

Solar energy in Algeria between exploitation policies and export potential**الطاقة الشمسية في الجزائر بين سياسات الاستغلال وإمكانيات التصدير****Fares Trek¹**¹ University larbi tebessi Tebessa, tarek.fares@univ-tebessa.dz

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Abstract: This study aims to analyze the status of solar energy exploitation policies in Algeria in order to identify opportunities for export them.

We have found through the study that Algeria has enormous potential for solar energy because of its vast area and location within the solar belt, this has made it among the most reliable countries in the production of solar energy.

Through the discussion of the various proposed projects that aim to investing in solar energy and exporting it, we have reached That Algeria is not far from the exported of solar energy but that would be if there is a genuine desire to promote the exploitation of this energy source.

Keywords: Renewable energies; Solar energy; Desertec Project; Sahara solar breeder Project; Maghreb European Solar Hydrogen Project.

Jel Classification Codes: Q20, Q27, Q28.

ملخص: تهدف هذه الدراسة إلى تحليل إمكانيات الطاقة الشمسية في الجزائر ، وكذا تشخيص أهم سياسات ومشاريع استغلالها، وصولاً إلى تحديد فرص تصديرها. وقد توصلنا من خلال الدراسة إلى أن الجزائر تتمتع بقدرات هائلة من الطاقة الشمسية بسبب اتساع مساحتها وتموقعها ضمن الحزام الشمسي، مما جعلها من بين أهم الدول التي يعول عليها في إنتاج هذه الطاقة، ومن خلال التطرق لمختلف المشاريع المطروحة والهادفة إلى الاستثمار في الطاقة الشمسية وتصديرها، توصلنا إلى أن الجزائر ليست ببعيدة عن تصديرها لهذه الطاقة، ولكن لن يتم ذلك إلا إذا توفرت الرغبة القوية والحقيقية لتعزيز استغلال هذا المصدر الطاقوي.

كلمات مفتاحية: الطاقات المتجددة، الطاقة الشمسية، مشروع ديزرتيك، مشروع صحراء صولار بريدير، المشروع المغربي الأوروبي للهيدروجين الشمسي.
تصنيف JEL : Q28, Q27, Q20.

1.INTRODUCTION:

Solar energy is one of the greatest concerns of the contemporary world, as many parties seek to integrate it not only to the energy supply system but also to make it like other traditional energies cross borders and continents, the export of solar energy has been a preoccupation of many experts and energy specialists for a long time.

Although the traditional energies represent the basis of international energy exchanges, they are considered to be the artery of Algeria economy as a whole. It suffices to point out then, that 95 per cent of the country's income is due to its exports. Accordingly, because Algeria is not immune to problems facing traditional energies, it has also relied on some strategies for valuing Its potential of solar energy and the developing its use through current and future objectives and projects, This is to improve their exploited and exported.

From the above, problematic aspects of this study revolve around the following key question: What is the status of solar energy exploitation policies in Algeria, and is this energy usable in foreign trade? To answer the study problem, we formulated the following hypothesis: Algeria is not far from the exported of solar energy, but that would be if there is a genuine desire to promote the exploitation of this energy source.

This research study also attempts to clarify the potential of solar energy in Algeria, as well as the diagnosis the most important policies and projects of exploitation, in order to identify opportunities for export. In pursuit of our study objectives, we have used the descriptive-analytical approach, which is considered a form of scientific analysis and explanation organized to describe a specific phenomenon or problem, and to classify, analyze, and subject it to a study.

2. potential and resources of solar energy in Algeria

Algeria has enormous potential for solar energy, due to the vastness of its area on the one hand, and its geographical location on the other hand, it's one of the richest solar fields in the world, considering the amount of energy received per square meter of 5 kWh, on most parts of the national territory, and sometimes up to 7 kWh, this allows an annual radiation exceeding 3000 kWh per square meter per year over an area of 2,381,745 km². (BoudrieS, 2003, p74)

The average annual radiation in Algeria exceeds 2000 hours to reach 3,500 hours of sunlight in the desert, which constitutes 4/5 of its land area. (Abdeladim, 2014, P 4120) thus ranking Algeria among the best three solar fields in the world, where she and Iran and Arizona region in the United States of America the largest and best Solar fields in the world (Howaicha, 2014, p 9), As well the German Aerospace Center (DLR) concluded that Algeria has the largest solar potential in the Mediterranean basin (Abdeladim, 2014, P 4120), where this solar capacity represents (Ministry of Energy and Mines, 2008, P 03):

- 169,440 terawatt-hours / year;
- 5000 times Algerian electricity consumption;
- 60 times Europe's electricity consumption ;
- 04 times global electricity consumption.

The following table shows the solar energy capacity by region in Algeria.

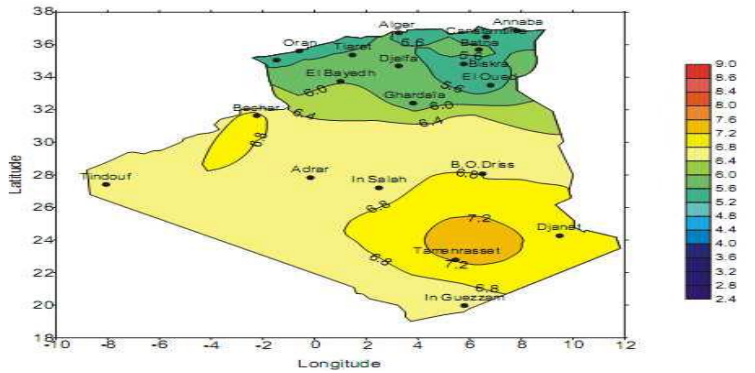
Table 1. Solar energy capacity by region in Algeria

Regions	Coastal areas	High plateaus	The desert
Area %	4	10	86
Average sunshine duration (hours / year)	2650	3000	3500
Rated power (kWh/m ² / year)	1700	1900	2650

SOURCE: ABADA, 2018, P 02

Thus, Algeria, through its geographical location, enjoys large amounts of solar brightness. This makes it an important solar mine as shown in figure (1).

Fig.1. Annual average of solar radiation intensity in different regions of the country (kwh/ m²/ day)



Source: CDER, 2002, P 12

It is clear from the figure that Algeria has a significant amount of solar radiation that could qualify it for the adoption of solar energy mainly in its development plans, especially the part related to the removal of isolation from remote areas, by raising human development indicators and providing safe, sustainable and less expensive energy supply.

3. Solar Policies within the National Renewable Energy Development Program (2011-2030)

Algeria crosses one of the countries of the world that possesses many wealth in the field of renewable energy sources, which need only the political will and economic management to maximize the use of them in the coming period, which gives it an advantage to enter the stage of mass industrialization and compete with the largest economies if well exploited this energy through Strong strategy.

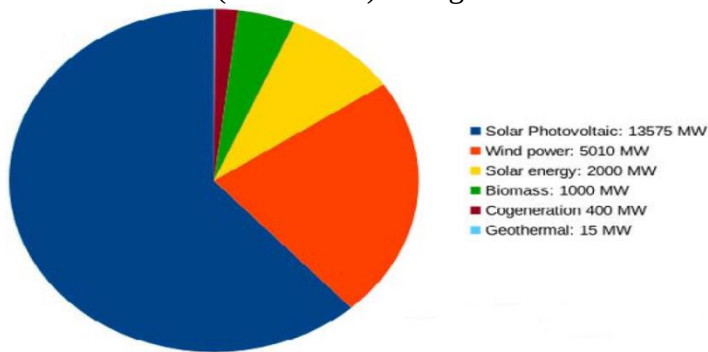
In this context, under the National Renewable Energy Development Program (2011-2030), Algeria began construction of the first solar power plant in Hassi Rmel in 2011 with a production capacity of approximately 25 megawatts.

By 2030, including 12,000 megawatts for domestic consumption and 10,000 megawatts for export abroad, with investments exceeding \$ 120 billion. This program is distributed on the achievement of 13575 MW photovoltaic energy, 2000 MW solar thermal energy, 5010 MW wind power, 1000 MW biomass energy, 400 MW thermal pressure energy and 15 MW geothermal energy.

(Renewable Energy Development Center of Algeria, <http://portail.cder.dz/ar/spip.php?article3301>)

As shown in figure (2).

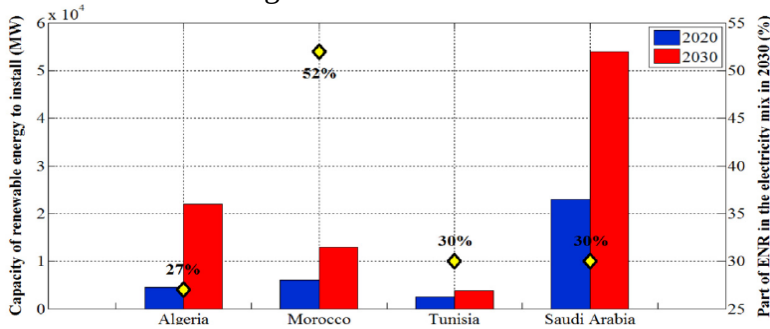
Fig.2. Objectives of the National Renewable Energy Development Program (2011-2030) in Algeria



Source: Renewable Energy Development Center of Algeria, <https://www.cder.dz/spip.php?rubrique330>.

By 2030, the program will achieve a share of renewable energy of about 27% in the national electricity production scheme. The natural gas supplied by renewable energy of 22,000 MW is about 300 billion MW, which is 8 times the national consumption in 2014. (Renewable Energy Development Center of Algeria, <http://portail.cder.dz/ar/spip.php?article3301>)

This share remains low compared to the objectives of national programs for the development of renewable energies in many Arab countries, despite the huge potential of solar energy in Algeria. as shown in figure (3).

Fig.3. Capacity and part of the renewable energy in the national electricity by 2030 in Algeria and other Arab countries

Source: Zhour Abada, 2018, P 7.

As for the phases of the 22,000 MW renewable energy program in Algeria, more than 4,500 MW will be achieved by 2020 as shown in table (2) and figure (3)

Table 2. Phases of the Algerian renewable Energy Development Program (2011-2030)

Energy type	1st phase 2015-2020 [MW]	2nd phase 2021-2030 [MW]	Total [MW]
Photovoltaic	3000	10,575	13,575
Wind	1010	4000	5010
CSP	-	2000	2000
Cogeneration	150	250	400
Biomass	360	640	1000
Geothermal	05	10	15
Total	4525	17,475	22,000

Source: Zhour Abada, 2018, P 7.

Under this program, 26 solar power plants with a capacity of 400 megawatts were completed by the end of 2018. It is worth mentioning that 1 megawatts is enough to illuminate 1500 houses, and 3 solar panels production plants were established (Renewable Energy Development Center of Algeria, <http://portail.cder.dz/category/efficacite-energetique>)

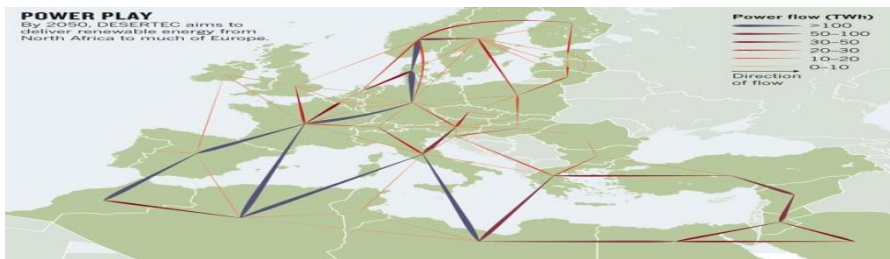
4. Solar energy export projects in Algeria

There have been numerous initiatives and projects aimed at exporting solar energy from its brightness sites to global networks, of which Algeria was an important part of its plans. The following are some of the most important projects for the export of solar energy from Algeria.

4.1. DESERTEC project for the export of solar energy

A. About the DESERTEC project: The DESERTEC project the largest renewable energy project in the world, sponsored by the German Foundation "DESERTEC", has been awarded the project by the Club of Rome and the Commission on Mediterranean cooperation in the energy, officially launched in July 2009, comes this program to be the most important International proposals for the use of solar energy as a primary source of electricity production. (Marie Legivere, 2010, PP 02-03) The DESERTEC project aims to exploit non-fossil energy capacity, especially solar energy, to produce electricity and provide 15% to 20% of the needs of the European market in 2050. The solar plan aims to generate 20 MW of electricity from renewable energy in the Mediterranean region. By 2020, reaching 50 MW by 2050, the project aims to create an industrial renewable energy market from the Sahara in North Africa and the Middle East. (Esmeralda Garcia Moreno, 2011, p13), as illustrated in figure (4)

Fig.4. The goal of Desertec project by 2050



Source: Powell Devin, <https://www.nature.com/news/saharasolar-%20plan-loses-its-shine-1.11684>

B. Cost of DESERTEC project: According to Christie Vittak, senior official at the Department of Renewable Energies at the German Ministry of Economy and Technology, the project Desertec has a financial envelope of 400 billion euros, to meet the needs of Europe's solar energy from the Sahara, where 350 billion euros is allocated for the construction of sophisticated connected plants By converting solar energy into electrical energy, the remainder is devoted to building networks of high-tension poles from production centers to Europe. (Isabel, 2010, PP 09-12)

C. The main obstacles facing the implementation of the DESERTEC project:

There are a number of constraints that faced the implementation of the Desertec project, can be limited to the following points (Isabel, 2010, PP 39-60):

- conflicts of interest with respect to production quotas and marketing;
- Germany's procrastination and obstruction of technology transfer to Algeria;
- The cost of power generation networks. It is estimated that the cost of investments to build power bridges across the Mediterranean is expected to be € 02 million per kilometer per 400 MW cable;
- Security risks associated with the risks of securing investments and laws, secondly, securing the transfer of energy from political and economic threats, and thirdly, securing energy infrastructure.

4.2. Algerian-Japanese project For solar energy "Sahara Solar Breeder (SSB)"

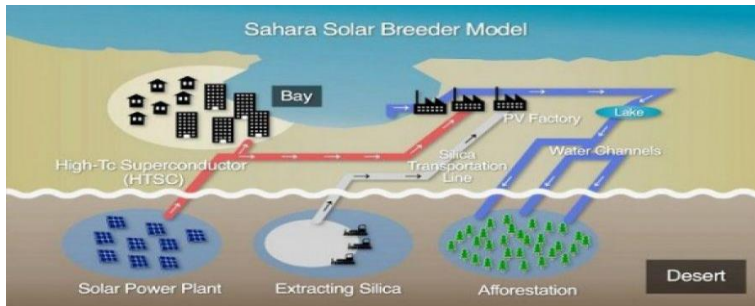
A. About Sahara Solar Breeder Project (SSB): The Sahara Solar Predder program, which is part of the Algerian-Japanese scientific cooperation, is an example of the Algerian-Japanese partnership based on technology transfer. It is based on "innovative solutions" such as superconducting cables that will be used to transmit electricity. Since its launch, the program on solar energy technology has allowed the Algerian University to benefit from significant research, training and equipment gains, explained Prof. Bodegen Istanbul at the Fourth Asia-Africa Forum on Sustainable Energy in Algeria. (sahara solar breeder foundation, <http://www.ssb-foundation.com>)

Prof. Istambouli Boden of the USTO University of Oran announced that the two-world global project of the university and six Japanese universities, including the University of Tokyo, is supervising the laying of its field foundations in Algeria through the arrival of the necessary equipment from Japan at the end of 2011. It also came because of the availability of a huge solar tank, where studies have shown that only 10% of solar energy can illuminate Europe, and this shows the large size of this natural energy available in our country, which Japan has been interested in through the project of photovoltaic power generation, where Extraction of th Silicium from the sand and its use in the generation of electricity, which can be used in homes and even for institutions and departments, depending on the size of the power plants and their high technologies.

Baudgen explained that the beginning will be happy to establish a pilot station working in coordination with the research center at the University of Oran. A second station is funded by the Directorate of Scientific Research at the University and the Research Center on Renewable Energies in Adrar. The research and experimental period will last until 2016, over a period of five years at a value of \$ 05 million for the generation of power of 100 GW, which is equivalent to 100 billion watts of photovoltaic power until the horizons of 2050, Bodgen said that the cost of research and installation may be large, but the cost of extracting silicon is low compared to extracting traditional energies. (Boudghene, 2013, PP 111-112) It is worth mentioning that the Sahara Solar Breeder Project aims in one way to develop the region through investment in the agricultural field. It allocates part of the energy produced to the purification of sea water, which will be used for irrigating crops, thus increasing employment in the industrial, agricultural and manufacturing fields. In this way Algeria will benefit from one of the most important type of renewable energy, solar energy. The Japanese partner will benefit from the project in the agricultural field through profit sharing. Thus,

the Sahara Solar Breeder project is indeed a true partnership between developing countries (Algeria) and developed countries (Japan). As shown in figure (5).

Fig.5. Sample *Sahara Solar Breeder Project (SSB)*



Source: H. Koinuma, H. Fujioka, K. Kurokawa, <http://www.ssb-foundation.com>

B. Cost of Sahara Solar Breeder Project (SSB):

At the University of Science and Technology, Mohamed Boudiaf in Oran, a new technique for the production of silicium has been developed, as announced by the Algerian-Japanese Program Manager (SSB) for solar technologies, he explained that Algeria's sands have 71% silicium, making it "the most important in the world", the exploitation of this material allows the development of the manufacture of solar panels in Algeria, it thus raises it to the ranks of its main supplier due to the availability of raw materials.

The technique is to extract the silicium contained in the rock called "diatomace", which is available in a significant amount in the Siq (Mascara). Silicium from sand is essentially a substance in photovoltaic components that allows solar radiation to be converted into electrical energy, the SSB program is based on the exploitation of solar energy from light layers, in this context, Mr. Assemboli pointed out the importance of exploiting the Diatomaceous rock, he pointed out that the stock of this raw material is estimated at 06 million tons in the region Only one-third of this capacity is needed to produce 100 GW, which is significant and economical. (Boudghene, Koinuma, 2012, PP 591-598)

4.3. The Maghreb-European project in the field of solar hydrogen

The partnership between the countries of Southern Europe and Algeria can be strengthened in the coming years through the Moroccan-European project of solar hydrogen, where the Center for the Development of Renewable Energies in Algeria, coordinate efforts at the level of the Maghreb. The responsibility of coordinating efforts at the level of the northern Mediterranean countries is entrusted to the European Company for Hydrogen Technologies. (Algeria, France, Greece, Spain, Italy, Germany, Switzerland, Turkey, United Kingdom, Libya, Tunisia, Morocco, Egypt) The project was created by the Algiers Declaration at the World Hydrogen Energy Conference on 14 June 2006. These experts highlighted their confidence in exploiting Algeria's enormous solar potential to produce high-level solar hydrogen through the establishment of a consortium of large companies and the birth of a major future project. (Bouziane, 2007, PP 3-4) The Maghreb-European project on solar hydrogen aims to achieve the following objectives (Bouziane, 2007, PP 7-9):

- The development of high-efficiency technologies for hydrogen production by solar energy, as well as hydrogen production, depending on the situation, from water or hydrocarbons;
- Development of hydrogen transport technology over long distances: natural gas pipelines, maritime transport;
- Assess, compare and validate the safety of high-quality technology from the perspective of its industrial development in its overall dimensions and levels;
- Forming effective experts in the fields of research, development and manufacturing in order to contribute to the development of this new energy.

In 2006, the Center for the Development of Algerian Renewable Energies was charged with coordinating the efforts of the Maghreb countries, while the

European Hydrogen Technologies Company has been mandated to coordinate efforts for countries on the northern bank of the Mediterranean, the Algerian research team concluded that the project could be launched by the establishment of a solar power plant near the city of Ghardaia, near the gas fields Hassi sand, because the site has all the ingredients of success, namely: a solar reservoir is considered, huge quantities of exploitable water, and gas pipeline network Trans-average through which hydrogen is transported. (Cherigui, 2009, P3938-3943)

5. CONCLUSION:

5.1. Discussion of the results

Algeria has enormous potential for solar energy because of its vast area and location within the solar belt, this has made it among the most reliable countries in the production of solar energy through which local needs and requirements can be met, in addition to the possibility of exploitation and export abroad.

Algeria seeks to search for export alternatives to traditional energies, relying on a variety of sources and more durable, and resorted to the model of the countries of the world to exploit their abundant potential of renewable energies and solar energy in particular, this is to give a new impetus to the sector and to support its energy export position.

Although Algeria was not the first to invest in solar energy, this is due to many reasons, including the availability of traditional energies, especially oil and natural gas, concerned about the high cost of solar and other investments, however, it has made progress in this area both from the research and technical side, or from the practical side.

Algeria has succeeded in setting up a good number of solar projects. There are also a variety of projects to export solar energy across continents, especially from North Africa to Europe. Algeria is a key link in these projects. The most important of which is the Algerian-German project DESERTEC, the Algerian-

Japanese project, the Sahara Solar Breeder, as well as the Maghreb European project for solar hydrogen and other projects aimed at exporting solar energy.

It is noteworthy that among these projects are doing well, such as the Algerian-Japanese project, the Sahara Solar Breeder, some of them are disabled, such as the Algerian-German project DESERTEC.

The most important reason for the success of the Japanese offering is to enable the Algerian party to acquire the advanced technology and technology of solar energy systems through joint research and development. The involvement of Algeria in the various details of the project for its own manufacturing or by the completion of projects and the production of electric power, the project is highly regarded as one of the most important future projects that will succeed in exporting solar energy across continents.

Although the future of clean industry for solar technologies is very promising, however, the export of its products from one place of production to another relatively remote place, such as the transfer of electricity across continents, continues to be hampered by many obstacles, problems related to network incompatibility and synchronization, lack of compression infrastructure, network interconnection, and energy storage problems. At first glance, it appears to be one of the biggest obstacles to the export potential of solar energy. However, the lack of serious and adequate political and governmental orientation and support for solar energy programs as well as reservations and preference for conventional energy options, conflicts of interest and lack of integration in addition to the various security risks spread in many areas. All these reasons are the main stumbling block to the success of the export of solar energy and the translation of strategies and policies in reality.

5.2. Recommendations

Directing attention to solar energy more than directing it to investing in shale gas, because it has many negative effects on the environment and pollutes

water resources, as it is considered non-renewable energies, and thus work directly to direct towards permanent energies instead of exerting huge efforts and sums in depleted energies and then returning Back to the starting point and the search for alternatives again.

Encouraging and providing opportunities and incentives for the private sector to invest in the production and marketing of energy produced from solar energy.

Work to spread awareness, provide incentives to use solar energy technologies, and support citizens who use solar energy in their homes or for various needs.

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