

## Energy vulnerability and the ability of achieving Sustainable Development Goal 7 in Arab region

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### **Abstract :**

This paper outlines the concept of energy vulnerability and discusses its sources in the Arab world in general and in particular Libya. The means to ensure universal access to affordable and reliable energy services for current and future generations will also be included. The paper will highlight the United Nation Sustainable Development Goal no. 7,( SDG7), and discuss the nexus with the vulnerability and the concept of sustainable energy in the long term. The paper will focus the discussions to the Libyan power network and inspect whether the system fulfils the criteria of vulnerability. The discussion will be extended to assess the Libyan electrical energy system from supply and demand side to define if the Libyan energy system complies with SDG7 goal and address Libyan network weaknesses.

### **Introduction :**

The United Nations adopted the Sustainable Development Goals (SDGs) in September 2015, along with the Paris climate conference (COP21) in December 2015, with the aim to end poverty, protect the planet and ensure prosperity for all with specific targets to be achieved by 2030. However, the primary current concern relates to the implementation programs that countries can develop to achieve those SDGs, including the ones in relation to developing more sustainable energy systems, as indicated by SDG7 aiming at “ensuring access to affordable, reliable, sustainable and modern energy for all”. Achieving the SDGs and enhancing the quality of life is largely dependent on the successful uptake of globally-coordinated measures to improve the energy system, especially with energy being at the heart of the 2030 development agenda and the climate change challenge.

Energy vulnerability results from a State's inability to safeguard the universal access to affordable, reliable and modern energy services for current and future generations. Energy vulnerability is a result of multifaceted challenges to current energy demand and supply patterns, in particular:

- (a) Incomplete access to affordable, reliable, sustainable and modern energy, or the high risk thereof.
- (b) The lack of checks on energy demand through effective mitigation
- (c) An undiversified, carbon-intensive energy mix

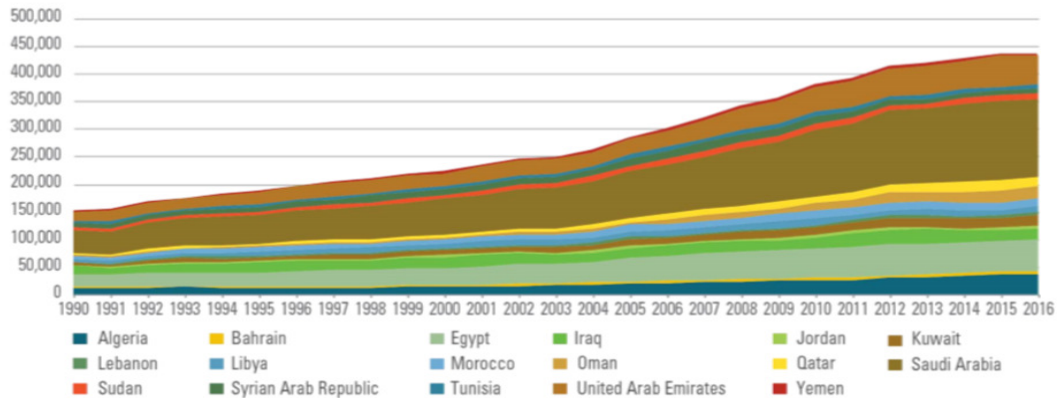
Worldwide, and due to the efforts taken by countries to provide energy to their people the number of people with electricity increased between 2000 and 2016, from 78 to 87 percent(1), and the numbers without electricity dipped to just below one billion. Yet the population continues to grow, so will the demand for cheap energy. However the economy reliant on fossil fuels is creating drastic changes to our climate. Investing in solar, wind and thermal power, improving energy productivity, and ensuring energy for all is vital if we are to achieve SDG 7 by 2030. Expanding infrastructure and upgrading technology to provide clean and more efficient energy in all countries will encourage growth and help the environment.

#### **Energy vulnerability in the Arab region:**

Beyond issues of incomplete access to electricity, the Arab region is comprised of substantial populations at risk of energy poverty, that is of losing previously held access to clean, secure and affordable energy. This is due to the lack of guarantees to sustain supply and demand in the energy sector due to the political and economic crises experienced by the Arab countries and the lack of diversification of the energy mix.

Energy vulnerability is a highly relevant concept in the Arab region and its implications warrant far greater discussion at social, economic, environmental and governmental levels. The Arab region has a high degree of intraregional heterogeneity in socioeconomic development and associated large differences in access to affordable, reliable, sustainable and modern energy. Even so, the region has rapidly increased its energy demand over recent decades, as shown in figure 1(2), combined with institutional, regulatory, infrastructural and sociopolitical structures that, in many cases, have lagged behind the region's needs.

Figure 1 shows the total final energy consumption in the Arab region.



From the figure above, the Arabic region has shown rapid vigorous increase in the energy demand in last two decades. The escalation of political conflict in the Arab region in recent years adds an additional dimension to the challenge of addressing energy demand in a sustainable way, with important consequences for post-conflict reconstruction and future socioeconomic growth if sustainable energy remains unaddressed.

### Energy pricing :

Pricing policies are of pivotal importance for the allocation of scarce resources, including energy. In the Arab Region , prevailing practice for much of the past decades has been state pricing and provision of the supply of energy to domestic consumers. The price of energy, such as electricity, liquefied petroleum gas (LPG) and transport fuel was not necessarily determined on the basis of its marginal cost to the state, but tied to a variety of factors, including socioeconomic development priorities such as safeguarding the affordability of modern energy services and promoting industrialization through low-cost energy provision. The result has often been extremely low energy prices across different user groups and with very limited differentiation between large and small consumers leading in some instances to among the lowest-priced energy in the world.

The fiscal impact of energy subsidies in the Arab region has been a source of vulnerability in its own right. The total fiscal value of energy subsidies – measured here as the difference between domestic and international prices for given fuels and electricity in Arab countries in 2016 – has been estimated at around US\$70 billion (down from \$133 billion in 2014 and \$100 billion in 2015), or around one quarter the value of the world’s energy subsidies. Saudi Arabia remains the world’s third largest subsidizer of energy(3), according to International Energy Agency (IEA) data, with total subsidies amounting to around \$30 billion (down from \$57 billion in 2014 and \$44 billion in 2015), close to half of the region’s total(4).

Figure 2. Average domestic utility tariffs in the Arab region, 2016 (US cents/kWh)

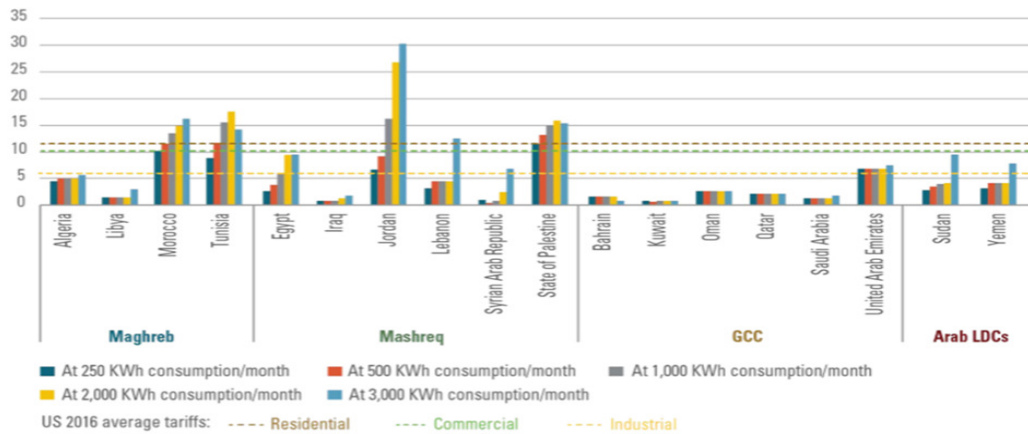


Figure 2 shows electricity tariffs across Arab countries for 2016 as an indicator for wider energy prices in these economies(5).

Particularly low tariffs were found in Arab oil and gas producers, especially in the GCC economies, Iraq and Libya. Energy price reforms in recent years in several Arab countries mean many of these tariffs are already significantly above their historical rates. In contrast to this scenario are the Arab region’s net importers of energy: Morocco, Tunisia, Jordan and the State of Palestine. Some higher volume consumers in these countries pay more for electricity than the average American household, reflecting more cost-reflective pricing policies in response to these countries’ need to import the majority of their energy supply.

**In Libya :**

The reluctance of citizens to pay their consumption bills since the revolution of 2011. This constituted an accumulation of debt in favor of the company with large and significant amounts of money. Libya spends annually 800 million dinars (\$ 615 million), to support the difference between the cost of production of energy unit and selling price, according to government estimates(6).

Table 1 :The following table shows the Libyan electricity pricing(7) :

Consumers	LYD/KWh
Industrial sector	0.31
Agricultural sector	0.42
Commercial sector	0.32
Residential Sector	0.20

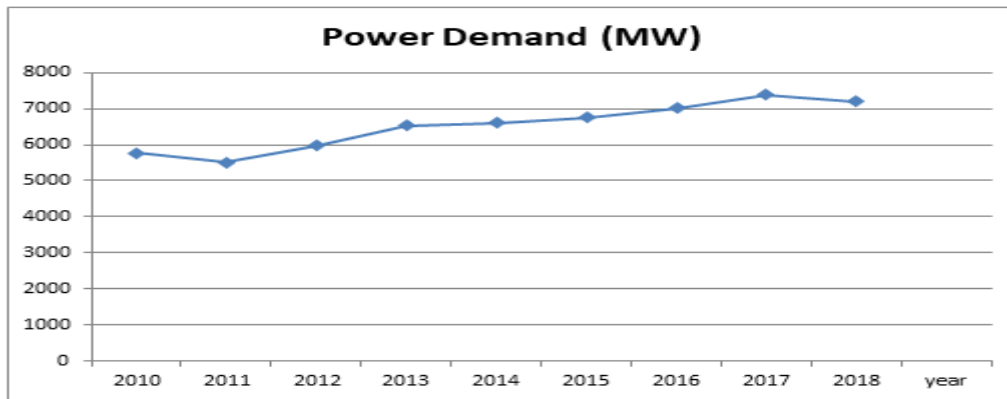
**Note :**There is no special tariff for residential consumers that encourage the rational use of energy.

### **Rapid and largely unchecked demand growth for energy:**

The rapidly growing Arab region has created a brisk market for energy and, given the region's projected continued economic and population growth, further industrialization and rising living standards, energy demand is expected to continue to increase over the coming decades. Adequate and affordable energy supply is a precondition to improving lives, powering the economy and safeguarding political stability in a region that is more fragile today than just a decade ago. In recent years, a number of Arab countries have witnessed increased policy focus on management of domestic energy markets with a view to longer term demand management that moves beyond safeguarding energy supply. Such policy initiatives include the introduction of more rigorous energy efficiency codes and the reform of domestic energy prices. Looking at Libya, In 2017, the electric grid capacity in Libya reached about 7383 MW, the steam generating units represent 10%, the gas and diesel generating units represent 42% while the double generating units represent 48%.

The maximum load of the network has grown from about 5760 MW in 2010 to more than 7300 MW in 2017, where the level of electricity consumption per capita increased by almost 28%, and the demand for electric power is expected to grow by up to 6% Per annum(8).

Figure 3 shows the average power consumption(9):



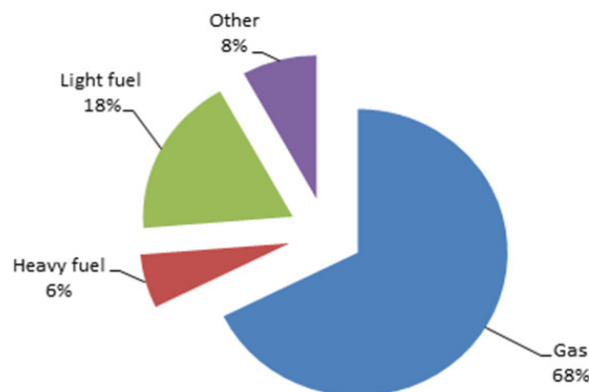
### An exceptional degree of dependence on fossil fuels:

More than anywhere else in the world, the Arab region relies on oil and natural gas for most of its energy mix. The region's fast growth in energy demand warrants an immediate and pressing investigation into cost-effective alternative sources of energy supply, especially renewable energy. Alternative sources of energy could also play a major role in helping Arab countries increase electricity access rates through a greater use of decentralised solutions. The prospects for reducing fossil fuel dependence are continually improving as costs for alternative energy technologies, particularly renewable energy, keep falling.

Looking at Libya, Libya is a member of the Organization of Petroleum Exporting Countries (OPEC). It has one of the largest crude oil reserves in the world and it is an important source of natural gas and oil to the world. But the civil war has caused the fossil fuel sector a heavy blow since 2011 and hasn't yet fully recovered from. Oil and gas account for 96% of total government revenue, making Libya highly dependent on its fossil fuel sector(10) .

Libya's primary energy consumption on fossil fuels increased by 92% for 2017(11).

Figure 4 shows the contribution of different fuels to energy production, 2017 .



### A continued and widening gap in energy access:

Despite enormous progress and achievement in universalizing access to modern energy across the Arab region, more than 30 million people live without basic access to electricity(12). The escalation of political conflict and instability in recent years in many parts of the Arab region has increased the number of people with insecure access, or at risk of losing secure access, to energy.

### Who is affected by energy vulnerability?

Energy vulnerability affects many different groups which highlights the importance of making sustainable energy planning an integral part of countries' socioeconomic development agenda.

### 1.High-, low- and middle-income countries:

Countries in the Arab region are characterized by a high degree of heterogeneity in terms of income levels, living standards and rates of socioeconomic development. As a result, different countries experience different aspects of energy vulnerability and are also differently equipped to deal with them.

Table 2. Selected macroeconomic indicators in the Maghreb region(13), 2014 :

Country	Population (million)	Total primary energy use (kg of oil equivalent per capita)	Annualized growth in total primary energy consumption, 2010-2014 (percentage)	Fossil fuel energy consumption (percentage of total)
Libya	6	2880	5	99
Morocco	34	553	4	88
Algeria	39	1321	2	100
Tunisia	11	944	2	89

### 2. Urban and rural populations :

A total of 56 per cent of the Arab region's population already lives in cities and the United Nations projects that by 2050 this proportion will increase to over 68 per cent. Cities add further pressure to the water-food-energy nexus, as they comprise higher water, food and energy consumption patterns in a smaller space, coupled with environmental degradation and urban air pollution. This trend suggests that urban centres will become more vulnerable to energy service disruptions and affordability

of access, while at the same time they will be increasingly important engines of growing energy consumption. Rural areas, on the other hand, already struggle with energy access, particularly in the Arab LDCs but also in some middle-income countries.

**As for Libya** in particular, only 0.1 % of the population is without electricity .

Table 3 .shows Population without access to electricity in the Arab region, 2016 (millions of people):

Sudan	Yemen	Mauritania
24.3	7.8	2.5

### 3. Countries affected by conflict and countries emerging from conflict:

In recent years, the Arab region has witnessed an escalation of political conflict and instability that has affected an increasing number of countries. It will be necessary to build safe, sustainable and affordable energy systems that can support the harsh social and economic conditions in these countries to enable their transition to a successful post-conflict state.

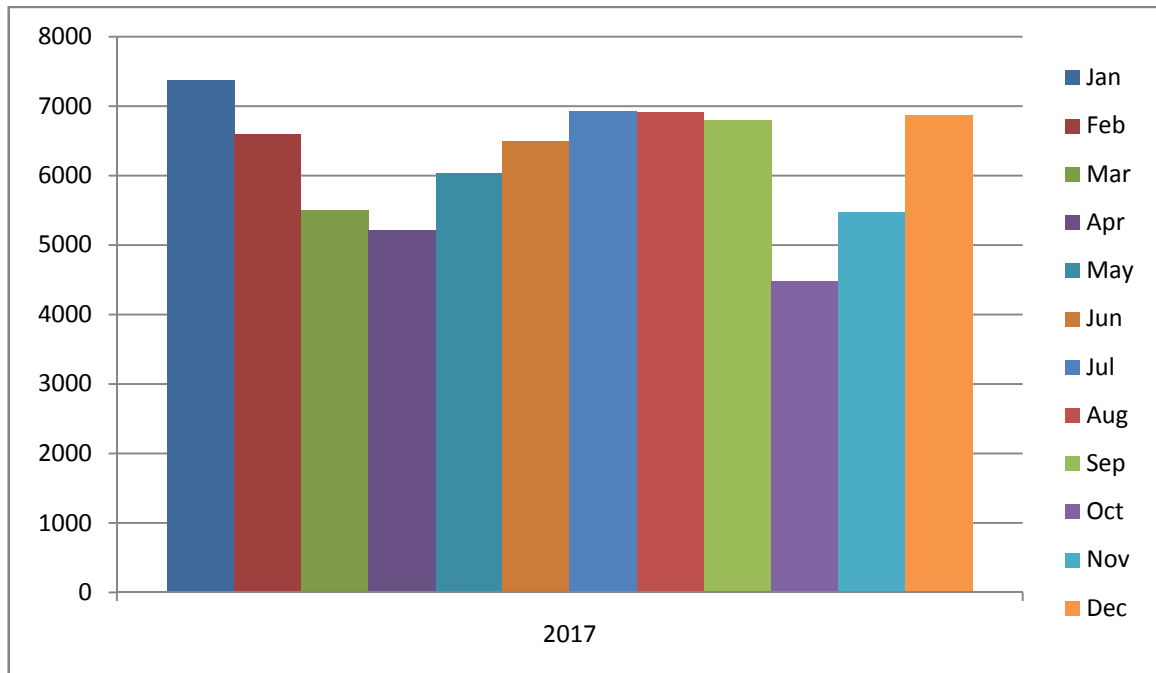
#### In Lybia:

Electricity Crisis:

a) Increase in demand for electricity over supply during summer and winter peak periods, but there is no power outage throughout the year, because the rates of withdrawal and consumption of electricity are variable and unstable during the days of the year. Weather plays a big role in influencing consumption(14)

Figure 5 .shows the energy consumption for 2017:





b ) Lack of financial resources as a result of the faltering economic situation of the Libyan state as of 2011 until now .

c) The company has suffered significant losses in power plants and transmission and distribution lines by saboteurs, some of which aim to sell wire and equipment physically, to losses of 1.5 billion dinars (\$ 1.1 billion) since 2011 due to the attacks(15).

d) New communications for the crime and without informing the electricity company, which constituted an unrealistic increase in the actual consumption of what was planned and approved by the company.

#### 4.High dependence on fossil fuels :

Fossil fuels as part of the regional energy mix :

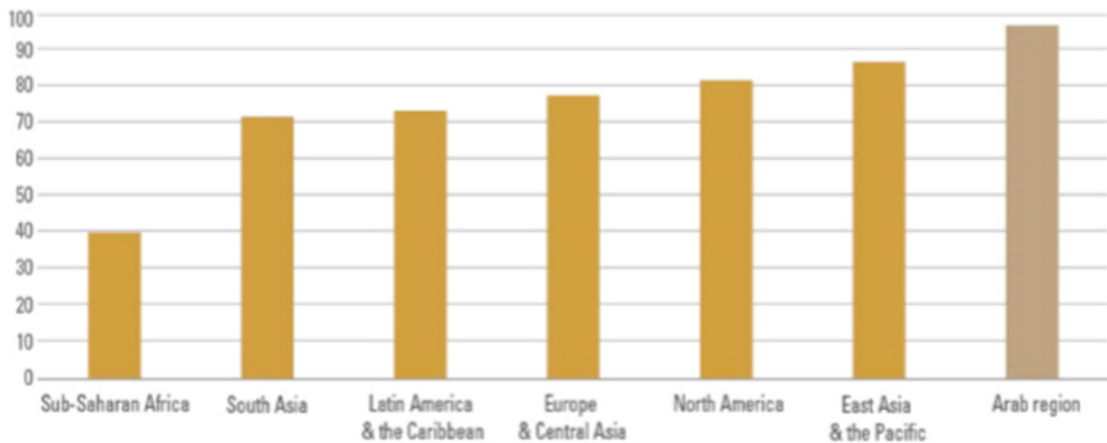
The Arab region's economies are vitally dependent on fossil fuels, both as a source of domestic energy supply and as a source of revenue in oil- and gas-producing countries. More than 95 per cent of regional energy supply is derived from just oil and natural gas, making the Arab region the most fossil fuel-dependent region in the world(16) (figure 7).

The absence of alternative energy sources, especially renewable energy, characterizes Arab economies across the board, whether exporters or net-importers of energy, with the few notable exceptions of countries with large hydropower resources, such as Egypt, Iraq, Morocco and the Sudan.

The increasing cost of hydrocarbon consumption also raises questions for the long term affordability and sustainability of the current energy mix, as depletable energy

sources need to be imported in increasing volumes from international markets or else reduce hydrocarbon supply available for export. The region's undiversified energy mix also contributes toward its rising carbon footprint, while at the same time Arab countries are missing out on capitalizing on key technological innovations and development in the area of clean energy, despite the vast potential in the region.

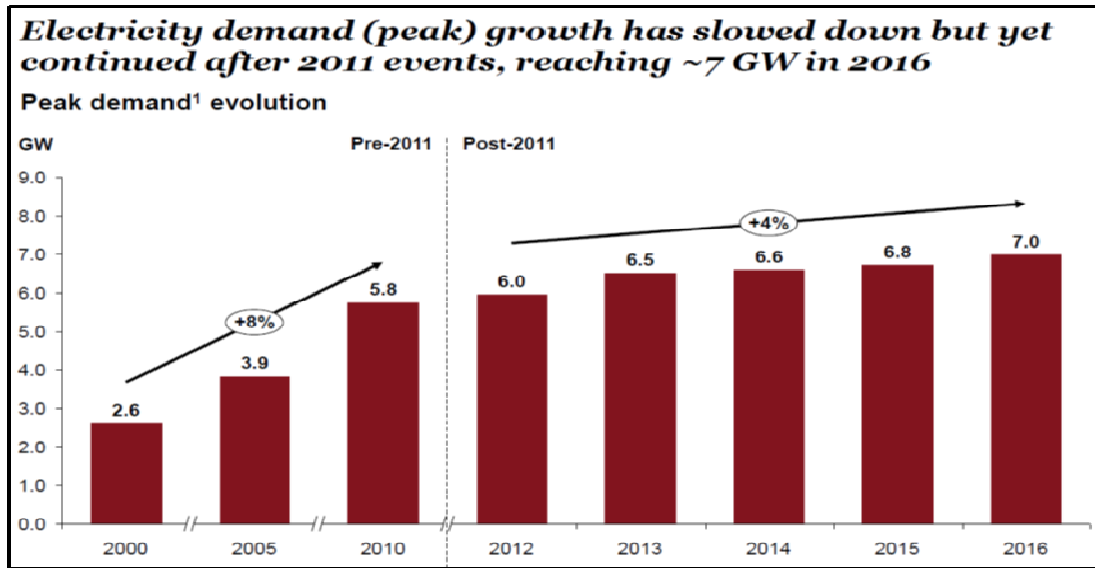
Figure 6 . Fossil fuel energy consumption by world region, 2014 (percentage of total primary energy supply) :



**Diversify energy sources and preserve the environment :**

The electricity demand under normal conditions in Libya has been increasing annually by 8% before the outbreak of the February 17 revolution, as shown in Figure 7. The demand increased from 2.6 GW in 2000 to 5.8 GW in 2010; an annual growth rate of 8%. As a result of instability and unsuitable security conditions, the annual growth rate of electricity demand decreased to 4% annually, i.e. by 300 MW annually (i.e. the demand for electricity has been increasing annually by 4% during the period 2012-2016 instead of 8% during the former period) due to the reduced economic and industrial activities in the State. This increase can be partially offset by the construction of renewable energy-operated power plants in parallel with the conventional fossil fuel-operated power plants that are currently being built(17).

Figure 7:



**Growth rate of electricity demand during the period 2000-2016 in Libya**

- a) Increase the share of renewable energy to 22% of the total energy mix as shown in Figures 8 and 9. Figure 8 shows the capacity to be installed over the next 12 years for different technologies, while Figure 9 shows in detail the capacity and type of technology to be installed each year. This way, the strategic plan is transformed into action programs and projects to be implemented, and then monitored in terms of its performance and evaluated as per a specific methodology (18).

Figure 8: The proposed strategy for the development of renewable energies in Libya during the period (2018-2030)

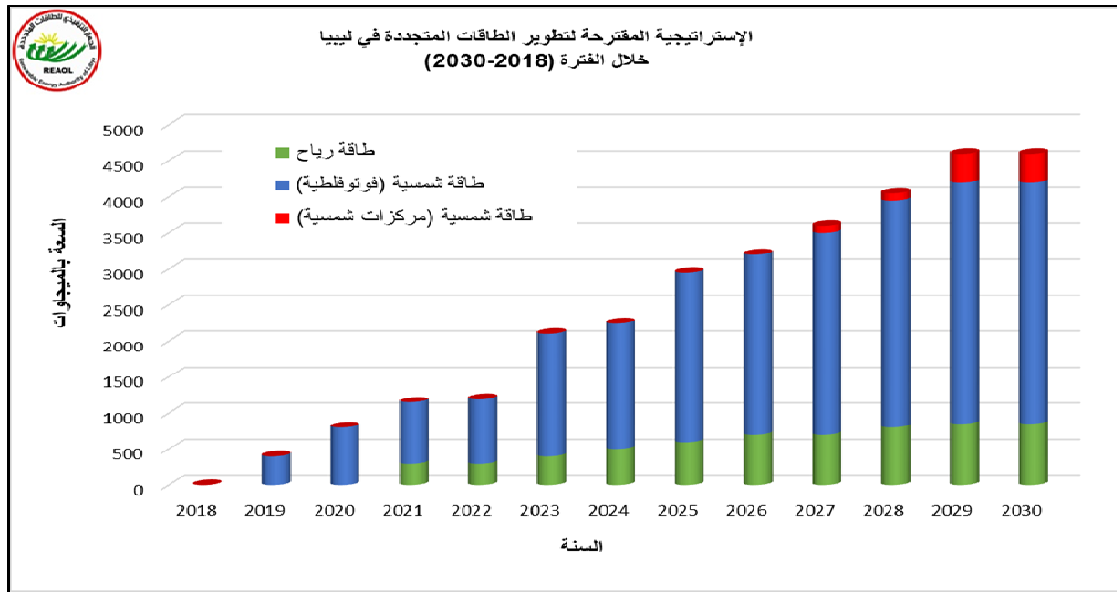
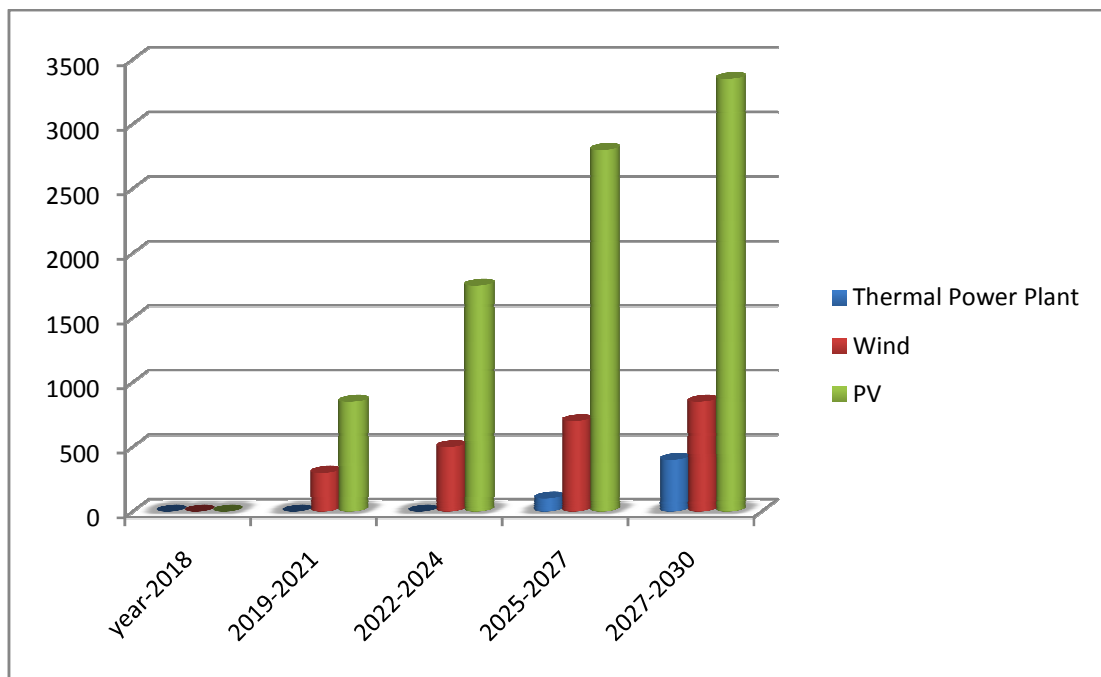


Figure 9 shows in detail the capacity and type of technology to be installed each year.



The electricity sector is one of the prominent sectors that have attracted the attention of development plans and budgets in order to provide electricity services to all citizens. This made Libya one of the few countries in which the electricity

coverage rate almost reaches 100% of the population. This indicator is usually used to classify countries either as developing or developed.

#### **a) Finance Methods :**

In order for the Libyan state to achieve its ambitions in this field, make the best use of the positive results of the Strategic Plan and overcome the potential risks, the Strategy adopts the search for alternative sources of financing for the projects proposed in the Plan.

The transformation from a system that fully depends on the State Budget in the implementation of projects to a system that opens the door for investment in this Sector and building partnerships between the private and public sectors is the logical mechanism and the inevitable method to ensure the implementation of the ambitious Strategic Plan and ensure the stability of economic activity in this field.

The volatility of crude oil prices, the diminishing State revenues from oil, insufficient domestic production of natural gas, and the increasing demand for electricity, with the expected increase in the need for it, double the need for investment and the need for huge investment in the renewable energy sector, which may have a great and promising impact on solving the energy issue.

#### **b. Mechanisms of Implementation, Investment and partnership between the public and Private Sectors**

The private and public sectors can take different roles in the development of renewable energy projects thanks to the existence of several possible mechanisms. The Strategy adopts one of these models depending on prevailing circumstances during the conclusion of contracts and the general vision of the State in the field of investment.

#### **The Proposed Structures**

##### **Build-Operate-Transfer (B.O.T) Model**

In the BOT model a private sector investor, after being licensed by the State, shall construct and build an electric power plant using one of the renewable energy technologies from the investor's resources, provided that the investor shall operate and manage such project, after its completion, for a certain concession period to be agreed upon. After the concession period ends, the project and its components shall be transferred to the State free of charge and become State-owned according to the details of the Energy Purchase Agreement with the investor.

Many countries favor the BOO model over the BOT model for several reasons, including:

- The evolution of technology: Due to the long period of concession (15-30 years), the evolution of technology is inevitable. Thus, the used technology

would not be fully feasible for the state after the expiration of the concession period and it is not in the interest of the state to continue using it.

- The Investor, as an owner of the power plant, must care for the equipment and continuously preserve and maintain it even after the expiry of the concession period.
- The cost of disposal and destruction of the power plant could be high.

There are also other models of partnership between the public and private sectors that may be used if there are technical justifications or financial imperatives, such as:

#### **Build- Own -Operate - Transfer (BOOT) Model**

It is similar to the BOT model, but the difference is that the investor shall retain the ownership, with the existence of an obligation to operate the project during the concession period. After the concession period ends, the project and its components shall be transferred to the State free of charge and become State-owned according to the details of the Energy Purchase Agreement with the investor.

#### **Build- Lease –Transfer (BLT) Model**

It is similar to the BOT model, but the investor or the Special Purpose Company (SPC) shall here build and construct the power plant and then lease the assets. After the concession period ends, the project and its components shall be transferred to the State free of charge and become State-owned according to the details of the Energy Purchase Agreement with the investor.

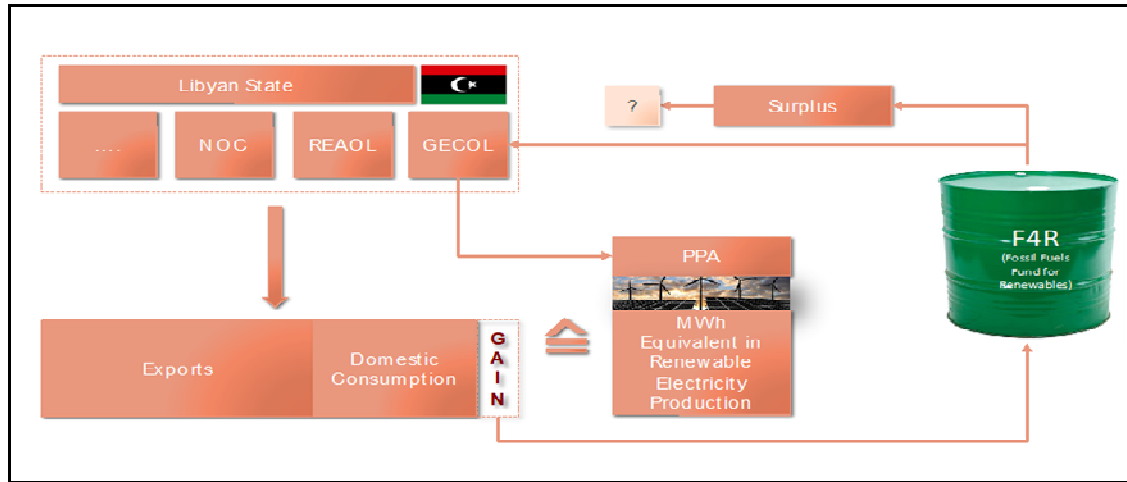
#### **Build- Lease -Own (BLO) Model**

It is similar to the BOT model, but the investor or the Special Purpose Company (SPC) shall here build and construct the power plant and then lease the assets. The difference is that the investor shall retain the ownership of the project during and after the concession period. The State may, after the expiry of the concession period, either purchase the components or ask the investor to disassemble, transport and dispose of the investor's equipment at the investor's own discretion and in accordance with the details of the Energy Purchase Agreement with the investor.

#### **c. A Program to Finance the Renewable Energies by Oil**

Renewable energy projects shall be jointly implemented by the public and private sectors, provided that the financial value of energy produced by the renewable energy plants shall be paid from a part of the financial value of fuel subsidies provided to the General Electricity Company, i.e. the funds that are paid to subsidy fuels shall be partially invested in power stations to begin reducing hydrocarbon fuel subsidies and subsidizing the renewable energy sector.

Figure 10: The mechanism of Fossil Fuels Fund for Renewables .



The following are some advantages of this program:

- It includes a mechanism to grant financial guarantees required by investors;
- It contributes to the gradual removal of the government subsidies on electricity;
- It contributes to removal of the hydrocarbon fuel subsidies in general; and
- It contributes to improve the economic situation.
- Securing funding through oil .

## IN Conclusions :

- 1- Urgent steps that need to be taken by Arab governments to adopt a proactive approach for developing more sustainable energy systems.
- 2- Arab countries need to integrate the energy related sustainable development goals (SDGs) and associated targets, particularly SDG7, into their socio-economic development plans. Monitoring mechanisms are required
- 3- Monitoring the Implementation of Energy Related SDG Indicators in the Arab Region is necessary measure.
- 4- The progress on the implementation of the SDG7 goals is monitored by the access to clean, affordable energy, increase substantially in the share of renewable energy in the global energy mix and double the global rate of improvement in energy efficiency. If these measures are weak the energy system considered vulnerable.
- 5- While in couple of Arab States people still suffering from incomplete access to electricity, Libya among few countries where the access to electricity is almost 100%.
- 6- The Arab region is comprised of substantial populations at risk of energy poverty if the other vulnerability criteria are not met.
- 7- Libyan energy system is vulnerable due to the conflict.
- 8- Depending on one source of primary energy increase the system vulnerability.
- 9- Introducing renewable energy improves the energy mix and reduces the price of the unit of energy.
- 10- When implementing the renewable energy strategic plan, Libya will reach 22% penetration rate, this will improve the energy system vulnerability .
- 11- Unfortunately, Libya did not set achievable goals for energy efficiency.



## Reference :

1. <https://www.undp.org/content/undp/en/home/sustainable-development-goals/goal-7-affordable-and-clean-energy.html>
2. Policy Briefs in Support of the First SDG7 Review at the UN High-Level Political Forum 2018, Accelerating SDG7 Achievement. New York. Available at [https://sustainabledevelopment.un.org/content/documents/18041SDG7\\_Policy\\_Brief.pdf](https://sustainabledevelopment.un.org/content/documents/18041SDG7_Policy_Brief.pdf).
3. Goal 7: Ensure access to affordable, reliable, sustainable and modern energy, affordable and clean energy. Available at <https://www.un.org/sustainabledevelopment/energy/>.
4. Energy and Arab economic development. Arab Human Development Report Research Paper Series. New York: United Nations Development Programme. Available at <http://www.arabhdr.org/publications/other/ahdrps/ENGFattouhKatiriV2.pdf>.
5. U.S Energy Information .Administration , 2017 .
6. ليبيا ستزيد تعرفه الكهرباء وتستنجد شركة أميركية لحل أزمتها/صحيفة العربي الجديد. 2018.6.24
7. الشركة العامة للكهرباء
8. تقرير الشركة العامة للكهرباء لسنة 2010
9. الشركة العامة للكهرباء
10. Rcreee /المركز الاقليمي للطاقات المتجددة و كفاءة الطاقة
11. الشركة العامة للكهرباء
12. International Energy Agency / 2018 .
13. International Monetary Fund 2017/  
<https://www.imf.org/en/Publications/PolicyPapers/Issues/2017/06/13/if-not-now-when-energy-pricereform-in-arab-countries>.
14. الشركة العامة للكهرباء
15. ليبيا ستزيد تعرفه الكهرباء وتستنجد شركة أميركية لحل أزمتها/صحيفة العربي الجديد. 2018.6.24
16. Word Blank / Global Atlas for Renewable Energy. Available at <https://irena.masdar.ac.ae/GIS/?map=3103>. Accessed on 15 November 2018.
17. “Strategic plan for renewable energy development, Energy mix and renewable resources assessment”, The world Bank, 2019
18. “Libyan strategic plan”, Renewable energy authority of Libya, 2019 (under printing)