared vision for a sustainable energy sector and fostering collaboration among key stakeholders are deemed essential for creating an enabling environment for sustainable energy development.

Furthermore, Abu-Rumman et al. (2020) conducted a detailed assessment of Jordan's energy landscape, exploring the potential for direct investments in renewable energy resources. Despite efforts to promote alternative energy sources, clean energy's contribution remains low, at around 7% of global energy use. The study reviewed the national power supply and demand dynamics, along with government programs, financial incentives, and tax breaks aimed at encouraging renewable energy projects. Jordan's renewable energy plan, with ambitious targets of $20 billion in investments and enhanced energy efficiency, offers promising opportunities for clean energy investors and developers. Notably, bids for 2,000 MW wind and solar energy projects are currently open, highlighting the momentum towards sustainable energy development in the region.

Additionally, Fichter et al. (2014) provided insights into Jordan's electricity sector, noting a significant increase in peak load and annual power demand. The study projected a need for up to 3,000 MW of new power production capacity over the next decade to meet escalating energy demand while ensuring supply security. Jordan's existing power plant portfolio predominantly relies on traditional fossil fuel-fired plants, underscoring the imperative for diversification and incorporation of renewable energy technologies.

In conclusion, the literature underscores the multifaceted challenges and opportunities in Jordan's electricity sector, emphasizing the urgency of transitioning towards a more sustainable and resilient energy future.

3.CHALLENGES OF ENERGY SECURITY AND ITS SUSTAINABILITY IN JORDAN

The main difficulty confronting Jordan's power sector is that supply should surpass demand, but no investments have been attracted in the previous seven to eight years. The key difficulties are regulations and a defined institutional setup: without these, no transformation would be feasible. Price, availability, and accessibility are the key impediments to diversifying sources: in Jordan, this reflects technical challenges with the need to expand

infrastructure, as well as changes in interests. The actors in the electricity sector, for example, are among the most influential groups battling the move. Consumption patterns must also be addressed, while pricing distortions and socioeconomic consequences are considered. Regional Cooperation's Potential and Difficulties Although connectivity in the electricity market would be appealing, there is no political will to make it happen. Losses Given outdated networks, there are significant electrical energy losses in Jordan at several stages: generation, transmission, and distribution. Poor control systems, aged generators, and obsolete transmission and distribution networks all contribute to such losses.

In general, any type of agreement would necessitate the establishment of a legal framework, the identification of trustworthy partners, regional stability, and the investment or construction of infrastructure (even if infrastructure would be present in part, for pipelines, for example, but also in part for grids, such as those connecting Lebanon to Syria). The link exists, but there is no exchange (MEMR Reports, 2017, 2019).

4. RESULTS AND ANALYSIS

In this section a deep analysis of problems and challenges facing electrical energy sector in Jordan are demonstrated and a suggested solution are suggested to overcome such challenges.

4.1 First: Sources of electricity generated and losses

Figure 1 represents the Energy power supply resources in Jordan between 2012 and 2021

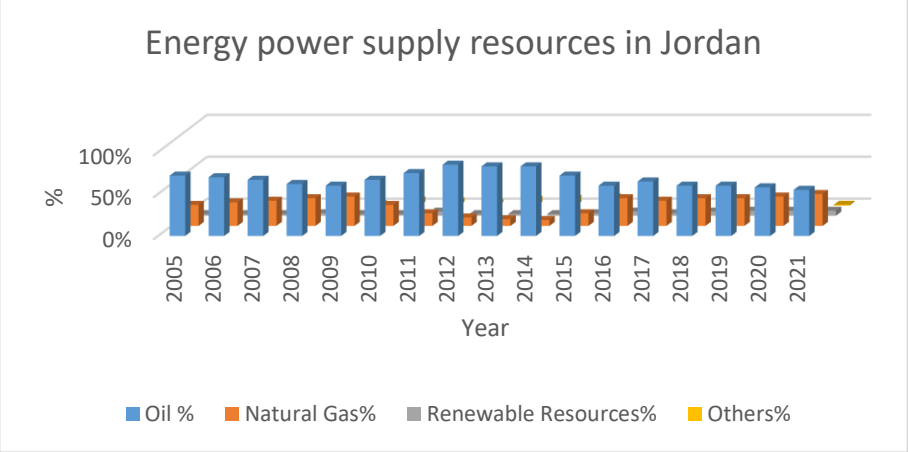

Fig.1: Energy power supply resources in Jordan between 2012 and 2021

Between 2005 and 2011, average real economic growth was 6% per year, but fell to 2.4 percent between 2012 and 2018. (World Bank, 2020). For the same time periods, average annual population increase was 4.6 percent and 3.8 percent, respectively (World Bank, 2020). Primary energy supply, on the other hand (energy production minus exports, foreign bunkers, and stock adjustments) rose slowly (1 percent per year between 2005 and 2011) but began to grow after 2012. (The average annual growth rate between 2012 and 2021 was 3.9 percent). The Arab Spring, the commencement of the Syrian war, and the entrance of numerous refugees, along with their needs for housing, power, water, and other necessities, have all had a significant impact on Jordan and its energy needs. The refugee crisis, combined with the disruption of relatively inexpensive Egyptian natural gas supplies, forced Jordan to reexamine energy security, and the energy discussion has emerged as one of the top political and economic objectives (Sandri et al., 2020; MEMR Report, 2017). Figure 2 depicts Jordan's primary energy sources and imports.

This line of thought is reinforced further by separating ultimate energy consumption from usage Figure 3). Household final energy consumption climbed in 2012, but industrial energy usage fell. The rise in the proportion of total energy consumed for transportation is another trend that can be explained by the same approach. Transportation accounted for half of overall energy consumption (49%) in 2018, followed by residential usage (21%), and industry (14%). (Sandri and colleagues, 2020).

The losses percentages in electrical energy in Jordan in all stages of generation, transmission, and distribution are shown in Table 2 below.

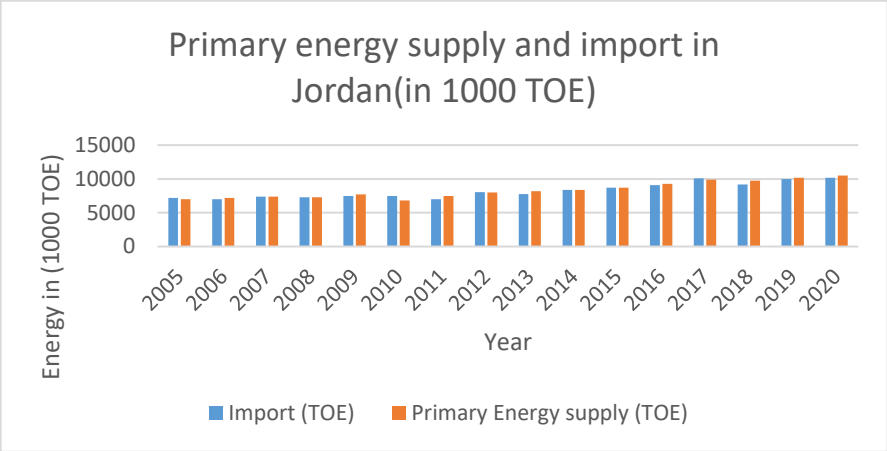

Fig. 2: primary energy supply and import in Jordan.

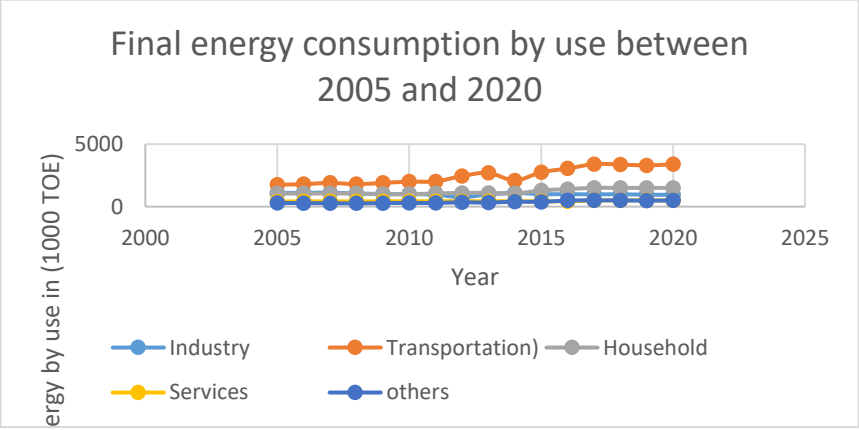

Fig.3: Final energy consumption by use

Table 2. Losses percentages in electrical energy in Jordan in all stages

Year	Generated	Sent out	Losses	Trans/Purchase	Sold Energy	Losses	Dist./Purchase	Sold Energy	Losses
2015	18516	17945	571	18541	18213	328	17282	14856	2426
2016	18924	18415	509	18764	18447	317	17663	15385	2278

2017	18690	18191	499	19287	18963	324	18320	16112	2208
2018	19146	18726	420	18913	18539	374	17985	15838	2147

4.2 Growth of electricity demand

The electricity energy demand in Jordan is growing up year after year, Figure 4 shows this growth from the year 2000 to 2020.

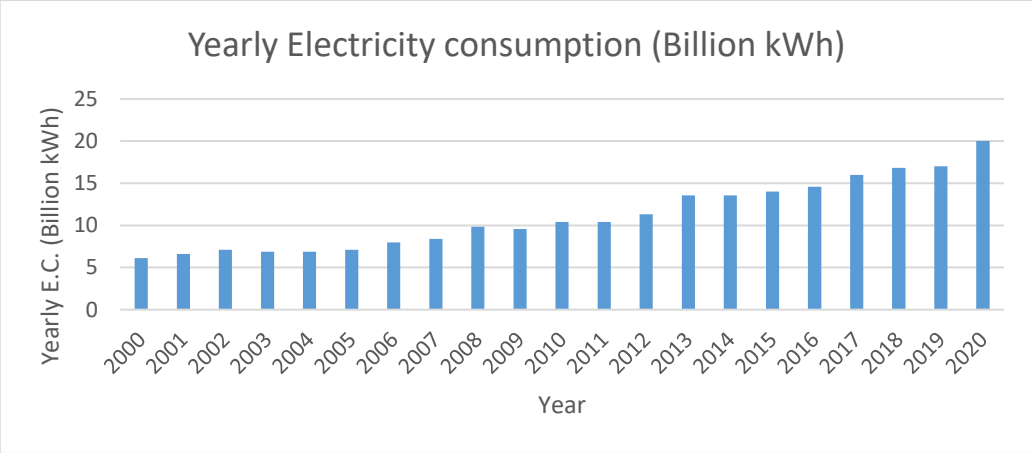

Fig. 4: Growth of electricity demand in Jordan (2000-2020).

4.3 Electricity generating alternative resources

Jordan's energy minister claims that "renewable energy will generate 50% of Jordan's power by 2030." This includes efforts such as solar energy, wind energy, geothermal energy, and others." Jordan has created significant relationships with top-ranked renewable energy countries such as Germany, which may pave the way for improved sustainable energy production by utilizing their experience." In terms of transmission and distribution networks, the minister noted that smart networks will improve grids' ability to absorb more renewable power generation, while electrical links with neighboring nations will increase the stability of the electric network. Other local energy sources are also a concern for the ministry, he noted, noting that drilling for three new wells in the Hamza oil field is continuing, while two other wells will be re-entered to locate new drilling locations and reserves, as well as oil and gas exploration in new places. According to the minister, a study is now underway to establish a natural gas business to be accountable for natural gas contracts, and two new oil derivatives marketing firms will be founded as part of reorganizing the energy sector and enhancing its global competitiveness. Jordan lacks its neighbors' natural resources and imports 90 percent of its energy and fuel needs, accounting for around 20 percent of the country's GDP. Jordan currently makes limited use of renewable energy. The ability of the country to generate electricity from renewable energy resources, notably solar and wind energy, is quite promising. Jordan's government is dealing with energy-related issues. Among these include increased demand as a result of population growth, higher per capita consumption, and rising power prices and cross-subsidies. Jordan's government proposed a $ 18 billion energy strategy plan in 2008, which will steer the country until 2020. The plan covers all sectors of the energy industry, such as generation, transmission, conventional electricity, renewable energy, and nuclear energy. As a result, Jordan's government is focusing its efforts on developing energy sources such as uranium, oil shale reserves, solar and wind power. By 2020, the energy strategy plan anticipates a $ 4 billion investments in power generation,

transmission, and distribution projects. Jordan has built new power plants based on the Independent Power Provider (IPP) business model. Central Electricity Generation Company (CEGCO) was privatized, and four IPP projects offered by AES of America and KEPCO of Korea were authorized. Jordan currently has a total generation capacity of approximately 5 GW. The government-owned National Electric Power Company (NEPCO) and other distribution firms with separate exclusive areas lead transmission and distribution. Jordan's energy strategy prioritizes energy efficiency, with an estimated $ 150 million set aside for this purpose. Aside from the national efficiency projects of NEPCO and its partners, the government is implementing awareness campaigns, capacity building, and price reductions on energy-saving lighting. In addition, the Jordan National Building Council has produced the Green Building Code guide for use in real estate development projects in order to become more environmentally friendly and energy efficient. Jordan will boost its renewable energy contribution of total energy output from 1% in 2007 to 10% by 2020, with an estimated $1.7 billion in investment. The Renewable Energy and Energy Efficiency Law was enacted to help achieve these objectives, and an energy efficiency fund was established. A Feed-in-Tariff schedule for renewable energy supplies was also developed, which is regularly updated. By August 2016, about 700MW of wind and solar projects had been approved. A new round of green project funding has been announced. Jordan has only one gas well, Al-Risha, near the Iraqi border in the country's north east, which produces roughly 15 million cubic feet, and one oil field, Hamzah, in the country's south, in the Azraq area, which produces only 28 barrels per day. However, the Ministry of Energy and Mineral Resources (MEMR) is pushing petroleum blocks in several sections of the Kingdom in the expectation of discovering economically significant volumes. Jordan's estimated 40 billion tons of oil shale deposits will meet the country's energy needs. Jordan's government has won contracts with large firms such as Shell and Eseti Energia for oil shale exploration. Jordan's nuclear energy policy intends to generate power and desalinate water using nuclear reactors. Jordan's Atomic Energy Commission (JAEC) intends to purchase 200-700 megawatts of power from Small Modular Reactors (SMR), which are projected to begin operations between 2025 and 2030. Following the cancellation of a contract to purchase two 1,000-MW nuclear power stations from the Russian state-owned firm Rosatom (MEMR, 2019 a, b, c), JAEC now intends to construct large-scale nuclear power facilities in the long run.

4.4 Electricity networks connection and export

The Eight Countries Electric Interconnection Project aims to connect Egypt's, Iraq's, Jordan's, Lebanon's, Libya's, Palestine's, Syria's, and Turkey's electric networks. Jordan, Egypt, Syria, and Libya currently have completely interconnected electricity networks. Figure 5 depicts the Electric Interconnection Project for Eight Countries.

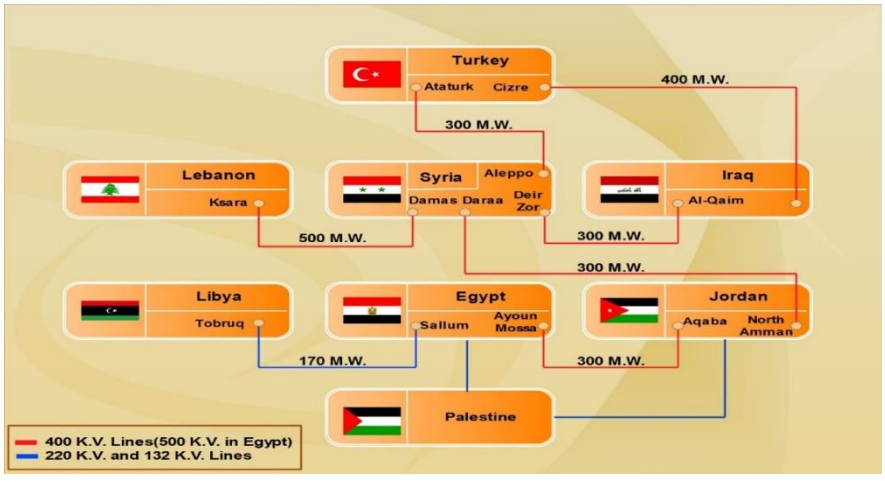

Fig.5: Eight Countries Electric Interconnection Project (Source: NEPCO)

5. EXISTING PROJECTS

Jordan and Egypt renewed their agreement for electric energy exchange in 2012, resulting in the connectivity of Jordanian-Egyptian-Syrian-Libyan electric networks. Jordan's electrical network is linked to Egypt's from the south by a (13) km, 400 kV undersea cable that spans the Gulf of Aqaba and has a (550) MW exchange capacity. The Jordanian and Syrian sides also agreed to prolong the agreement for the flow of electric energy until 2012. Jordan is currently linked to Syria's electrical network from the north by a (58) km 400 kV overhead single circuit transmission line with an exchange capacity of (1000) MW. In 2011, NEPCO imported (1457.6) GWh from Egypt and (280.5) GWh from Syria to cover Jordan's power needs, while Jordan exported electricity to Egypt (4.2) GWh, Jerusalem Co (Jericho), and Border Trabeel (5.7). This energy exchange resulted in mutual technological and economic benefits for all parties involved. During 2011, the Egyptian network sent (235.1) and (30.4) GWh to the Lebanese and Syrian networks, respectively, while the Syrian network transmitted (8.9) GWh to the Egyptian network through the Jordanian network. Jordan profited from Wheeling Charges, which are fees for electric energy transmission. Electric energy exchange between the Egyptian and Libyan sides has been ongoing since the interconnection line was operational in 1998, in accordance with the two countries' agreement. In 2011, Egypt exchanged (129) GWh of electricity with Libya and (113) GWh of electricity with Egypt (MEMR, 2019; NEPCO, 2019).

5.1 Under Construction Interconnection Projects

Syrian-Turkish Electric Interconnection: On the Turkish side, all works related to the interconnection line project have been completed since 1997, while on the Syrian side, they were completed in the middle of 2003. By exporting power from Turkey to Syria, the connecting connection between the two countries serves as an island connectivity. The European Network Operators Group (ENTSO-E) opted to connect Turkey to its electrical network in three stages over a year, which ended on September 18, 2011. However, due to an unanticipated delay in the experimental operation's first phase, the experimental operation was only delayed for a short period of time (NEPCO, 2019; MEMR, 2019).

-The Syrian Lebanese Electric Interconnection: The Syrian-Lebanese Electric Interconnection Line was finished and operational on April 27, 2009, albeit without synchronization. It is expected to be finished in 2012. Since then, Lebanon has imported a portion of its electrical needs from Egypt via Jordanian and Syrian networks in exchange for specified wheeling rates paid by the supplier to the median networks. In February 2009, the Egyptian and Lebanese governments reached an agreement to distribute electricity. NEPCO, 2019; MEMR, 2019)

-The Iraqi-Turkish Electric Interconnection: The 400kV interconnection line between the two nations is now operating as an island interconnection on 154 kV. To boost connectivity, a second 400kV interconnection cable is being built between the two countries. The Iraqi side of the line is 90% complete but work on the Turkish side has yet to begin. All relevant work is expected to be completed in 2012. NEPCO, 2019; MEMR, 2019).

5.2 The Syrian-Iraqi Electrical Interconnection

Because the two parties confirmed their intention to begin implementing the interconnection project, the 400 kV substations associated with the project were completed on the Syrian side, while their associated 400 kV transmission lines are being built; however, this interconnection line will be operational once the necessary operational studies are completed. The joining project and Syrian network fortification are projected to be finished in 2012, with the Iraqi side having completed (100%) of the 28-kilometer interconnection line (NEPCO, 2019; MEMR, 2019).

5.3 The Egyptian-Libyan Electrical interconnection:

In early 2012, the capacity of the two countries' interconnection line will be increased by increasing the voltage to 500 kV on the Egyptian side and 400 kV on the Libyan side. The feasibility studies to expand the capacity of the two countries' interconnection line have been completed (NEPCO, 2019; MEMR, 2019).

5.4 Cost Analysis

The maximum day load from was 2380 M.W. At night, the maximum load was 2840 M.W. During peak hours, power use is approximately 2800 MW. Until 2022, the annual growth rate is expected to remain approximately 8.4 percent. Electricity tariffs will be raised by 20-25 percent on average for all users, reaching up to 88 fills/kWh, while electrical system tariffs would cost roughly 190 fills/kWh. MEMR and NEPCO (2019).

5.5 Promising solutions –Renewable energy resources

Jordan's geographical location and climate, according to Bani Younes (2017), make the country one of the greatest in the world for renewable energy generation. Local renewable energy potential is particularly tempting, according to Azzuni et al. (2020), and a transition to a 100% renewable energy system is technically and economically feasible by 2050. In light of these findings, Jordan's National Energy Strategy (2015-2025) recommends that Jordan increase its energy supply security and reduce its reliance on foreign energy sources by harnessing indigenous renewable energy capability. Renewable energy (mostly solar and wind power) supplied 6% of total electrical power output in 2016, with a target of 20% by 2025 (MEMR 2015; MEMR 2021). This lofty goal necessitates thorough research and planning to incorporate appropriate renewable energy sources and technology. In 2019, total installed renewable energy capacity was 1423 megawatts (MW) (MEMR, 2021).

5.5.1 Solar energy

Jordan, like most Middle Eastern countries, has a high potential for solar energy, with an average yearly solar radiation of 5.5 kWh/m2 and a monthly sunlight length of 2900 hours (Mason et al. 2009). Several photovoltaic solar energy farms have been built in Jordan over the last decade, with a total installed solar energy capacity of 2063 MW, representing for 20% of total electrical energy consumed in Jordan (MEMR, 2020).

5.5.2 Wind energy

Jordan's Wind Atlas was developed in 1988 in partnership with the National Laboratory in Denmark (RISO) by the Ministry of Energy and Mineral Resources (MEMR), the Jordan Meteorological Department (JMD), and other local organizations. This Atlas was the first of its kind in the region, and it is now used to identify and choose locations around the country with high potential for electricity generation (Hrayshat 2007; Sabra 1999). Figure 3 depicts Jordan's yearly mean wind speed at 100 meters, which ranges between 6 and 8 meters per second (m/s). Such high wind speeds, according to Ramachandra et al. (1997), make several Jordanian locales suitable for wind-energy projects. Al-Soud and Hrayshat (2009) evaluated the viability of wind energy for rural Jordanian power and proposed Zabda, approximately 80 kilometers (km) north of Amman, as a good location for small-turbine electrification as well as future commercial-scale wind-energy development. Prospective wind energy conversion device locations were identified as Al-Risha al Garbia and Al-Risha al Sharkia, around 270 kilometers northeast of Amman. Southern Jordan today has three large wind farms: Tafillah (117 MW), Maan (86 MW), and Alfujaij (89 MW), which was just developed. The total installed wind capacity in the country is 370 MW (MEMR, 2019).

5.5.3 Energy from Biomass

Biomass energy is generated by using organic waste, such as agricultural and urban garbage. According to Abu-Ashour et al. (2010), the annual energy generated in Jordan from olive and animal waste is equivalent to 157,000 tons of oil equivalent (toe). According to Abu Qdais and Alshraideh (2016), co-combustion for energy recovery

is the greatest option for dealing with Jordan's olive oil industry's solid waste. Currently, a closed solid-waste disposal in Russaifah generates 4 MW of power (Abdullah et al. 2004; Abu Qdais et al. 2011). Furthermore, the Greater Amman Municipality has activated a 4.8 MW biogas plant in the Alghabawi rubbish dump. Finally, all newly built wastewater treatment plants in Jordan contain a sewage sludge biogas-recovery system, with the biogas being used to generate combined heat and power (CHP). (2019, Abu Qdais).

5.5.4 Hydropower

Hydro-generated energy can be produced by moving water from a higher height to a lower elevation (often via a dam) or by recovering energy stored in a pressurized water flow. Jordan now has two small hydropower sources: the 5 MW King Talal dam in the country's north, and the 6 MW Aqaba thermal power station (Mason et al. 2009). One component of the proposed Red Sea-Dead Sea water desalination project is a massive hydropower station capable of generating 550 MW by utilizing the 420-meter difference in level between the Red and Dead Seas (Abu Qdais 2008; Shatnawi et al., 2021).

6. ENERGY POLICY

Jordan's energy policy is guided by many national plans, including the "National Energy Strategy," the "National Master Strategy of the Energy Industry," and the "National Renewable Energy Strategy," as well as several regulations governing the power sector. To reduce dependency on energy imports, the National Energy Strategy (2011-2020) prioritizes energy supply diversification. Its primary goal is to develop solar and wind resources, as well as nuclear power and shale oil. In 2011, oil products accounted for 82% of Jordan's energy supply, followed by natural gas (12%) and renewables (2%). By 2020, the National Energy Strategy envisions the following energy mix: a 40% decrease in oil product share, a 29% increase in natural gas share, a 10% increase in renewable energy, and the introduction of new energy sources such as oil shale (reaching potentially 14 percent of the national energy mix) and nuclear (reaching potentially 6 percent of the national energy mix) (EMRC, 2015). Jordan's official objective is for the country to become a net energy exporter by 2030.

Aside from plans, Jordan has a number of laws that lay the groundwork for energy policy. The General Electrical Law is the foundational piece of legislation controlling the electrical industry. It established the Electricity Regulatory Commission (ERC), which is widely regarded as a viable and dependable approach of liberalizing the Jordanian market while ensuring its efficiency, reliability, and development (OECD, 2005). The ERC has the right to regulate pricing for all sectors except generating, the General Electricity Law. Any agreements in place between the generation licensee and NEPCO as a bulk supply licensee influence generation pricing (General Electricity Law,). When computing tariff methodology, the ERC, like any licensed service, must take the following variables into account. (OGEL, 2013):

- Enable an efficient licensee to recoup the whole cost of its business activities while earning a respectable return on capital investment.
- Provide incentives for continuous improvement in the technological and economic efficiency with which services are delivered, as well as in service quality.
- Provide economically credible indications to consumers about the expenses that their consumption imposes on the licensee's business.

The General Electricity Law governs the licensing process. The regulatory authority gives permits to enterprises that seek to create, distribute, or sell energy under this Act. Without a license, generating units with a capacity of up to one MW are permitted to operate. Local supply networks with a maximum capacity of 100 kW, as well as self-consumption power plants, are exempt from licensing requirements. To purchase electricity from a power plant with a capacity higher than 5 MW, power supply firms or intermediaries must first engage in a public procurement procedure. These regulations apply to regular thermal power plants as well as renewable energy power plants (GTZ, 2007).

Figure 6. Hierarchy of the Regulatory Framework for the electricity sector in Jordan. Source: EMRC (2015).

- The law specifies four key renewable energy goals (MEMR, 2012):
- Making use of renewable energy sources.
- Increased renewable energy contribution to whole energy mix.
- Environmental safeguards.
- Long-term development and increased energy efficiency in numerous areas.

REEL has tasked the MEMR with locating suitable places for renewable energy applications and including their selection into the land use list. It also requests the continuation of the tax-free Renewable Energy and Energy Efficiency Fund, which was established in 2013. The goal of the fund is to fund the use of renewable energy sources and technology. The fund was established with contributions from the Jordanian government, the European Union, PROPARCO, and the Gulf Cooperation Council (GCC). MEMR oversees it and directs international donor funds to renewable energy and energy efficiency demonstration projects throughout the country (Nadejda et al., 2017).

7. CONCLUSIONS

Electricity sector in Jordan faces many problems represented by sources, distribution, and losses. Generating electricity in Jordan depends mainly on fuel and gas which are imported from outside the country which forms a big problem for the country budget especially after the huge increase in their prices. The study demonstrated and analyzed all problems face the sector of electricity in Jordan, and suggested a set of solutions represented by estimated the demand on electricity on the future periods, the losses and prices. Also, it describes some promising solutions of the growth costs of energy in Jordan represented by using alternatives like renewable sources and networking with other countries to make the demand stable and keeping the costs of supporting customers at lower prices.

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