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Solar energy and its role in achieving sustainable development in Libya

Energia słoneczna i jej rola w osiąganiu zrównoważonego rozwoju w Libii

ABSTRACT

This article aims to develop and innovate methods of energy production in Libya, where these projects depend on 95% of oil and coal resources, as it is from the researcher's point of view that solar power plants are not very expensive, as is the case in other sources that depend on petroleum products in the power generation stages.

Keywords: renewable energy, sustainable development, development, human resources, pollution.

STRESZCZENIE

Artykuł ma na celu opracowanie i unowocześnienie metod produkcji energii w Libii. Produkcja ta jest w tym kraju w 95% uzależniona od zasobów ropy i węgla. Z punktu widzenia naukowca elektrownie słoneczne nie są bardzo drogie w porównaniu z elektrowniami opartymi na innych źródłach, uzależnionymi na poszczególnych etapach wytwarzania energii od produktów ropopochodnych.

Słowa kluczowe: energia odnawialna, zrównoważony rozwój, rozwój, zasoby ludzkie, zanieczyszczenie.

INTRODUCTION

Libya has much potential that can be exploited in terms of renewable energy, despite the fact that Libya is a country rich in petroleum and petroleum products, which are among the most important natural resources used in energy production.

The majority of electricity in Libya can be produced from oil and gas, and it is one of the main sources of income on which the Libyan economy depends on as well as status and future systems. The pollution that occurs through refining of crude oil causes the problem of greenhouse gas emissions through energy production processes, which requires many studies in this field and development into renewable energy, as well as its investment in a sustainable development system.

The rapid growth and increase in the demand for energy in Libya appears remarkably recently, for example, the demand for electric energy in Libya will exceed 115 gig watts until 2030, from the researcher's point of view it is necessary to address these type of articles to solve some of the problems that may occur in the event of relying on coal and petroleum to obtain electrical energy which are not environmentally friendly by percentage of pollution.

Alternative systems must be followed to obtain energy and preserve the environment from pollution, as well as not to exhaust the needs of future generations. The demand for raw fuel needed for energy production as a whole will rise from the equivalent of 1.6 million barrels per day in 2010, to the equivalent of double that is approximately 3 million barrels per day in 2030 **(**Al-Farsi, 2021).

From this point of view, sustainable development methods must be followed by the implementing agencies for energy production projects through renewable natural resources, as well as seeking to provide the necessary capabilities in the Libyan south and the Libyan desert to benefit from the temperatures and sunlight in generating electric power in a sustainable manner, as well as reducing demand on coal. The vast area in the south of Libya and the appropriate climate for the investment of energy projects are very impor-

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tant factors in terms of reducing pollution and also developing solutions to increase the demand for energy.

Improving efficiency and energy conservation as well as the benefits to accruing through the provision of raw fuel and petroleum products leading to achieving sustainable development in terms of management and improving the ability to provide human resource capabilities and harnessing them in achieving a series of international products, as well as Libya's role in the field of alternative energy sector, keeping pace with the development taking place in the world (Al-Naas, 2020).

Figure 1. The map of energy and vast areas in Libya
Source: Shinkada & Ibrahim (2021).

There is no doubt that alternative (renewable) energy sources for energy will significantly reduce the use of oil in the production of electric power, as the environment and climate in general in Libya achieve the ability to use solar energy (thermal) to meet the necessary needs. In the Libyan regions, there is the possibility of exporting surplus energy to neighboring countries and making investments in this field (Figure 1).

The amount of sufficient demand for energy from renewable sources such as the sun or wind, for example, requires the adoption of the appropriate technology for renewable energy in an ideal manner and in keeping with the development in this aspect, and it can be gradually so that it becomes 50% of the electricity production processes from non-petroleum sources that are not from coal until 2040.

On the other hand, standards must be followed to provide the principle of security and safety, implement all means of protection for individuals and facilities, and avoid any obstacles that may occur in the stages of energy production. Through these type of articles, it is possible to obtain information in the field of renewable energy, as well as to expand the innovation of the mechanism used in countries that depend on the production of electric energy, how to develop it and the possibility of its application in Libya in a way that is concomitant with development away from creating pollution, as well as avoiding the depletion of natural resources and saving them for future generations.

What is happening in Libya in terms of political events that in one way or another affect the implementation process of development projects and the development of infrastructure in general, the discussion of sustainable energy innovation and refining operations from oil fields is very important, and often contradicts the procedures for developing the Libyan economy under these conditions. The energy supply in Libya from natural sources such as the sun has encountered some obstacles in its implementation stages due to political factors that the country has gone through, which may lead to delays in the implementation of sustainable development projects such as: The Integrated Renewable Energy City Project; through a remarkable innovation in the implementation mechanism in development that benefits the area and the population.

One of the most important projects that have been implemented in the city of Al-Zawiya in western Libya are road lighting projects through solar panels, although these projects are considered limited, they provide some of the city's energy needs (Abuashe & Almariami, 2020).

From the researcher's point of view, the world today is seeking to develop methods of energy production and obtaining it from natural sources that are environmentally friendly and non-polluting, and are on the other hand inexpensive, as is the case when using other sources such as petroleum and coal.

Energy consumption has increased throughout the world due to the population census, which increases the demand for energy, as some studies indicate that the rate of energy consumption has increasing exponentially. It is necessary to support the implementation of this type of project in most of the Libyan regions and to work on integrating solar energy in the terms of obtaining energy.

Some steps must be taken to help implement development projects (renewable energy), including:

- Developing the use of sustainable energy and the possibility of benefiting from the available local factors and resources.
- Working on producing an ideal mix of electric energy by keeping pace with technology and competition in the implementation of projects.
- Take advantage as much as possible from the vast areas, especially in the south of Libya, where temperatures rise to (50) degrees Celsius in summer.
- It is possible to invest in these factors and the possibility of meeting the region's energy needs through renewable energy, as well as exporting the surplus to neighboring countries and to Eastern European countries, for example.
- Focusing on this type of project and providing the necessary capabilities for the implementing companies to reach a developmental and advanced energy system that can be applied throughout the Libyan territory.

1. THEORETICAL BACKGROUND

This article aims to develop and innovate methods of energy production in Libya, where these projects depend on 95% of oil and coal resources, as it is from the researcher's point of view that solar power plants are not very expensive, as is the case in other sources that depend on petroleum products in the power generation stages.

In terms of natural resources, Libya is one of the countries that have the most oil wealth, as it depends heavily on these resources for energy production. The oil fields in Libyan cities and the increase in oil refining operations cause pollution in terms of rising gases in the environment.

In the figure 2 are some of the cities from which energy is obtained through petroleum products. Libya ranks as the ninth out of 10 countries in terms of the largest oil reserves in the world, with oil production reaching 1.2 million barrels per day. Libya began drilling for oil in 1955 after the issuance of the General Petroleum Law, through the management of the National Oil Corporation. Libya faces a challenge in terms of preserving oil and gas, despite its geographical location, it is considered an attractive region in terms of availability of renewable energy resources and also its proximity to the European market. The economic advantages of extracting oil using solar energy in an enhanced manner reduces the amounts of gases emitted by a percentage (80%) where it can be exploited in the processes of generating electric power. As one of the most important benefits of generating steam from enhanced oil using solar energy is to obtain energy that is free from gas emission problems, as the enhanced recovery of oil with solar energy helps reduce the amount of nitrogen oxides and carbon dioxide elevation into the atmosphere.

The integration of solar energy in this field enjoys advanced technologies, as well as economic and environmental benefits, in contrast to traditional technology in the refining of crude oil and gas.

In order to achieve and meet the increasing demand for energy, we must focus on the use of resources from natural energy, through reports published in the International Energy Agency that the oil reserves in Libya have reached nearly 48 billion barrels (OPEC).

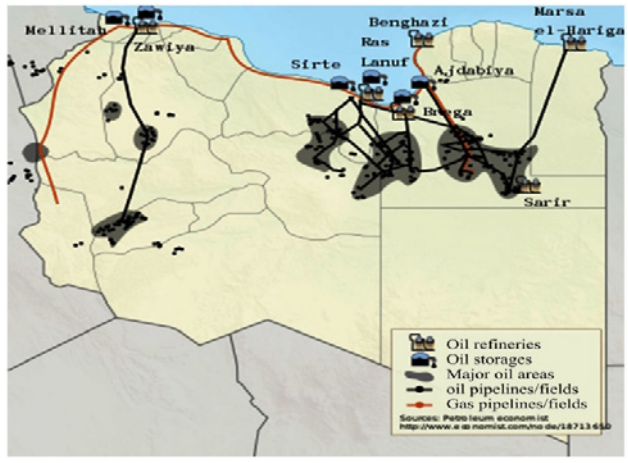

Figure 2. Oil refining operations in some Libyan regions
Source: Jenkins et al. (2019).

Also, according to data from the Organization of Petroleum Exporting Countries (IEA), natural gas reserves are 1.45 cubic meters. The daily oil production in Libya amounts to 1.6 million barrels per day. Through studies in the field of renewable energies, it is necessary to address the expansion of the use of natural sources of renewable energies, to create a kind of balance in electricity generation projects, where solar energy is one of the best renewable solar energies that can be used in the construction of solar power plants by designing many solar panels in the vast areas in the Libyan territory.

Libya has a clear and ambitious intention of creating a mixture of renewable energies and researching the possibility of developing methods of obtaining electric energy from a pure source.

In the past few years, Libya has relied on electric power plants that depend on fossil fuels to produce energy. Sometimes the amount the demand for electricity is greater than the power generated, and it is necessary to resort to alternate

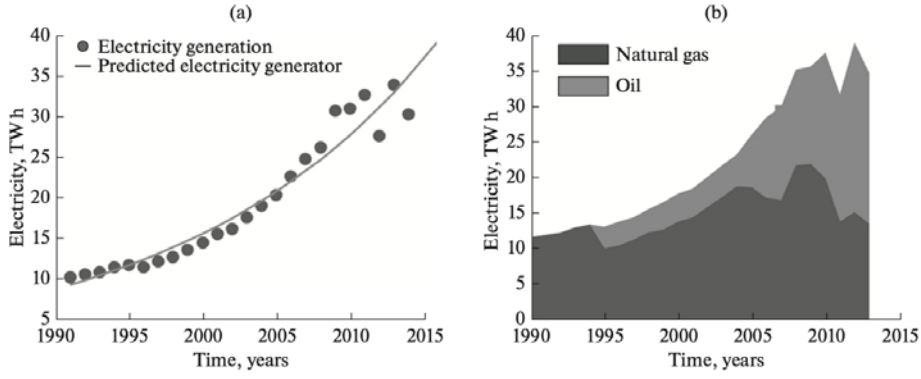

Figure 3. The benefits od the transition. (a) The electricity consumption in Libya from 1990–2015. (b) The electricity generated by the oil and gas
Source: Khalil et al. (2017).

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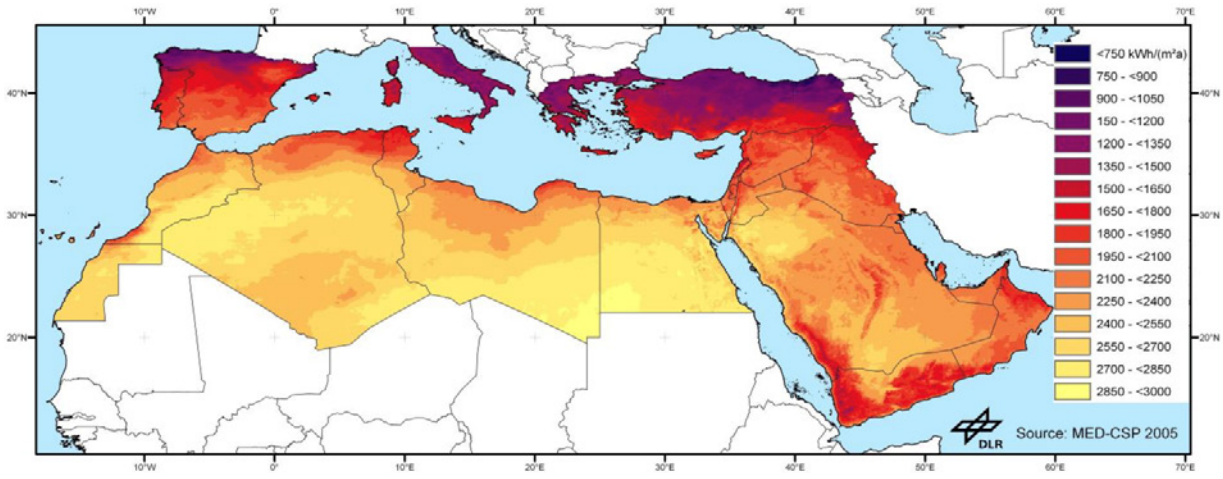

Figure 4. Direct solar radiation over the vast areas in Libya
Source: Belgasim & Elmnefi (2014).

sources of energy, creating a balance in production processes and finding innovative methods in preserving the electrical grid from consequences of collapse in terms of deficit in energy production (Figure 4).

Solar energy in the right climate and the ideal management of renewable energy projects produce balance in the electrical grid, as well as access to energy and through these projects cities become developed and have an ideal ecosystem (Figure 4).

Some projects in communication systems, for example, the mobile phone company (Al-Madar Company) has made the first experiment to generate electric power through solar energy (renewable energy) by distributing solar panels in 1998, and these projects have proven their success through obtaining energy in an independent manner by solar panels. (Maghrebvoices, 2022).

There are some foreign companies that had been granted Libyan licenses and contracts to implement solar power plants, including the Dutch company (AG Energy),which started to implement these projects in the Libyan city of Ghadames with a capacity of 200 megawatts in northwestern Libya. These projects were mentioned on the Solar Quarter website through the latest renewable energy news, as these projects are considered among the first renewable energy (solar energy) works in western Libya.

The French company Total had signed a contract for the implementation of solar energy projects also in November 2021, and that was agreed upon at the Libya Energy and Economy Summit that was held in the capital, Tripoli, where one of the most important things in this agreement is the implementation of electric power plants with a capacity of 500 megawatts from Solar Energy. Also, the Italian company Eni announced in 2021 its study of implementing a group of solar power plants in the city of Rabiana in southern Libya to cover the region's needs for electric energy. The possibility of obtaining electrical energy through solar power is very encouraging, as this is due to the location of Libya in the center of North Africa, where the desert constitutes vast areas

Figure 5. Solar panels in the vast areas of Libyan land
Source: Shinkada & Ibrahim (2021).

(Figure 5), and through some studies, solar radiation reaches approximately 1900 kilowatts per hour\square meter in the northern region. As for the southern region, the radiation reaches more than 2,800 kilowatts per hour/square meter.

Solar Energy in Libya is very important, as solar radiation in the summer, for example, reaches a high percentage that encourages investment projects of renewable energy (solar energy), but when an appropriate mechanism is developed to invest this energy, which can be a basic pillar to produce renewable and environmental friendly energy.

Through the development and innovation in the field of solar energy, the positives are reflected through the reduction in dependence on fossil fuels and the depletion of the country's resources and the needs of future generations. The Libyan energy strategy should have among its priorities the principle of renewable energy, which depends on integrating methods of obtaining energy from natural and renewable sources. It is also necessary to research how to implement these projects with local and international companies in this field, as well as ways to achieve them in a way that ensures development and sustainability.

2. RECOMMENDATIONS

One of the advantages of the Libyan cities' projects for the production of renewable energy is to contribute to improving economic development, as it can provide many job opportunities for Libyans as well as develop their skills in this field. In order to achieve these goals, we must continue to develop this type of projects in Libyan cities and research On ways to harness renewable energies, as well as encourage the principle of human resource development through raising competencies and development inside and outside Libyan cities.

The world today is highly dependent on energy in all fields, and thus the pursuit and competition in obtaining energy from natural resources continues.

Solar energy is one of the types of energy that is renewable in nature and research in this field through such studies and comparing them with what was followed in developed countries in order to develop an appropriate mechanism for investing money in the regions. Although the climate plays an important role in the production of electrical energy through solar panels, solar energy also requires innovation in power generation systems to achieve a sustainable development system. The pursuit of finding ways to benefit from solar energy is one of the priorities of developing cities through renewable energy, as well as opening the way for local and international companies to invest in this aspect.

It is necessary to establish the principle of not depleting the savings of future generations and moving away from dependence on oil and gas wealth, as diversity in natural resources and access to energy to meet the needs depends on the ideal management of these projects by the companies implementing the development projects and the authorities that guarantee access to energy in an ideal and environmentally friendly manner. In terms of time, a specific mechanism and timetable must be established between the companies executing the project and the project owner, whether it is the government, the General Electricity Company or the private sector through power generation programs.

From the researcher's point of view, the political will in sustainable development projects is to be better aware of the development taking place in the world, as well as to seek to innovate renewable energy generation systems and keep pace with the times.

Increasing the production capacity of electrical energy in Libya through solar panels is a necessary issue and how to achieve it is considered one of the responsibilities of all parties to live in a pure environment in one way or another far from the sources of energy that produce gases and pollute the environment.

3.CONCLUSION AND DISCUSSION

Through this article, some of the renewable energy projects that have been sought to be implemented, and some that have been contracted with European companies to implement electric power plants from renewable energy sources (solar energy), are identified.

Encouraging this type of business in Libyan cities, for example in the capital, Tripoli, to directly rely on solar energy in street lighting, as well as generating electric power separately from the electric grid, as was indicated in the work of mobile phone companies (Al-Madar Al-Jadeed) (Saleh et al., 2010).

The world today suffers from gas emission problems, including carbon and carbon dioxide. Although some countries have large reserves of oil and gas, the world encourages electricity generation from renewable energies (sun and wind). The projects that have been implemented in the city of Al-Zawiya in western Libya using renewable energies (solar energy) have achieved satisfactory results in street lighting in the region, thus encouraging energy investment in this field. (Abuashe & Almariami, 2020).

The climate in Libya is very suitable for the implementation of renewable energy projects, where radiation and temperatures are important factors in this aspect. Although the oil and gas wealth in Libya is relatively large, the goal of integrating solar energy (renewable energies) in electricity generation is to reduce the emission of gases into the atmosphere as much as possible.

By encouraging and subsidizing access to electricity from renewable energy, people can switch to electric and environmentally friendly transportation. From the researcher's point of view, there is a noticeable balance in the natural resources for energy production; that is if the increase in demand for petroleum products is not significant in the presence of other natural energies and resources such as solar energy.

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Although the prices of fuel from petroleum products in countries rich in oil and gas are low, and the possibility of changing to solar energy is something that we may meet in the early stages of investing renewable energy, but awareness and articles in reducing pollution and investing in renewable energies can facilitate the mechanism. The world today is based on renewable, clean and environmentally friendly energies.

REFERENCES

Abuashe, I. A., & Almariami, A. A. (2020). Street lighting using solar energy in the municipality of Zawiya. https://www.researchgate.net/publication/342529880_anart_alshwar_bastkhdam_altaqt_alshmsyt_bbldyt_alzawyt

Al-Farsi, A. (2021). The future of renewable energy in Libya. Attaga. https://attaqa.net/?p=78290

Al-Naas, J. S. (2020). Renewable energies in Libya. Studies on solar energy in Libya. https://www.researchgate.net/publication/355188129_altaqat_almtjddt_fy_lybya_-_drast_lltaqt_alshmsyt

Belgasim, B., & Elmnefi, M. S. (2014). Evaluation of a solar parabolic trough power plant under climate conditions in Libya. In *13th International Conference on Sustainable Energy technologies (SET2014). 25th – 28th August 2014, Geneva, Switzerland*, Paper ID: SET2014--E10031. https://doi.org/10.13140/2.1.3788.4485

Jenkins, P., Elmnifi, M., Younis, A., Emhamed, A., Amrayid, N., Alshilmany, M., & Alsaker, M. (2019). Enhanced Oil Recovery by Using Solar Energy: Case Study. *Journal of Power and Energy Engineering*, 7(6), 57–67. https://doi.org/10.4236/jpee.2019.76004

Khalil, A., Rajab, Z., Amhammed, M., & Asheibi, A. (2017). The benefits of the transition from fossil fuel to solar energy in Libya: A street lighting system case study. *Applied Solar Energy, 53*, 138–151. https://doi.org/10.3103/S0003701X17020086

Maghrebvoices. (2022). The Libyan city of Ghadames, an international company intends to build the largest solar power plant. https://www.maghrebvoices.com/libya/2022/10/01/

Saleh, I. M., Zageb, K., & Ellforti, A. (2010). Solar cell systems and their role in distributing the communications base in Al-Madar Telecom Company. In *Libyan Arab International Conference in Electrical and Electronic Engineering, Tripoli, Libya*. https://www.researchgate.net/publication/321342864_mnzwmat_alkhlaya_alshmsyt_wdwrha_fy_twsy_qadt_alatsalat_fy_shrkt_almdar

Shinkada, H. S., & Ibrahim, A. A. (2021). Improvement the MPPT Algorithm for Solar Energy Systems in Libya. https://www.researchgate.net/project/Solar-Energy-Systems-In-Libya