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A solar energy source used as a suitable alternative to the required household electric energy in Tripoli city

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الملخص

الكهرباء هي العامل الأساسي في حياتنا اليومية من جميع النواحي ، سواء كانت اجتماعية أو اقتصادية أو صحية و في بلادنا تعاني مدينة طرابلس وباقي المدن في الوقت الحاضر من مشكلة حادة في أنقطاع الكهرباء خلال السنوات السبع الماضية (2014–2021) ، خاصة في مواسم الصيف والشتاء و أوقات الذروة ، بحيث أصبح حوالي 60٪ من السكان داخل االمدن يعانون من عدم وجود مصادرطاقة من مولدات كهربائية وانظمة طاقة شمسية مع انقطاع الكهرباء لساعات قد تصل إلى 12 إلى 18 ساعة في اليوم. حيث إن سعة محطات الإنتاج غير كافية لتغطية احتياجات المدينة ، حيث تحتاج مدينة طرابلس إلى حوالي 500 ميغاواط ، بينما تبلغ الطاقة المولدة من محطة غرب طرابلس قرابة 670 ميغاواط وهي غير قادرة على تلبية طلب مدينة طرابلس والمناطق المحيطة بها ، وفي هذه الحالة ، يمكن أن تكون تقنية "أنظمة الطاقة الشمسية المنزلية" حلاً ذكيًا لهذه المشكلة من خلال تسخير الطاقة المتدفقة من ضوء الشمس إلى الطاقة الكهربائية التي نستفيد منها بحيث تقودنا هذه التقنية إلى حل مشكلة الطاقة لدينا بشكل أكثر فعالية و نجاح. تقدم هذه الورقة دراسة عن المعلومات الأساسية لشبكة الكهرباء الليبية ، مع التركيز بشكل أكبر على نظام توليد الطاقة. تتضمن المعلومات الطلب الحالي على الطاقة ونقص الطاقة والمشكلات والاقتراح والحلول الممكنة. ومن أهم التوصيات و الاقتراحات المستقبلية هي ان تقوم الحكومة الليبية بدعم و تشجيع السكان علي اقتناء و تركيب منظومات الطاقة الشمسية المنزلية و مساعدتهم في ذلك بنظام الدفع بالأقساط و كذلك شراء الفائض من الطاقة لديهم كما يحدث في الدول المتقدمة. علاوة على ذلك ، تناقش الورقة خطة قطاع الكهرباء الليبي لاستخدام الطاقات المتجددة والطاقة الشمسية علي وجه الخصوص لتغطية جزء من الطلب على الطاقة. أخيرًا، تم عرض الصورة المستقبلية المحتملة لاستخدام الطاقة المتجددة في ليبيا.

ABSTRACT

Electricity is the main factor in our daily life in all respects, whether it is social, economic, or health. In our country, the city of Tripoli and the rest of the cities are currently suffering from a severe problem of power cuts during the past seven years (2014-2021), especially during the summer and winter seasons, and peak times, about 60% of the population inside the city suffers with the lack of generators and solar energy systems due to electricity cuts for hours that may reach 12 to 18 hours a day. As the capacity of the production plants is insufficient to cover the city's needs, the city of Tripoli needs about 500 megawatts, while the power generated from the western Tripoli station is about 670 megawatts, which is unable to meet the demand of the city of Tripoli and its surroundings, and in this case, technical "Solar Home Systems" is a smart solution to this problem by harnessing the energy flowing from sunlight

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into electrical energy that benefited from, so that this technology leads to solving the energy problem more effectively and successfully. This paper provides basic information about the Libyan electricity grid, with a greater focus on the power generation system. The information includes current energy demand, energy shortage, problems, and proposed solutions. One of the most important recommendations and future suggestions is for the Libyan government to support and encourage the population to acquire and install home solar energy systems, and help them with this by paying in installments, as well as buying their surplus energy, as happens in developed countries. Moreover, the paper discusses the plan of the Libyan electricity sector to use renewable energies in particular, wind and solar energy to cover part of the energy demand. Finally, the potential future picture of the use of renewable energy in Libya is also presented.

Keywords: solar, energy, source, power, Tripoli.

I. INTRODUCTION

Electrical energy is the fundamental base of any technological and socio-economic development of any country. Studies indicate that there is a clear and strong correlation between electric energy consumption and economic growth [1]. in addition, it's known that the growth level in modern societies is measured by the average power consumption. Based on these facts all industrial and developmental countries work very hard for securing the necessary funds for supplying all their cities and villages with electric energy. There are other sources of renewable energy besides solar energy, but they are not practical as required, which enables us to produce the electrical energy required to provide the population with electricity within the city of Tripoli, especially since Tripoli is a sunny city and has few wind resources and other types of renewable energy [2].

Due to the extensive research that has been done in the field of solar panels, solar panels have evolved into more efficient models than ever before and some panels can produce more than 550 watts, which made the level of competition between manufacturers very large and at low prices as well. The reasons for choosing to conduct this research on providing the city of Tripoli with solar energy are what we see through the increasing number of small and medium projects that are implemented by companies and private partnerships to install home lighting systems for homes and institutions within the city during the last five years of our history. The current energy demand is increasing day after day in the State of Libya in general for various reasons, the first of which is a large number of power outages, the weakness and deterioration of public stations, and the lack of maintenance and renewal in the required and correct manner, as well as the increase in the population and the aspiration to improve the standard of living and general economic and industrial growth. Harnessing renewable energies and developing relativistic technologies is a very important strategic choice. Also, it is important in communities in rural areas and especially in remote areas of the whole of Libya, and in the context of environmental protection, renewable energies can contribute significantly to providing alternative energy to users and so on. The crisis, which extends for more than 10 years, i.e. since (2011), during which the parties did not succeed in providing energy by 100

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percent of domestic consumption, in a country that is considered one of the largest deposits of proven oil reserves in the world, where the hours of unloading loads reach more than 10 hours per day, due to a shortfall in production capacity by the company. Last summer, the hours of unloading loads in Libya reached their highest levels, exceeding 20 hours per day. At the time, the director of the General Electricity Company said in an interview with Anadolu Agency on 01.02.2021 that the three-hour power outage in the neighborhoods of Libya these days is due to a deficit of 1000 megawatts present after t exceeded 2500 megawatts during the summer. Al-Madi explained that the company currently produces an amount of 5,500 megawatts, which is not enough to cover the consumption that needs about 6500 megawatts. We also need 8000 megawatts in the summer [3].

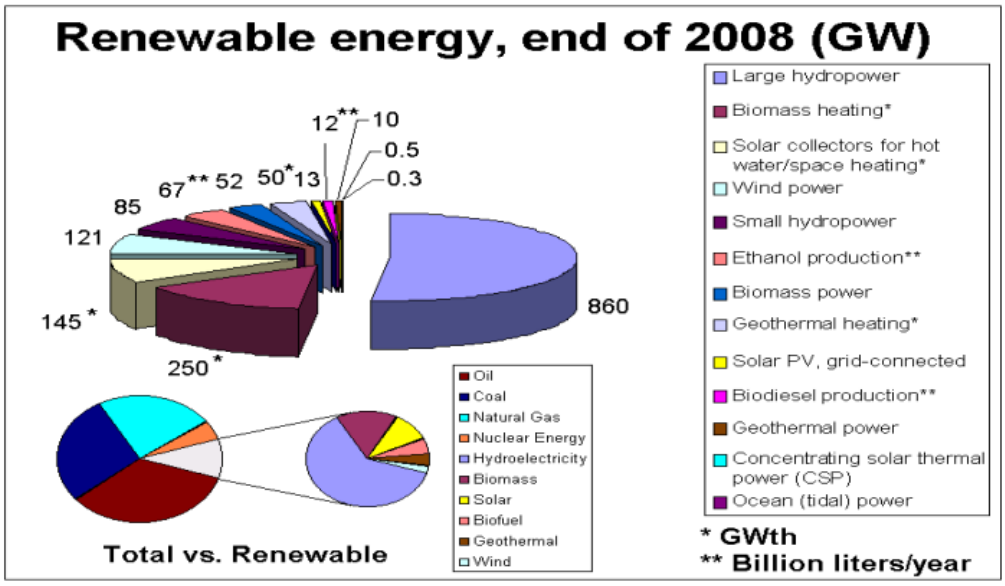

Fig. (1). Shows the types of renewable energy [4].

II. Solar system components.

The complete system that's separate from the public network is shown in Figure (2), and its best application is in isolated places or places where the public network is absent, or some applications that need to be separated from the public network [5].

1) Solar panels: Responsible for converting solar energy in its light form into DC electrical energy, and there are many types of solar panels.
2) Inverter: If it is needed, it is used if loads are running AC, it must be used to convert the electricity generated from the panels from DC to AC. But if the loads are DC, we do not need it.
3) Battery: Of course, we all know that the panels work in the event of solar radiation, and in the absence of it, either in the evening periods or during cloudy periods, we need to store

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energy to benefit from it in case we need it through the batteries, and there are many types that we will talk about later [6].

4) Charger controller: In the case of using batteries, it must be used to protect the battery from overcharging or over-discharging and to regulate charging and discharging operations
5) Cables and Protection DC.

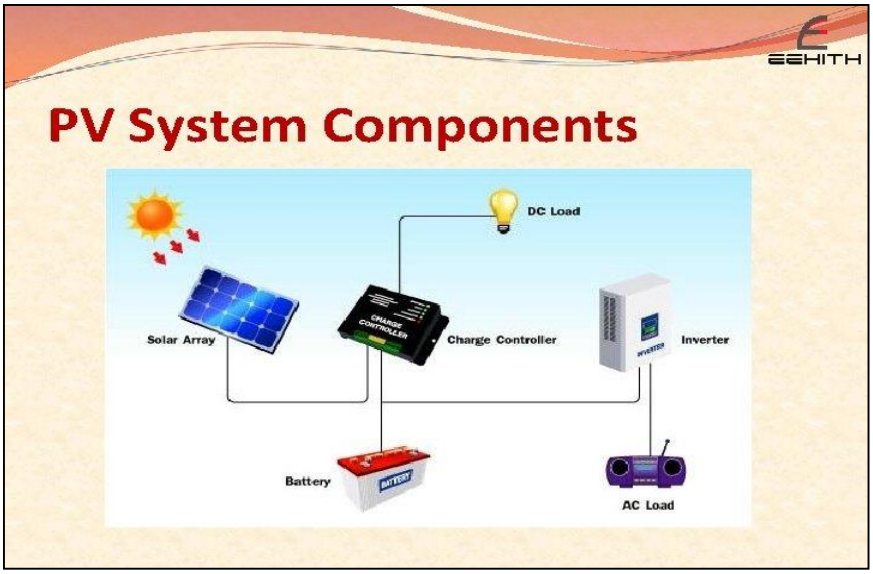

Fig. (2). Solar system components.

III. Power generation.

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

Table 1: 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	

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IV. The Renewable Energy in Libya, Chances & Challenges.

Libya has a 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/m2/day, refer to figure (3), with a sun duration of more than 3500 hours per year [7]. photovoltaic technology seems to be the most reliable in rural areas of Libya for its convenient use and economic attraction. According to Trans Mediterranean Interconnection for Concentrating Solar Power, solar energy in Libya is the most promising source. it can provide energy of around 140,000 TWh per year, while wind and biomass have only potentials of 15,000 and 2,000 TWh per year, respectively [8].

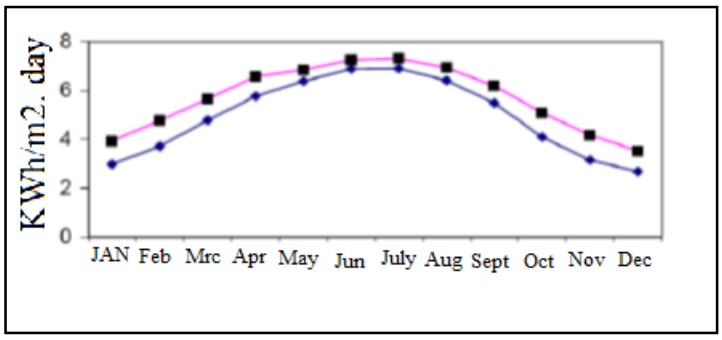

Fig. (3) . The average monthly Daily global radiation on the horizontal surface [9]

Although, photovoltaic technology was started in Libya a long time ago in 1976. It is used to supply electricity for a cathodic protection station, since then; the use of photovoltaic systems is used in different applications as standalone systems, but their 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, Cathodic protection, rural electrification, and systems for water pumping, more detailed information about these applications can be found in GECOL and Renewable Energy Authority of Libya (REAOL) are working in parallel for planning to install photovoltaic systems. GECOL has the plan to install 340 systems for a total capacity of 240 kWp (kilowatts-peak) [10].

REAL also prepared all technical and financial studies for installing three PV systems, grid-connected types. These systems will be installed in Aljfra, Sabha, and Green mountain areas, 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 the target of the plan is to provide around 12% of total power demand.

Libya at this time relies strongly on 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. All these expected events pushed the energy authority toward a rapid and not well-planned investment in renewable energy. Based on the REAOL

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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 renewable energy technology is economical, clean, and, liable, but its many barriers. All the planned projects are financed by the GECOL and REAOL which are state-owned bodies with no chance for privatization or competition. Due to planning and financing problems, renewable energy projects are delayed or suspended.

The lack of field data makes a decline and the make decision-making tasks. Additionally, the Libyan renewable strategy is suffering lack of good surveys or detailed studies about the current energy situation and demands evolution information from Libya. As soon as renewable energy share increases, many problems could appear, such as the impact of renewable energy penetration on the Libyan grid which has not been studied yet [11].

V. Calculating the cost of solar energy for homes.

The method of calculating solar energy from panels, batteries, and a transformer isto convert a house to be fully powered by solar energy. From table (2) amount of energy consumed per day can be calculated by applying the following equations :

energy consumed by the device/day = Number of devices * device capacity * working hours.

Table (2) simple example of the power needed for the home per day.

s.n	Appliances	Number of devices	Power (W)	Working hours	Total power (KW)
1	Led lamps	4	10	6	240
2	TV	1	80	6	480
3	Computer	1	80	4	320
4	Receiver	2	20	6	120
Total power needed					1160

❖ Loss calculation during installation

Of course, there is a loss during the installation of any electrical system, and the loss may reach 30% due to the connection, the quality of the wires, the resistance of the batteries used, as well as the efficiency of the solar panels [11]. Therefore, this loss must be added to the total energy consumed per day by applying the following equation:

- Total Energy Desired = Total Energy Consumed per Day * 1.3
- To apply it to the example, the energy to be generated = 1160 * 1.3 = 1508 watt-hours.

❖ Calculation of the number of solar panels:

To find out the energy of the solar panels, the total energy to be generated must be divided by the capacity of the oasis panel.

- Number of panels required = total capacity of the house ÷ Capacity of one panel
- Number of panels = 1508 W ÷ 350 W = 4.3 panels = approximately 5 solar panels

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❖ **Calculating the number of batteries:**

Batteries capacity (ampere-hours) = {(energy to be generated * number of cloudy days (in which the charging of the panels will be interrupted) * 1.3 (necessary to keep 30% of the capacity of the batteries to maintain)} ÷ Voltage

For example, the capacity of the batteries in our example, assuming that the system voltage will be 12 volts = (1508 * 2 "assuming it will be cloudy for two days" * 1.3) ÷ 12 = 3920.8÷12 = 326.76 ampere-hours [6].
Assuming that the system voltage will be 24 volts = (1508 * 2 "assuming it will be cloudy for two days" * 1.3) ÷ 24 = 3920.8÷24 = 163.36 amp-hours. In our example, we will operate on a 24-volt system.

❖ **The rate of using electricity inside the house (electricity loads):**

Using of electricity monthly bill, the rate of using electricity in kilowatt-hours can be calculated, and of course the bill cost. It is very easy to read the value of electricity consumption in kilowatt-hours from the electricity bill and calculate the average for several consecutive months.

VI. Conclusion.

As a result of economic developments and increases in population, the demand for electric power will increase rapidly in the next few years. Based on the fact that Libya has a very good location it is considered optimum for using renewable energy especially 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 a 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 privatize the electricity sector to increase transparency, decrease corruption and attract private investments. Finally, the very important observation in this study is the very small contribution of universities and education institutions in researching and studying fields to develop renewable energy technologies. Therefore .Establishing cooperation platforms and building strong cooperation between electricity sectors and research institutions will affect positively the process of transferring and implementing renewable energy technologies in Libya.

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