

# The Future of Renewable Energy in Libya

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## **Abstract:**

*This paper introduces the basic information of the Libyan electric network, with more focusing on power generation system. the information includes the current power demand, the power shortage, the problems, and the suggestion and possible solutions. furthermore, the paper discusses the Libyan electric sector plan for utilizing the renewable energies particularly, the wind and solar energies for covering part of power demand. Finally, the potential future picture of using renewable energy in Libya will be introduced.*

**Keyword;** *Conventional energy; renewable energy; Power demand; Electricity shortfalls; Wind Energy; Solar Energy.*

## **1.Introduction:**

Electrical energy is the fundamental base of any technological and socioeconomic development of any country. Studies indicate that there is a clear and strong correlation between electric energy consumption and economic growth[1, 2]. in addition ,It's well known that the growth level in modern societies is measured by the average of power consumption. Based on these facts all industrial and developmental countries work very hard for securing the necessary funds for supplying all its cities and villages by electric energy.

Because Libya is one of the oil and gas producing countries, nearly all its electric loads are supplied from power plants which are totally operating by heavy, light oil or gas fuel, particularly steam and gas turbine power stations. In fact this strategy results in increasing the cost of the operation, increasing the cost of maintenance and damages the environment as well. Although, there are no real renewable energy plant working at the moment except the solar supplies which constructed to feed the communications network, but the master plan of the future energy in Libya includes many projects. These planned projects will be introduced and discussed in this paper.

The continuous growth in the power demand and the increasing of oil prices in non oil producing countries and the increasing of the power demand and the reducing of the oil prices in oil producing countries, both situations in addition to the ozone problems forced most of the countries which Libya one of them for looking to new, clean and economic sources to provide required power and reducing the operation and maintenance costs and complies with the international conventions.

Indeed these countries took a decision for utilizing the different renewable energy specially wind and solar

energy, which can provide the customers by sustainable, renewable, cheap and clean electric power.

## **ii. Libyan Grid Basic Information :**

Today, general electric company of Libya (GECOL) is the unique utility responsible for the electricity system of Libya. The company is a property of the state, and it is owned and operate generation, transmission and distribution systems. This situation put GECOAL in front of very huge challenges, the most important one is the failing to provide its customers by the required right quantity and quality of electric power.

### **Power generation:**

Because of population density, loads centers, logistical issues and other technical and financial reasons, Most of the power plants are located at the north on the beach. The total installed power plants are 16, with total installed generation capacity around 9000 MW. Table 1 illustrate the installed power plants and their capacity and fuel types.

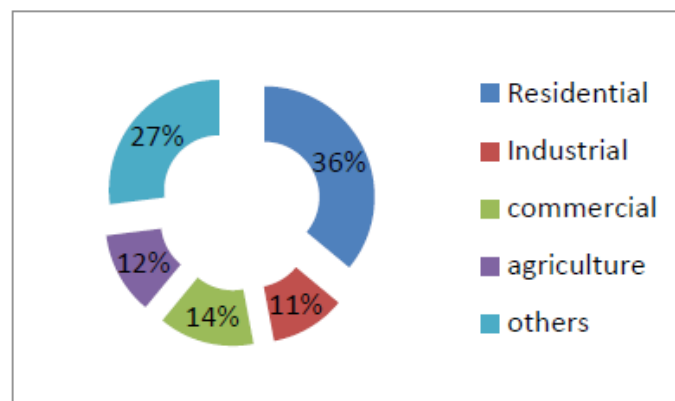
**Table 1: The installed power plants**

No	plant	capacity	type	Fuel	
1	Alzawia	990	GT	gas	cc
2	Alzawia	450	ST	gas	cc
3	Bengazi	1131	GT	oil	cc
4	Bengazi	550	GT	gas	cc
5	Musrata	570	GT	gs	cc
6	Musrata steel	504	ST	gas	*
7	Tripoli sou	648	GT	oil	
8	khomes	600	GT	gas	

No	plant	capacity	type	Fuel	
9	khomes	480	ST	gas	
10	W moountain	936	GT	oil	
11	Zewitena	770	GT	oil	
12	Serrier	570	GT	oil	
13	Derana	130	GT	oil	*
14	Tobruk	130	GT	oil	
15	Sirat,350*4MW	350	GT	oil	*
16	Tripoli west	500	ST	oil	*
Installed capacity		9309 MW			

\*power stations out of service

Use of electrical energy in Libya is rapidly increasing. The annual growing in electric power demand is around 7 - 13 % [3], with an estimated demand for 2020 of around 8 GW [4]. This growing energy consumption is a logical result of the urbanization process in the region, economic growth, population growth and industrialization. In the last ten years in Libya, the data indicates a clearly rapid increase in electricity consumption every year. Based on this information, by 2050 the government of Libya will face more pressure on the future energy supply, especially in the residential sector, because of the increasing in cooling and heating demand. Figure 1, shows the consumption of electricity by sector.



**Figure 1: consumption of electricity by sector**

As can be seen from figure 1, the residential sector is the most sectors consuming electricity energy. It consumes around 36% of total grid load. The increasing in residential consumption is related to the increasing in cooling and heating demand. Because of these facts demand on electricity in the future, the Government will be forced to use more efficient energy to overcome the increasing energy cost. The maximum load in this summer 2016 is around 7200 MW, while the available power from the concurrent power plants only around 5000 MW, with power shortage around 1500 MW. The difference between the required power and available power is due to war and country instability, which force the international companies to leave the country. The instability and political problems resulted in stopping all the new power generation projects. Table 2 gives clear idea about the generation projects under construction.

**Table 2: Power plants under construction**

No	plant	capacity	type	Fuel
1	Tripoli	1400	ST	Gas
2	sirat	1050	ST	gas
3	khomes	526	GT	gas
4	Ubari	640	GT	gas
5	Alzhra	141	GT	gas
Total projects capacity			3757 MW	

As can be seen from table 2, the total projects capacity is 3757 MW, while as mentioned earlier in this paper the power shortage this summer was around 1500 MW, therefore it would not be any power shortage if there is no political and military conflicts.

**Power Transmission :**

The power plants in different areas and the centers of the loads are connected by each other by means of transmission lines networks system at different levels of voltage. Based on the fact of big area and distributing populations in different and far area, the transmission faced and is facing many problems related to the operating and maintenance issues. The wide area and fragmenting loads force Libyan government to provide yearly continues investment to deal with the load growth and to save the continues flow of the power for all the customers. Therefore For covering the load-growth which is estimated around 7-13% , the transmission network with all main electric power plants remains the most important part of the Libyan power sector. The transmission power system of Libya can be divided in to three interconnected regions. Figure 2, shows the high voltage transmission lines.



**Figure 2: the Libyan transmission network**

The voltage levels which is used in Libyan grid as main power transmission between the generating power plants and the load centers in different regions are 400 and 220KV, while the power is transmitted in

each local regions through 66, 32, 11 KV lines. It is important to mention that Libyan transmission system faces many problems, specially the problems which connected to the environmental effects, such as salt sediments, wind containing large volume of very soft sand...etc. these problems are causing numerous faults or even local blackouts. Therefore, proper investigations must be carried out not only for reducing power losses created by these 'black consumptions' but also for increasing the reliability of the power system operation. Table 3 summarize the existing Libyan grid transmission lines and its approximately lengths as well as the existing sub-stations.

Table 3: Libyan power transmission

No	voltage	Length km	Substations numbers
1	400 KV	2290	13
2	220 KV	13706	87
3	66 KV	14311	195
4	30 KV	11142	461
Total lengths		41449	756

### III. The Renewable Energy in Libya, Chances & Challenges:

#### Chances :

Libya is the one of the main oil producer in Africa. The oil and natural gas exportation is forming approximately the unique Libyan economical revenue. Most of industrial sectors in Libya essentially depending on the oil and gas fuel. The most clear example sector is electric utility, which uses gas and oil to generate electric energy. To meet the demand on the local electricity market. As all other countries, the demand on energy will substantially increase in the near future as a result of the

economic development in order to build new infrastructure in Libya after the massive destruction that happened during the last four years. This growth in energy demand will result in more consumption of oil and gas which causes a reduction in the national economical input and increase the amount of the carbon dioxide emission. Therefore, it's very crucial to start use its alternative energy sources to cover some of its load requirements.

The location of Libya on the high centered radiation area as well as its long coastal line on the Mediterranean make it one of the countries that have very high potential for solar and wind energy in addition to other renewable sources such as geothermal, biomass and tidal waves, however, at the moment all these sources have not yet utilized in proper and efficient ways. The Libyan government view of renewable energy is summarized in table 3.

**Table 4 : shows the plan for developing RE in Libya**

<b>Strategic Plan for developing the RE in Libya (2013-2025 )</b>			
year	2020	2020	2025
wind	260	600	1000
pv	85	300	450
csp	25	150	800
Total power	370	1050	2250
% RE	3%	7%	10%

**Solar energy :**

Libya has high chance to take advantage to generate and utilize energy from renewable sources, such as solar, wind and biomass energies. Simply because The daily average of solar radiation on a horizontal plane is around 7.1 kwh/m<sup>2</sup>/day, refer to figure 3, with a sun duration of more



than 3500 hours per year [5]. photovoltaic technology seems to be the most reliable in rural areas of Libya for its convenient use and economical attraction. According to Trans Mediterranean Interconnection for Concentrating Solar Power, solar energy in Libya is the most promising sources. it can provide energy around 140,000 TWh per year, while wind and biomass have only potentials of 15,000 and 2,000 TWh per year, respectively[6].

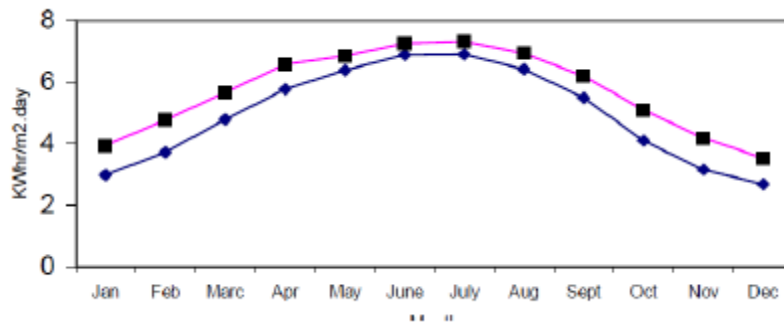


Figure 3 : The average monthly Daily global radiation on the horizontal surface [7]

Although, the photovoltaic technology was started in Libya long time ago 1976. It used as to supply electricity for a cathodic protection station, Since then; the use of photovoltaic systems is used in different applications as standalone systems, but its contribution in network is very small less than 0.03% of the total demand, the total generated power of all these systems is around 1.5 MW.

The PV technology is used in four main applications: microwave Communication Networks, in Cathodic protection, rural electrification and systems for water pumping, more detailed information about these applications can be found in[6].

GECOL and Renewable Energy Authority of Libya (REAOL) are working in parallel for planning to install photovoltaic systems. GECOL has a plan to install 340 systems for a total capacity of 240 kWp (kilowatts-peak).

REAOL also prepared all technical and financial studies for installing three PV systems, grid connected type. These systems will be installed in Aljfra, Sabha and Green mountain area, but unfortunately the security situation blocked all these promised projects or postponed them at least . In addition to all previous information , the GECOL and REAOL are planning to benefit from thermal solar for heating water . Their target of the plan is to provide around 12% from the total power demand.

**wind energy :**

The wind map of Libya indicates that wind speeds of between 6 : 7,5 m/s which is sufficiently high to run high power units. based on these speeds There are several suitable sites along the coast, such as Dernah, Almagron, Msalata,...etc. figure 4, illustrates the suitable sites for wind farm and its wind speed.



**Figure 4: the suitable wind farm and its wind speed**

The use of wind power has not extended to include many applications in addition to the pumping of water in several oases, simply because it requires periodic maintenance.

In 2000, a German-Danish consortium was signed a contract with GECOAL to conceive of and construct a 25 MW wind farm. Several appropriate sites were identified and masts were installed in order to conduct a survey of wind conditions over the course of a year. Technical specifications for all components of the pilot wind farm and the call to tender documentation were prepared, but the project did not implemented yet . The 2008- 2012 development plan for renewable envisages the installation of several wind farms, with a capacity in the region of 1000 MW, table shows the wind energy project plan. Table 5 presents the wind projects funded by government.

**Table 5 : The wind projects in Libya**

Dernah	60 MW	Under construction
Almagrun	120 MW	awarded
Meslata, Tarhuna	250 MW	Under construction
Southern region	250 MW	projected

**challenges and difficulties :**

As pointed out in previous sections, Libya at this time relies strongly on the oil and natural gas for electricity generation. These resources are not sustainable and renewable energy. All prediction indicates that the energy demands are ramping quickly in Libya which for sure will affect the oil and natural gas production by decreasing in the country revenue. All these expected events pushed the energy authority toward a rapid and not well planned investment in renewable energy. Based on the REAOL data, the renewable energy share is expected to reach 10% of energy demand by

2025 . The planned projects are mainly solar and wind energy systems. Even though, the renewable energy technology is economical, clean and reliable, but it faces many barriers. All the planned projects are financing by the GECOL and REAOL which are a state-owned bodies with no chance for the privatization or competition. Due to the planning and financing problems most of renewable energy projects are delayed or suspended. The lack of the field data makes the planning and the decision making a cumbersome task. Additionally, the Libyan renewable strategy is suffering lack of good surveys or detailed studies about the current energy situation and demands evolution in Libya. As soon s renewable energy share increased, many problems could appears, such as the impact of the renewable energy penetration on the Libyan grid which has not been studied yet. Because of the aforementioned reasons and the lack of the awareness and experience in the renewable energy technology, this new technology is still viewed from many public and private sectors as suspicious technology [8].

#### **IV. Conclusions:**

As a result of economic developments and increasing in populations, the demand on electric power will increase rapidly in the next few years. Based on the fact that Libya has very good location which is considered optimum for using renewable energy specially wind and solar technology. There is a very good chance and suitability for utilizing, home and grid connected photovoltaic systems as well as large scale grid connected electricity generation using Wind farms, and CPS systems. the quick and efficient use of renewable energy needs good field studies, good planning and enough funds. Solar energy resources in particular can be of great

source of energy for Libya after oil and natural gas, and can be developed to be a reliable national revenue resource . The electricity sector must reform and privatized electricity sector in order to increase the transparency, decrease the corruption and attract the private investments. Finally, The very important observation in this study is the very small contribution of universities and education institutions in researching and study field to develop the renewable energy technologies. Therefore., establishing cooperation platforms and building strong cooperation between electricity sectors and researching institutions will effect positively on the process of transferring and implementing renewable energy technologies to Libya.

## **V. Refernces:**

- [1] Ahmed M.A. Mohamed1, A.A.-H., Hafez Abdo2, *future prospects of the renewable energy sector in libya, in Dubai-UAE. 2016.*
- [2] Jan Veleba, Zaidan Buhawa, *perspectives of large wind power plant installations to the national transmission power system of libya*
- [3] Ahmed M.A. Mohamed, A.A.-H. And M.J.R.A. afez Abdo, *the significance of utilising renewable energy options into the libyan energy mix. Energy Research, 2013. 4(1).*
- [4] Salah H. E. Saleh, A.N.M., Naji Abdalaziz Ali, uhammad Nizam, Miftahul Anwar, *Forecasting Of the Electricity Demand in Libya Using Time Series Stochastic Method for Long- Term From 2011-2022. International Journal of Innovative Research in Science, Engineering and Technology, 2014. Vol. 3(5).*

- [5] *M. Saleh Ibrahim Al-Jadi, M.A.E., N. M. Krema, photovoltaic in libya applications, and evaluation, in International Conference on Renewable Energy for Developing Countries.*
- [6] 231. *The effects of fluid properties on cavitation in centrifugal pumps : W A Spraker, J Eng Power, 87 (3), 1965, 309-318. Vacuum, 1966. 16(2): p. 105.*
- [7] *Mohamed Ekhlal, I.M.S.E.N.M.K., Energy Efficiency and Renewable Energy Libya - National study. 2007. P. 45.*
- [8] *Ali asheibi , a.k., the renewable energy in libya: present difficulties and remedies.*