

Renewable energy potential , Legal , regulatory framework and real implementation in Algeria

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Abstract— Due to fossil source price disturbance such as petrol and natural gas in the world market, the transition to renewable energy resources integration in Algeria becomes an essential key for reducing greenhouse emission and decreasing the dependence to conventional sources. In this paper. Firstly, a brief of renewable energy potential was reviewed. Followed by an overview of the real application of national program launched in 2011 especially concerning the PV/ Wind grid-connected systems in Algeria was addressed. Finally, the main negative reasons that affect renewable energy education in Algeria are discussed.

Keywords— *Renewable energy potential; Legal and regulatory framework; RE education; real implementation.*

I. INTRODUCTION

Algeria has a significant energy resource potential. Beyond oil and gas resources, the exploitation of renewable energies, especially solar energy [1], will diversify the energy base and reinforce the country's sustainable development. Algeria is launching a green energy dynamic by launching an ambitious program of development of renewable energies (RE) and energy efficiency. This vision of Algerian government builds on resource development strategy inexhaustible as solar and their use to diversify energy sources and prepare the Algeria of tomorrow. Thanks to the combination of initiatives and intelligences, Algeria is embarking on a new sustainable energy era. The updated renewable energy program consists of installing a 22,000 MW of renewable energy by 2030 for the national market, with maintaining the export option as a strategic objective, if market conditions allow it [2].

II. GEOGRAPHICAL CONDITIONS

Algeria has a key location in the north of Africa, and it is the largest country in Africa. Algeria is situated between the 35° and 38° of latitude north and 8° and 12° longitude east. The total of the surface of Algeria equal to 2,381,741 km² where Sahara occupies 86 % of this area it is divided into 48 provinces. Furthermore, bordered from the north by the Mediterranean Sea, to the south by Mali and Niger, to the

East by Tunisia and Libya, to the west by Morocco, Western Sahara, and Mauritania [3], as presented in Figure 1.



Fig.1. Algeria map [4].

III. POTENTIAL OF RENEWABLE ENERGY

A) Solar energy

View of its geographical location (see Figure 2), Algeria has one of the most raised in the world. The duration of sunstroke on almost the entire national territory exceeds 2000 hours annually and can reach 3900 hours (highlands and Sahara). The energy received annually on a horizontal surface of 1m² is close to 3 KWh / m² north and exceeds 5.6 KWh / m in the South (TAMENRASSET) [5], [6].

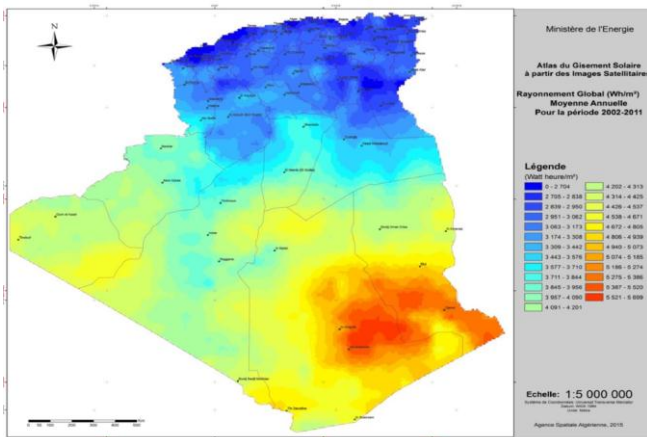


Fig.2 Average Annual Global Direct Irradiation Map (Period 2002-2011).

B) Wind

The wind resource in Algeria varies a lot from one place to another. This is mainly due to a very diverse topography and climate. Indeed, our vast country is subdivided into two distinct geographical areas. The North Mediterranean is characterized by a coastline of 1200 Km and a mountainous terrain, represented by both chains of the Tellien Atlas and the Saharan Atlas. Between them are interspersed plains and highlands of Continental climate. The South, meanwhile, is characterized by a Saharan climate. The map shown below shows that the South is characterized by higher speeds. Northern, particularly in the Southeast, with speeds greater than 7 m / s and which exceed the value of 8 m / s in the region of Tamanrasset (In Amguel). Regarding the North, it is generally noted that the average speed is low. We notice however, the existence of microclimates on the coastal sites of Oran, Bejaia and Annaba, on the highlands of Tebessa, Biskra, M'sila and Elbayadh (6 to 7 m / s), and the Great South (> 8m / s) (see Figure 3) [7], [8].

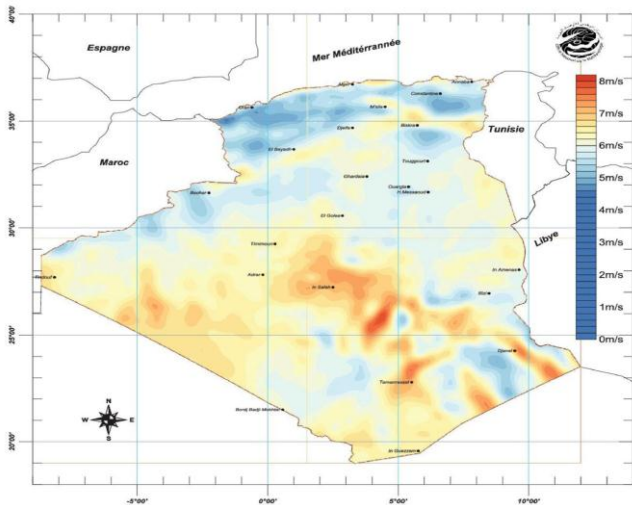


Fig.2 Average Annual Wind Map (Period 2001-2010).

C) Geothermal Energy

The compilation of geological, geochemical and geophysical data has identified more than two hundred (200) hot springs that have been inventoried in the northern part of the country. About one-third (33%) of them have temperatures above 45 ° C. There are: high temperature sources up to 118 ° C in Biskra. Studies on the thermal gradient have identified three zones whose gradient exceeds 5 ° C / 100 m [9].

- Relizane and Mascara area
- Area of Aïne Boucif and Sidi Aïssa
- Guelma and Jebel El Onk area

D) Hydraulic

The global quantities falling on the Algerian territory are important and estimated at 65 billion m³, but finally benefit little to the country: reduced number of days of precipitation, concentration on limited spaces, strong evaporation, and fast evacuation towards the sea.

Schematically, the surface resources decrease from north to south. At present, 25 billion m³ of useful and renewable resources are being evaluated, of which about 2/3 for surface resources. 103 dam sites have been identified. More than 50 dams are currently in operation [10].

F) Biomass

The current potential is estimated at around 37 Million TEP (Tonnes Equivalent Oil). The recoverable potential is of the order of 3.7 Million PET. The current recovery rate is of the order of 10%

In addition 05 million tons of urban and agricultural waste are not recycled. This potential represents a deposit of the order of 1.33 millions of TEP / year [11].

IV. RENEWABLE ENERGY DEVELOPMENT PROGRAM

A) Program

Through this renewable energy program, Algeria intends to position itself as a major player in the production of electricity from the photovoltaic and wind sectors by integrating biomass, cogeneration, geothermal energy and beyond 2021, solar thermal. These energy sectors will be the engines of a sustainable economic development able to impel a new model of economic growth 37% of installed capacity by 2030 and 27% of electricity generation for national consumption, will be of renewable origin. As the national potential for renewable energies is strongly dominated by solar energy, Algeria considers this energy as an opportunity and a lever for economic and social development, particularly through the establishment of industries that create wealth and jobs. This does not preclude the launch of many wind farm projects and the implementation of experimental projects in biomass, geothermal and cogeneration.

Electricity generation projects dedicated to the national market will be conducted in two steps:

- First phase 2015 - 2020: This phase will see the realization of a power of 4010 MW, between photovoltaic and wind, as well as 515 MW, between biomass, cogeneration and geothermal energy.

- Second phase 2021 - 2030: The development of the electrical interconnection between the North and the Sahara (Adrar), will allow the installation of large renewable energy plants in the regions of In Salah, Adrar, Timimoune and Bechar and their integration into the system National Energy. At this time, the solar thermal could be economically viable.

Algeria's strategy in this area aims to develop a real energy industry renewable resources combined with a training and knowledge capitalization program, which will ultimately allow the use of local Algerian engineering, especially in engineering and project management. The RE program, for the electricity needs of the market national level, will create several thousand direct and indirect jobs [11].

The consistency of the renewable energy program to be achieved for the national market over the 2015-2030 period is 22,000 MW, distributed by sector as provided in Table 1 [12]:

Table. 1. National renewable energy development program over 2015-2030 period

Unit :MW	1 st phase 2015-2020	2 st phase 2021-2030	Total
Photovoltaic	3000	10575	13575
Wind	1010	4000	5010
CSP	-	2000	2000
Cogeneration	150	250	400
Biomass	360	640	1000
Geothermal	05	10	15
Total	4525	17475	22000

B) Legal and regulatory framework

The adoption of the legal framework favorable to the promotion of renewable energies and the construction of infrastructures relating to the production of electricity from renewable energy sources is defined mainly through the following laws, executive decrees and ministerial orders: Renewable energies and energy efficiency development is supervised by whole legislative texts [13]:

- Law No. 99-09 dated 28th July, 1999 pertaining to energy control.
- Law No. 02-01 dated 5th February, 2002, pertaining to public distribution of gas by pipes.
- Law No. 04-09 dated 14th August, 2004, pertaining to promoting renewable energies under sustainable development.

Regulations were reinforced by publishing the following texts:

- Executive decree No. 1-423 dated 08th, December, 2011, that sets terms and conditions for the running of earmarked account No. 302 – 131 with the title «National Funds for renewable energies and cogeneration «.

- Ministerial order dated 28th October, 2012 that determines the bill of incomes and expenses to be debited from FNER.
- Ministerial order dated 28th October, 2012, which specifies terms and conditions for the follow-up and assessment of FNER.
- Executive decree No.13-218 that sets terms for granting allowances under costs for power generation diversification.
- Executive decree No.13-424 dated 18th December, 2013, that amends and completes the executive decree No.05-495 dated 26th, December, 2005 pertaining to energy audit for the large-consuming energy establishments.
- Joint ministerial order dated 19th ,June, 2014 amending and completing the joint ministerial order dated 29th ,September,2010 pertaining to the approval of audit and experts offices
- Ministerial orders dated 02 , February, 2014 setting the purchase list prices guaranteed for power generating from facilities using the photovoltaic industry and the terms of the enforcement thereof.
- Law No.11-11 dated 18th, July,2011 on the complementary finance law for 2011 raises the rate of oil royalty that cashes for the National Funds for renewable energy and has extended its application fields to cogeneration facilities.

V. REAL IMPLEMENTATION

In this section, a general overview of the implement renewable energy power plants like the photovoltaic central and wind farm in different regions of Algeria. The details of grid-connected power plants based on renewable energy managed by the electricity & renewable energy company (SKTM) till June 2018 [14] are given below [15]:

- numbers of centrals installed (21 PV and 1 wind :see Figure 4)
- installed power 354.3 MW
- energy produced since the date of commissioning (PV:865 GWh ,Wind :65 GWh)



Fig. 4 wind farm 10 MW installed in Kaberten (Adrar)

Concerning the installed capacity in Algerian territory till June 2018 is provided in Table 2.

Table 2 The installed capacity to June 2018 [15]

Central		Installed capacity (MW)
Location	Province	
Kabertene (Wind)	Adrar	10.2
Adrar city	Adrar	20
Kabertene (PV)	Adrar	03
In Salah	Tamanrasset	05
Timimoune	Adrar	09
Reggan	Adrar	05
Zaouiat Kounta	Adrar	06
Aoulef	Adrar	05
Tamnrasset	Tamnrasset	13
Djanet	Illizi	03
Tindouf	Tindouf	09
Oued Nechou PV	Ghardaia	1.1
El Hadjira	Ouargla	30
Sedret	Naama	20
Oued el kebrit	Souk Ahras	15
Ain Skhouana	Saida	30
Ain El Bel 1 and 2	Djelfa	53
Lekhneg 1 and 2	Laghouat	60
Labioudh sidi chikh	El Baydh	23
Telagh	Sidi Bel abbes	12
Ain El Melh	M'sila	20
Oued El Ma	Batna	02
Total SKTM	354.3	

VI. RENEWABLE ENERGY EDUCATION

Renewable energy education is an important factor for increasing the attention and promotion of renewable energy [16], in this section of the paper we give the main reasons to avoid for the reinforcement of the education of renewable energies:

- Weak number of the expert in the renewable energy domain.
- Study of renewable energy-focused only in the post-graduate Master program and PhD thesis.
- Weak number of conferences and training concerning the renewable energy field.
- Weak coordination between universities and research centers.

- Weak publicity of the importance of renewable energies for the population in newspapers and TV.
- Weak knowledge of the farmers concerning the importance of photovoltaic pumping, especially in remote areas

VII. CONCLUSION

The Algerian energy ministry has made important efforts for promoting renewable energy integration in the public electricity network and faraway areas through several steps, like the launching of a national renewable energies development program in 2011. An overview of the application of this national program especially about the PV/Wind grid-connected systems in Algeria is presented. Furthermore, the axis of renewable energy education is addressed.

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