Algerian Renewable Energy Projects for Clean Environment

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ABSTRACT

Renewable energy sources RES (solar, wind resources, biomass, geothermal, etc.) that use indigenous resources and that supply16% of the total world energy demand, have the potential to provide energy services with zero or almost zero emission of both air pollutants and greenhouse gases during the last few years, political support for renewable energies has been growing continuously both at the national and international level. In fact the Algerian Government has been promoting the use of renewable energy by means of a series of laws and official programmes. This article presents the progress and efforts for the usage of the existing, on-going and planned projects of the renewable energy in Algeria over these last decades. Through these projects could be very interesting under the Clean Development Mechanism CDM of Kyoto protocol because they reduce greenhouse gas emissions GHG whereas contributing to sustainable development of desert communities if developed correctly.

Keywords: Algeria, CO_2, Renewable energy projects.

1 INTRODUCTION

Ever since its establishment in 1976, the Arab League Education, Culture and Scientific Organisation (ALECSO) has given a great emphasis to the importance of Arab cooperation in the field of renewable energy, bearing in mind that the world is increasing its demand, year after year, on limited sources of non renewable energy. At the same time renewable energy policy has become an essential ingredient of social and economic development plans in the Arab as well as at the world level [1]. According to the Special Report on Emission Scenarios issued by the Intergovernmental Panel on Climate Change (IPCC) under the auspices of the UN, by the end of the 21st century, nations could expect to see carbon dioxide concentrations of anywhere from 490 to 1260 ppm (75-350% above the pre-industrial concentration)[2-3]. The Arab region, that includes Algeria, represents about 15% of the world's total primary energy production [4]. Table 1 shows that energy consumption within the region has more than tripled during the period 1980-2004, from 6.27 quadrillion Btu to 21.48 quadrillion Btu [4-5]. The table also includes the energy production in both Algeria and Arab region and CO_2 emissions.

	Energy Production*			Energy Consumption*			CO_2 Emission**		
Year	1980	1999	2004	1980	1999	2004	1980	1999	2004
Algeria	2.8	6.06	10.03	0.8	1.31	6.21	16.44	23.42	28.60
Arab region	46.82	55.57	62.54	6.27	15.59	21.48	141.65	268.40	354.21

*Quadrillion (10^{15}) British thermal unit (1055.54 J),**Million Metric Tons

Table 1 : Primary production and consumption and CO_2 emission in the Algeria and the Arab region.

In Algeria, in 1980 the electric energy consumption was 6.2 TWh by 1.6 million electricity consumers. These figures have been increased to 5.4 million consumers with energy consumption of 30.9 TWh in 2004.

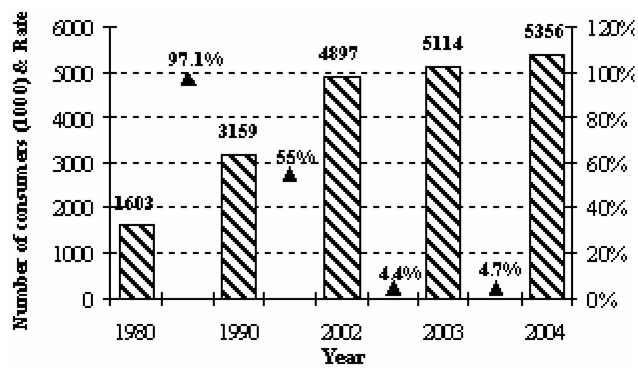

Figure 1: Year wise growth in number of consumers

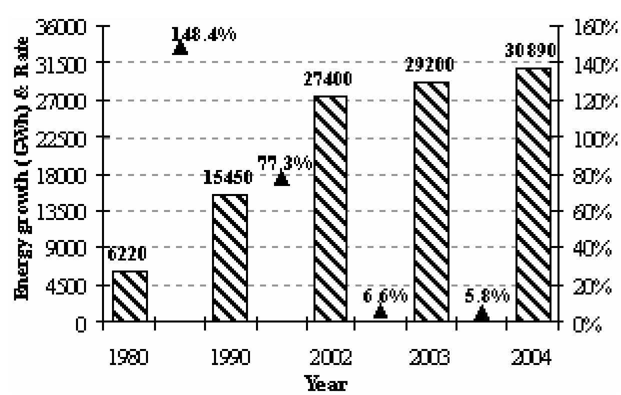

Figure 2 : Year wise energy growth

Figure 1 and Figure 2 show the growth of number of consumers and the electric energy consumption respectively in some selected years [6]. With this growth in electric demand the Algerian Government has realized the importance of renewable energy. It has been realized that the renewable energy projects could be used as tools for the management of reserves and sustainable development of desert communities. There are generally areas where a diesel or gas-powered generator present a problem of fuel transportation and may potentially harm the environment. The Government has initiated programs that aim at increasing the use of renewable energy technologies in Algeria, therefore providing green power to isolated villages and combating global climate change, especially greenhouse gas emissions [7]. The share of renewable energy sources in Algeria primary energy supply is relatively low compared with European countries, though the trends of development are positive. One of the main strategic priorities of NEAL (New Energy ALgeria) which is Algeria's renewable energy agency (Government, SONELGAZ and Sonatrach), is striving to achieve a share of renewable energy sources in primary energy supply of 10-12% by 2010 [8]. Table 2 outline a list of renewable energy projects that have been planned till 2015 [9].

Project and place	Capacity (MW)	Bill-book	Cost ($\$x10^6$)	Observation
SPP1. Hassi R'mal	150	2006-2008	160	Hybrid. Solar gas
SPP2. Naama	400	2007-2010	286	Solar power plant
SPP3. Megha	400	2010-2012	286 + 120	Solar power plant + unsalted process
SPP4. Hassi R'mal	400	2012	286	Hybrid. Solar gas
Total	1350	-	1138	-
WPP1.Tindouf	6	2006-2007	13	Wind power plant
WPP2.Tindouf	10	2008-2010	23	Wind power plant
WPP3.Timimoun	10	2010-2012	23	Wind power plant
WPP4.Bechar	10	2015	23	Wind power plant
Total	36		82	

Table 2 : A total list of power production with renewable sources up to 2015.

NEAL beside Government support has solicited several sources of funding to support these projects including World Bank, AIE and the European bank of investment. The following sections present topography of Algeria and a review of renewable energy potential and projects undertaken in Algeria.

2 TOPOGRAPHY AND ENERGY DATA OF ALGERIA

Algeria's geographic location has several advantages for extensive use of most of the Renewable Energy Sources RES (Wind, Geothermal, biomass, solar, etc). Algeria is situated in the centre of North Africa between the 35°-38° of latitude north and 8°-12° longitude east, has an area of 2,381,741km2 and a population of 32.5 Millions of inhabitants. The Sahara occupies the 80% of the area [10]. It lies, in the north, on the coast of the Mediterranean Sea. The length of the coastline is 2400 km. In the west Algeria borders with Morocco, Mauritania and occidental Sahara, in the southwest with Mali, in the east with Tunisia and Libya, and in the southeast with Niger. The insolation time over the quasi-totality of the national territory exceeds 2000 hours annually and may reach 3900 hours (Sahara) .The daily obtained energy on a horizontal surface of 1m² is 5 kWh over the major part of the national territory, or about 1700 kWh/m²/ year for the North and 2650 KWh /m²/year for the South of the country [11] (See Table 3).

Region	Coastal	High Plateau	Sahara
Surface (%)	04	10	86
Average duration of sunshine per annum (Hour)	2 650	3 000	3 500
Average energy received (KWh/m^2/annum)	1 700	1 900	2 650

Table 3 : Solar potential in Algeria: Table of statistics of the sunshine hours per zone (Ministère de l'énergie et des mines).

3 PHOTOVOLTAIC

SONELGAZ, the electricity company of Algeria, has used photovoltaic based solar energy to power the isolated villages and remote houses of south Algeria. These locations include Adrar, Timimoun (Tala Hamou-Moussa) and Tindouf (Gara Djebilet, Hassi Mounir, Draa el Khadra) [7].

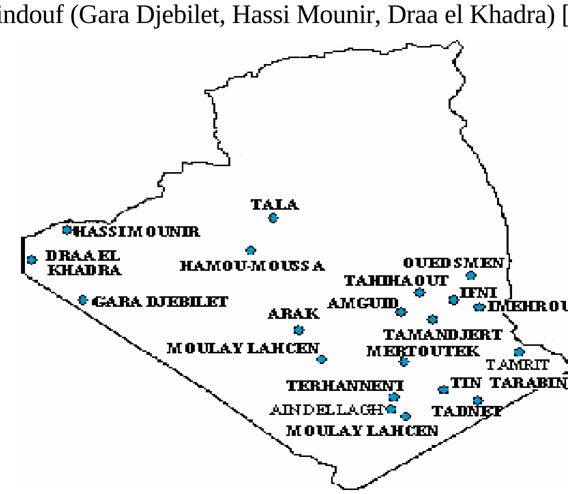

Figure 3 : Installation of photovoltaic in 20 villages of the desert of Algeria

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Figure 3 presents installation of photovoltaic projects in 20 villages of Algeria's desert. The solar energy produced by these systems is above 1.5 GWh [11]. Recently, the company BP carried out in collaboration with the SONELGAZ R&D office, a hybrid photovoltaic/diesel power station. This latter supply 300 homes of Ihrir village (the wilaya of Illizi).The total cost of this project was estimated at Euro 115,000 [12, 13].

4 FIRST SOLAR COMBINED CYCLE HYBRID PLANT IN THE WORLD TO BE BUILT IN ALGERIA

Algeria is by far the largest country of the Mediterranean. Over 70% of its area is Sahara (desert). According to a study of the German Aerospace Agency, Algeria has the largest long term land potential for concentrating solar thermal power plants [14]. METEOSAT images from 1998 were used for the calculation of the direct normal irradiance on North Africa. The results were also used to create a map of the yearly sums of solar direct normal irradiance [15].

In 2004 Algeria became the first non OECD country to launch a solar electric thermal incentive program aimed at diversifying its energy sources and making use of its vast solar resources [8]. There are number of investments in this field:

1. 150 MW ISCC power plants will be composed by 25 MW solar field of Iso-parabolic trough technology and will provide complementary thermal energy to a combined cycle of 125 MW at Hassi R'Mel. This project has been promoted by Solar Power Plant One (SPP1), a combined consortium between Abener and NEAL, constituted for that purpose and it will operate and exploit the plant for a period of 25 years. The Algerian state utility Sonatrach will buy the total amount of the produced energy. The reflecting surface of the solar field will extend over 180,000 m^2. The novelty of this project will be the electrical use of the heat generated in the same steam turbine that exploits the residual heat of the gas turbine. On the one hand, it minimizes the investment associated to the solar field on the other hand, it reduces the discharges of CO_2 associated to a conventional plant [16].
2. 120 MW hybrid gas/solar power plant near Timimoun reportedly under construction.
3. NEAL has proposed a scheme of 400-MW hybrid solar gas project that will be installed at Hassi R'Mel [14]. It is worthy to point out that the exploitation of the 1% of the Sahara surface with solar thermal electric plants could provide the whole planet with electric energy and Algeria is the country that has most potential in this area [17].

5 GEOTHERMAL ENERGY POTENTIAL

Concerning the geothermic energy, a total installed capacity of 152.3 MWt of which 2.3 MWt is for greenhouse heating, 0.1 MWt for space heating, and the rest (149.9 MWt) for bathing and for balneology uses [18]. So 240 hot springs and wells in the north of the country, with 7,200 m^2 of greenhouses that are heated by the Albian geothermal water of which one third's temperatures (Figure 4) exceed 45° C and where the highest temperature registered is 118° C in Biskra . There is a new project of heating 10,000 m^2 of greenhouses at El Oued [18]. The geothermal water is also used for heating a building of 50 rooms. Some greenhouses at Ouargla and Touggourt in the central region are reported to be using 60°C geothermal water for heating. Bellache, et al. [19] states that the geothermal potential in these regions is sufficient to heat 9,000 greenhouses, with a flow of 3,421 l/s. Actually, there non electric applications of geothermal heat in spite of that a project was envisaged for installation of small power- plant in the Bouhadjar zone, east Algeria[20].

Figure 4 : Geothermic chart of Algeria.

6 BIOMASS POTENTIAL

The largest amount of woody biomass is found in Algeria, which accounts for 50 percent of the total biomass in the North Africa [21]. This is due to the high stocking level of forest plantations. The current potential is evaluated to approximately 5 million TEP of which 3.7 millions of TEP coming from forests and 1.3 millions of TEP per year coming from agricultural and urban wastes. Biomass can be burnt directly or it can be converted into solid, gaseous and liquid fuels using conversion technologies such as fermentation to produce alcohols, bacterial digestion to produce biogas and gasification to produce a natural gas substitute. Industrial, agricultural livestock and forest residues can be used as a biomass energy source [22].Biomass technology was introduced to Algeria in 1950s, when l'Institut National d'Agronomie (INA) d'El Harrach (Algiers) used a biomass plant which produced combustible gas (biogas) via organic waste [23]. Sonelgaz's biomass power project is at the feasibility study stage in Oued Smar site, at an installed capacity of 2 MW that can reach a peak of 6 MW from the discharge of this site (urban waste and sewage) [11] .

7 CO_2 STORAGE

Once the CO_2 is captured from a major stationary source of emissions, it is compressed, usually to a dense supercritical fluid, transported (mainly by pipeline) to a suitable location and then injected into a suitable deep rock formations (sediments) usually at a depth of 800 - 1000 metres or more. The main storage capacity appears to be in deep saline reservoirs, but depleted oil and gas fields and deep coal also offer some promise [24]. Figure 5 shows current locations of CO_2 storage planned or underway.

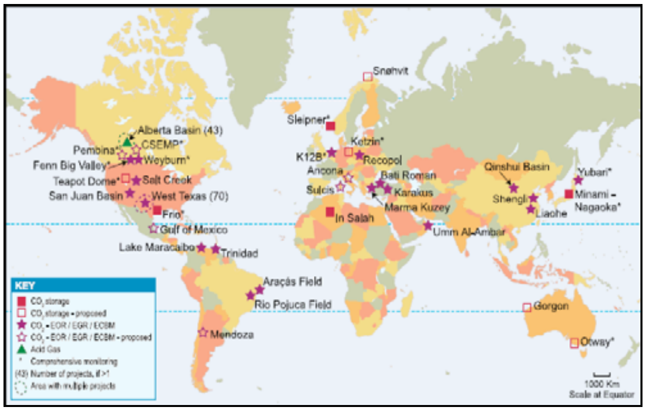

Figure 5: Current locations of CO2 storage planned or underway (IPCC, 2005).

The Norwegian company Statoil and BP work with Sonatrach, on the gas and condensate field in Salah, which came on stream in 2004. Figure 6 shows a picture of CO_2 storage project in Algeria. Each year 1.2 million tonnes of CO_2 are removed from the natural gas and injected into and stored in the sandstone formation in Krechba [25,26].

Figure 6 : CO2 project in Algeria.

8 WIND ENERGY

The SONELGAZ Company is leading the way towards the development and utilization of renewable sources of energy in the country in general and wind energy in particular as can be seen from Haddouche et al. [27] and SONELGAZ [12]. According to HELIMAX [28], Algeria is among the 15 African countries (South Africa, Eritrea, Mauritania, cap avert, Algeria, Lesotho, Seychelles, Madagascar, Somalia, Djibouti, Morocco, Chad, Egypt, Maurice, Tunisia) which have the good potential of wind energy. The best wind energy potential is in the South-Western especially in Adrar region where the wind velocity is higher than 6 m/s at 10 m above the ground surface [7, 29].

The NEAL efforts are reflected in a second project: a wind energy farm of 10 MW in Tindouf, of which global cost is €13 millions [9]. Within this framework, there is an Algerian and German cooperation concerning the CO_2 emission purchase planned by the Kyoto protocol [30].

Sites	Adrar	Tindouf	Bordj Badji Mokhtar	Béchar	Taman-rassat	Djanet
Annual Average Speed (m/s)	6.3	5.1	4.6	4.4	3.7	3.3
Latitude (deg)	27° 49' N	27° 40' N	21° 20' N	31° 37' N	22° 47' N	24° 33' N
Longitude (deg)	00° 17' E	08° 06' W	00° 55' E	02° 14' W	05° 31' E	09° 28' E
Altitude (m)	263	401	398	811	1377	1054

Table 4 : The annual average wind velocities in the six identified places

At present, there are six supplementary projects using wind for electrification and telecommunication are identified and quantified (Table 4) [7].

9 CONCLUSION

Electricity in Algeria could be produced by different renewable energy source namely solar, combined heat power, geothermal, biomass and wind power. Heat and electricity could be jointly produced in Combined Heat Power CHP plants using solar. Concerning geothermal energy, it's more reliable and favourable in agriculture for heating the greenhouses and also for space heating. The electricity produced by wind should also be exploited. Within its policy of climate and environment protection, the Algerian government fully supports the objective of the Concentrating Solar Power (CSP), Global Market Initiative (GMI) to build a number of power plants with a total capacity of 5000 MW of CSP worldwide and, secondly, to construct two power system interconnection cables (Algeria-Spain and Algeria-Italy) with an import/export capacity of 1200 MW. Meanwhile, both Algeria and the private sector are aware of Europe's commitment to renewable energy sources, in particular the European Union's aim to have 12% of renewable energy by 2010.

We can conclude that in the future there will be several renewable energy projects in Algeria aimed at:

1. Delivering electricity to isolated rural populations, based on village-scale mini-grids.
2. Addressing the global approach of RES introduction in the building sector in coherence with the energy efficiency policy and desalinating sea water.
3. Increasing agricultural water pumping by solar, wind and biomass powered water pumps.
4. Addressing in the grid-connected urban and tourist areas, the household and the community demand for lighting, food and drugs cooling, access to the communication networks, using solar home systems, small wind turbines, biomass power technologies.
5. Creating joint ventures and other manufacturing, assembly and distribution/installation capabilities in developing countries.

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