

Economic and governmental facilities aspects of Solar Photovoltaic's in Algeria.

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Summary

Algeria is firmly committed to the promotion of renewable energy in order to provide comprehensive and sustainable solutions to environmental challenges and to the problems regarding the conservation of the energy resources of fossil origin. The strategic choice is motivated by the huge potential in solar energy. This energy is the major focus of the program of which solar power and photovoltaic systems constitute an essential part. Solar should achieve by 2030 more than 37% of national electricity production.

Key words:

Solar Photovoltaic, Electricity Market, Support policies, Feed in tariff.

ملخص:

تعتزم الجزائر تشجيع قطاع الطاقات المتجددة من أجل مواجهة التحديات البيئية والقضايا المتعلقة بالحفاظ على موارد الطاقات الناضبة. وفي هذا الصدد تبنت الجزائر برنامجا طموحا لترقية الطاقة من الشمس بتقنية الألواح الفلوطوضوية، حيث تؤهلها إمكانيات الطاقة الشمسية لتغذية ما يفوق 37% من إمدادات قطاع الطاقة الكهربائية بحلول سنة 2030.

الكلمات المفتاحية: الطاقة الفلوطوضوية، سوق الكهرباء، السياسات الداعمة، التعرفة التحفيزية.

1 Introduction

In discussions about environmental protection, the current and future energy mix plays an important role. Electricity produced in fossil-fueled power plants is an important contributor to anthropogenic CO₂ emissions, and thus adds to the problem of climate change. Over recent years, renewable energy sources have emerged as an important of world energy consumption.

In order to further increase the electricity production from renewable sources, government need to promote research for efficient technical solutions of renewable power generation, so renewable energy will stabilize electricity costs, as it is not dependent upon depleting resources. Photovoltaic systems will also increase access to electricity in rural areas without the need of complex policy decision-making, thus balancing the socioeconomic infrastructure of the region. For that solar power in Algeria will be especially useful for heating and cooling systems and water desalinisation.

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The PV system electric power is of particular value when it coincides with the peak demand, can also reduce transmission and distribution losses as they generate the electricity close to the point where it consumed.

Thus, when considering these energy options on a large scale, PV systems is the most efficient choice in long-run. The vast solar potential of Algeria is waiting to be tapped.

This introduction is followed by 4 sections. The next section provides facts about electricity market in Algeria. The third section reviews the solar photovoltaic potential in Algeria. The fourth section analyses the role of public instrument in reducing financing cost of renewable energy. The fifth section draws some conclusions and policy to improve photovoltaic systems.

2 Electricity market in Algeria

As the largest country in Africa and one of the major gas producers in the world, Algeria is promising country. Powering almost 80% of national electrical needs, but with 98% of its electricity being produced from natural gas, mostly with low efficiency simple cycle gas turbines, Algerian reserves are rapidly depleting and the need for efficiency arose.¹ Electricity prices have also been unchanged since 2005. However the cost of gaining an electricity connection to obtain access can be time-consuming and costly. Nonetheless, more than 99% of Algeria's population has access to electricity. Algeria's government is attempting to reduce the country's dependence on natural gas in the power sector by initiating more renewable energy projects. "Sonelgaz", Algeria's state electricity and gas utility, has signed contracts to bring online solar projects, and they recently initiated a wind farm pilot program.²

Table (01): Fuels used in electricity generation

Generation mix	Total generation Gwh	Share of total %
Steam turbines	9 653.7	19.8
Combined cycle	15 701.3	32.1
Natural gas	22 055.3	45.1
Hydro	378.3	0.8
Diesel	463.9	0.9
Hybrid stations	618.7	1.3
Total	48 871.2	100

Source : chiffres clés électricité et gaz pour l'année 2011, on: <http://www.energie.gov.dz/francais/index.php?page=la-production-d-electricite-2>

While natural gas still remains the largest single source of Algeria's electricity generation, its role declines as hydropower and hybrid stations pick up increasing market share.

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Table (02): Co2 emissions by sector

Sector	Greenhouse Gas Emission (MT of CO2)	Share of total %
Agriculture and hydrology	1538	3.84
Industry and BP	3881	9.70
Residential and tertiary	6312	15.78
Transport sector	9574	23.93
Energy industries	18544	46.36
Total	40000	100

Source: Projet CCDM Algérie, Guide de Développement de Projet MDP en Algérie, Ministère de l'aménagement du territoire, de l'environnement et du tourisme, Février 2010, p36.

In 2013, direct industrial greenhouse gas emissions accounted for approximately 46.36% of total Algerian greenhouse emissions after the transport and residential sector as shown in table 02.

3 Solar photovoltaic potential in Algeria

A.PV capability options:

A solar photovoltaic (PV) system is a collection of PV cells known as PV string, that forms a PV array collectively are called a PV generator which turns sunlight directly into electricity.³

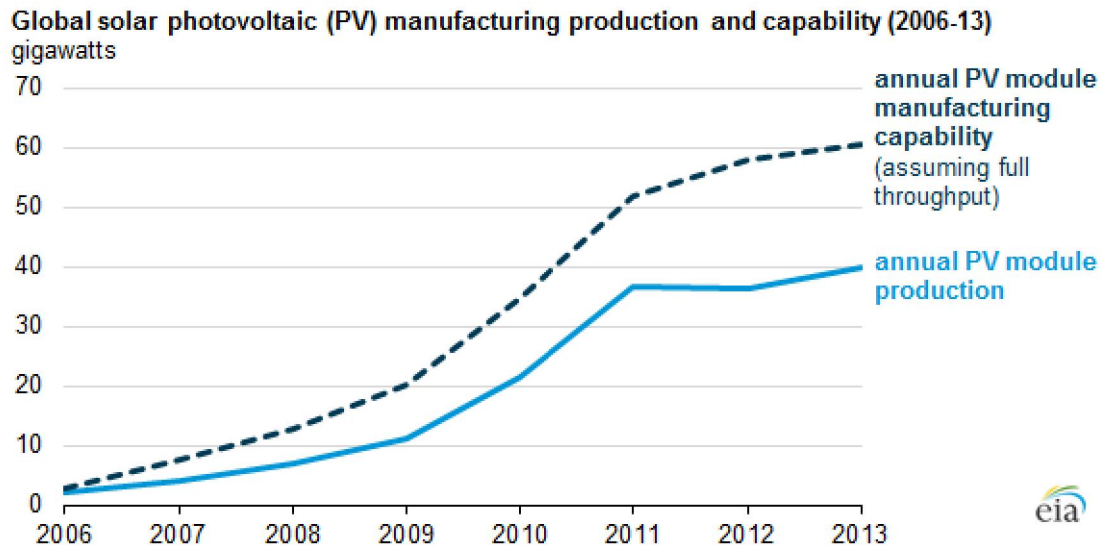
Photovoltaic (PV) systems provide electric energy and the range of uses for electricity and the situations in which it is employed are enormous. Moreover, there are numerous other well developed and widely used technologies for supplying electricity. Conventional fossil-fuel and hydroelectric generation are presently far more widely deployed than PV. The question arises then, of how PV systems can penetrate the world's electric supply in competition with these alternatives, or, more narrowly, how a PV system can compete with other electricity sources for a specified application.⁴

Growth in solar photovoltaic (PV) module production has slowed in recent years to 4% annually from 2011 to 2013 after increasing by an average of 78% from 2006 to 2011. In addition, the gap between global PV module manufacturing capability and production has grown, leading to lower utilization rates of manufacturing facilities. The utilization rates of PV module manufacturing facilities (in terms of actual production as a percent of maximum throughput) peaked in 2011, when production was 36.6 gigawatts (GW) and capability was 52 GW, giving an utilization rate of 70%.

In 2013, although production and capability increased slightly, the utilization rate of manufacturing facilities declined to 66% as shown on figure (01).

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Figure (01):



Source: International Energy Agency, Photovoltaic Power Systems Programme, 2014, Trends in Photovoltaic Applications.

Solar energy has received particular attention because of high solar radiation in Algeria. Table (03) shows the potential for solar energy in coastal high plateaus and the desert area. A potential annual output of 63116 TWh of solar energy is thus available. For comparison, world electricity generation was estimated at 18184 TWh in 2005.

Table (03): Average annual insolation in various areas of Algeria

Area	Costal	High plateaus	Desert
Percentage of the overall surface	4	10	86
Sun hours/year	2650	3000	3500
Yearly insolation (KWh/m2/year)	1700	1900	2650

Source: www.sonelgaz.dz/Potentiels-des-Energies.

In spite of this huge solar energy potential, renewable represents about just 0.3% of the overall primary energy consumption in Algeria (www.omc.org). Indeed, of 276.5 MW installed renewable power capacity in 2005, only about 1 MW is related to PV, 0.5 MW is wind and the rest (275 MW) is hydro.⁵

B. Costs and challenges

For five years (2010-14), investment in renewable energy has bobbed around the \$230 billion to \$280 billion range. Last year's total was towards the top end of that range, but that does not mean 2014's upward momentum will necessarily continue. In 2015 and after, renewables will face plenty of challenges, including **support policies** that are less predictable than before for investors.

There are also structural challenges in the electricity system, such as the difficulty created for grids and utilities from North Africa to Europe. In developing countries such as Algeria there are many different obstacles. These can be entrenched national electricity

company with little knowledge of renewable, or a difficulty in accessing project finance at affordable interest rates or in striking power purchase agreements, or the presence of subsidized electricity prices in the local market.⁶

C. Economic and technical analysis

The goal of this paper is to define the lines of action necessary at the national scale for the installation of PV systems appropriate to meet the needs of users and to respect the limits imposed on co2 emissions under Kyoto Protocol. To accomplish this goal, a development plan must be defined for the design of any PV system;⁷ past experiences have showed that importing PV modules and their BOS parts to developing countries is not economically. Although thin-film based solar cells may provide the best long-term solution for cost-effective PV power generation, the developing countries lack of advanced technology is a major drawback for development and deployment.⁸

Based on a recent NREL study, it seems that module fabrication technology with the lowest rated power cost is not always the best long-term solution for lower electricity production cost. Higher efficiency technology is also not the best solution. Fabrication technologies that combine high efficiency and lower cost are probably the best long-term solution.

Presently, the installation cost of grid-tied PV solar panel, based on crystalline and thin film technologies, is relatively similar. However, given the fact that thin film technologies are not mature, it is likely that their performance will continue to improve.⁹ In this study, the economic viability of the various commercial PV technologies is based on the following hypothesis for the NREL scenario:¹⁰

Polycrystalline module with a power efficiency of 15%. The price of these module is set at 4 USD/W.

Since a lower efficiency module will increase the BOS¹¹ cost, we adjust the overall cost of the solar farm. A model developed by the NREL group is available. The overall PV system cost is given by:

System cost (USD/W) = Module cost (USD/W) + BOS cs cost (USD/W) * (1+BOS pen).

Where:

BOScs is the cost of the BOS of crystalline silicon,

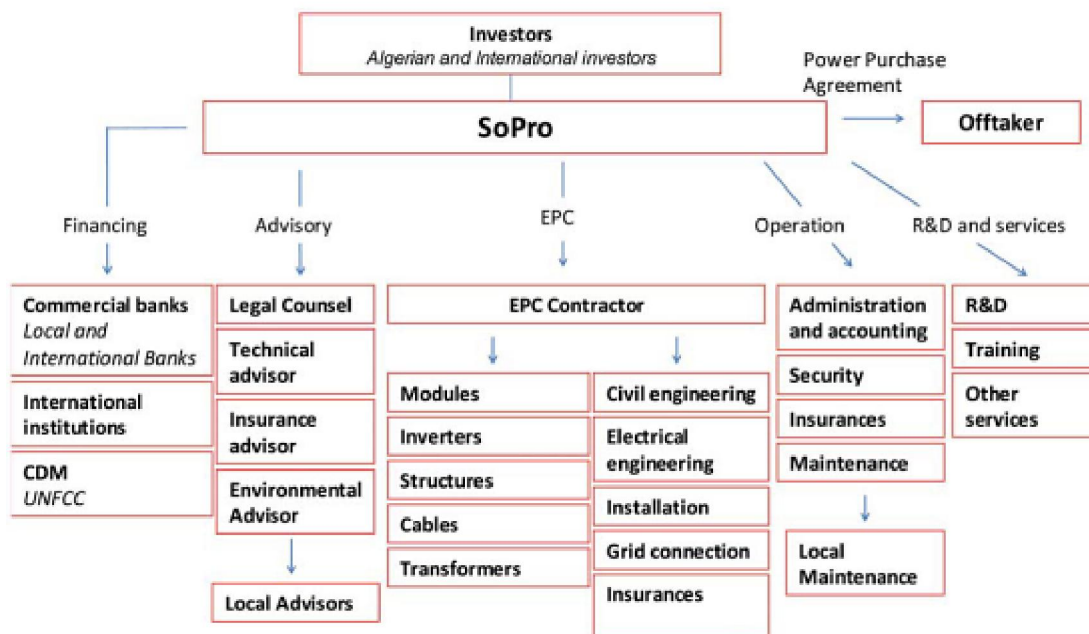
BOSpen=0.5*[(Ecs/Enm)-1], is the penalty when lower efficiency technology is used.

Ecs is the efficiency of the crystalline silicon module,

Enm is the efficiency of the new module.¹²

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Figure (02): Structure of PV project



Source: Keiichi Komoto, Masakazu Ito, Peter van der Vleuten, David Faiman, Kosuke Kurokawa, Energy from the Desert, Very Large Scale Photovoltaic Systems: Socio-economic, Financial, Technical and Environmental Aspects, First published by Earthscan in the UK and USA, 2009, p 143.

The gross of the system is possible to evaluate in terms of a fair market price for an EPC (engineering, procurement, construction) contract as shown in the figure above.

4. The role of public instrument in reducing financing cost of renewable energy

A. National Development Program for Renewable Energy

The renewable energy development program adopted by the Algerian government in 2011 was updated in February 2015. This program, which experienced a first dedicated to pilot projects and tests of the various available technologies, now he bets mainly on large-scale development of photovoltaic and wind power over 15 years (2015-2020-2030).

Table (04): Algerian program of renewable energy

Technology	First phase (MW)	Second phase (MW)
PV	3000	10575
Wind	1000	4000
CSP	-	2000
Cogeneration	150	250
Biomass	360	650
Geothermal	05	10

Source: Renewable Energy and Energy Efficiency Program, document produced by the ministry of energy and mines of Algeria, March 2011.

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Algeria ratified the Kyoto Protocol in 2005, allowing Algeria to participate in the CDM. The government, through its state-owned power utility, has successfully electrified 20 isolated villages in south, including Tamanrasset, Illizi, Tindouf and Adrar regions. PV systems with rated power of 1.53 and 6 KW have been installed and used.(www.cread.edu.dz). Algeria also enacted an Executive Decree on 14 August 2004. Under this decree, solar PV electricity providers will receive a premium 300% over the electricity price baseline as established by the market operator.

B. Incentives and subsidies

Algeria's Decree on the Diversification of Power Generating Costs adopted in 2004 introduced FiTs to support the private production of electricity from renewable energy sources, but has not yet been implemented. The types of renewable energy covered include hydropower, wind power, geothermal and solar power and electricity from waste. The Commission of Electricity authorized power companies to produce electricity from renewable energy up to a capacity of 50 MW. The authorities bear the additional costs related to the use of these technologies through FiTs. The mechanism includes the following incentives:

- **Incentive tariff:** Article 12 of the Decree specifies the premium tariff granted to private production of renewable energy in a percentage of the price of electricity fixed by the operator on the national market per kWh. This mechanism also encourages hybrid production of electricity. Indeed a specific incentive tariff scheme is proposed for the combined use of solar energy and natural gas based on the percentage of contribution of renewable energy to the total electricity generated by the plant. Renewable energy producers that use such a system are granted an incentive tariff of 200% of the current price of electricity if it accounts for 25% or more of the total electricity produced by the plant. If it accounts for 20% to 25%, the incentive tariff is 180%. The rationale for using this mechanism is that the authorities find it one of the most effective ways of making use of renewable energies.

- **Guaranteed tariff:** The authorities guarantee to buy the quota of renewable energy stipulated in the authorization contract at the incentive tariff. This quota is established by the commission based on a percentage of the power capacity of electricity produced by the plant. There is no indication whatsoever regarding the duration of the contract.

- **Access to the national grid:** The energy company is allowed access to the national grid and the national electricity distributor has the responsibility to connect the plant to the national grid under the condition that it is "reasonably feasible". The costs of extending the electricity network to connect the electricity production are shared as follows:

- ❖ The cost of the study for the connection of the site to the national grid is borne by the electricity generating company.

- ❖ The connection cost to the electricity network is borne by the network operator.¹³

5. Conclusion and results:

We conclude that Algeria's energy needs are met almost exclusively by hydrocarbons, mainly natural gas. The other forms of energy are mobilised only when natural gas cannot be used. The long term extension of the national energy consumption pattern can affect the existing supply-demand balance for this energy source.

The level of natural gas volumes, produced of the domestic market would be 45 billion m³ in 2020 and 55 billion m³ in 2030. Electricity consumption is expected to reach 75 to 80 TWh in 2020 and 130 to 150 TWh in 2030. The massive integration of renewable sources in the energy mix represents a major challenge for preserving fossil resources, diversifying electricity production systems and contributing to sustainable development.

The Algerian energy efficiency program consists mainly in the achievement of the following:

Improving heat installation for buildings; Developing solar water heating; Spreading the use of low energy consumption lamps; Substituting all mercury lamps by sodium lamps; Promoting co-generation; Developing solar cooling systems.

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- ¹³ OECD, Incentive Schemes for Renewable Energies in Algeria, in Renewable Energies in the Middle East and North Africa : Policies to Support Private Investment, OECD Publishing, 2013, p 120.