



# Feasibility study of grid connected photovoltaic system in family farms for electricity generation in rural areas



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## ABSTRACT

This paper proposes a feasibility analysis of grid connected photovoltaic energy systems in Algerian dairy farms considering technical and economic requirements and respecting the local specific characteristics and legislations. The aim is to design an optimal solar system satisfying the farms' electric needs for each Algerian region and investigate the feasibility as well as the impact of replacing the existing conventional systems with solar energy systems. Real electricity consumption data from experimental dairy farms are recorded using typical herd size for each region and projected herd size according to the livestock intensification policy followed by the government. The pilot farms are determined to be the farms of the technical institute of breeding ITELV. The electricity consumptions of a set of Algerian family farms, ranging from 10 to 30 milking cows, were analyzed. It is found that the average energy requirements are between 330 kWh/cow/year and 560 kWh/cow/year, which is considerably lower than north European and North American dairy farms consuming up to 2900 kWh/cow/year. The results indicate that the on-farm self-produced electricity is able to achieve the energy balance between forecasted photovoltaic generation and farm energy demand with a cost of electricity ranging from  $-0.008$  \$/kWh to  $0.033$  \$/kWh.

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## 1. Introduction

Algeria's electricity demand is growing rapidly in average 9.5% annually [1], as a result of the economic growth and demographic development. Therefore, the electric production capacity has to increase as much as twice in the next decade [2,3]. Currently, the generation capacity is dominated by natural gas power stations, which account more than 95% of the installed capacity, the balance originating from diesel and hydroelectric power plants.

The renewable energy share in the national energy mix was negligible until the recent introduction of 150MWe hybrid solar/gas power plant in Hassi-Rmel (south Algeria). With this growth in electric demand (Fig. 1) and the rapid depletion of fossil fuel namely natural gas, Algeria envisages the substitution of the fossil energies by other sources.

The interest for the development of renewable energies was perceived very early in Algeria with the development of a long term

strategy since the mid-eighties [4]. The main objectives are to ensure the change from hydrocarbons to renewable energy and a sustainable development without pollution for the environment. The first program called "the solar energy great south program" was initiated in 1985. Its purpose was to install standalone PV systems in remote isolated areas for different applications such as water pumping, lighting in rural houses, telecommunication repeaters, traffic lighting for the Sahara pathway and small refrigeration systems. The second program was "the south rural electrification program (1995–2000)" for the electrification of 18 isolated villages with low population density, where the demand consists essentially in satisfying basic energy requirements (light, refrigeration, pumps, television, radio) [5]. The third rural electrification program (2006–2009) provides photovoltaic electricity to 16 villages with a total of 800 houses [6]. The total installed standalone PV capacity in isolated rural areas is estimated to be 2.3 MWp [7]. These programs were conducted in order to enhance the quality of life and rural development where there is no grid access.

In the past few years there has been a dramatic rise in grid connected photovoltaic development and deployment on global scale due to several factors like the falling prices of silicon,

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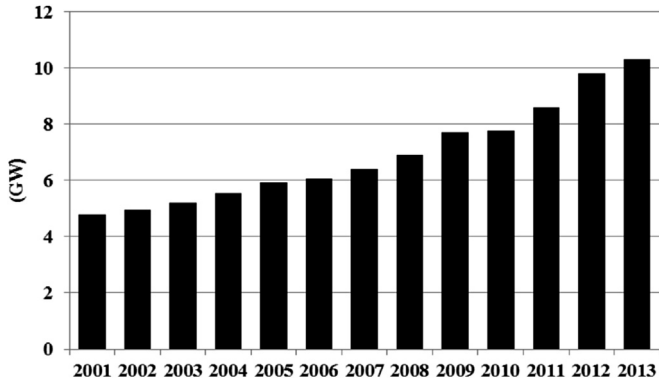


Fig. 1. Algerian installed electric power evolution.

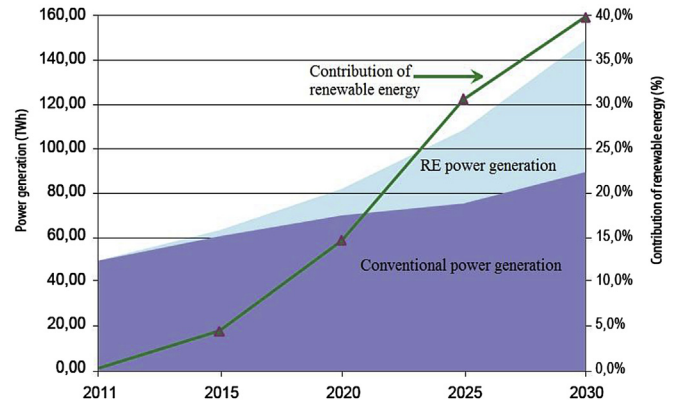


Fig. 3. Electricity production and renewable energy share growth, outlook 2030.

technological advancements in large scale manufacturing and continued improvement of power converter technologies. In Algeria, the use of grid connected photovoltaic systems began in 2011, relatively very late compared to other countries. However, since the huge solar potential with more than 3000 sunny hours per year and 5 kWh/m<sup>2</sup> received energy over the quasi-totality of the national territory (as shown in Fig. 2) [8], it was not surprising when the government announced a new program (2011–2030) in the renewable energy development strategy.

The new target of the Algerian energy and environmental policy is to achieve a share of 40% of renewable energy (mostly from grid connected photovoltaic) in electricity supply by installing up to 22,000 MW of power generating capacity from renewable sources by 2030 (Fig. 3) [9]. The first phase of the renewable energy program (2011–2013) was dedicated to pilot projects and testing various available technologies. In the second phase (2014–2015) the program was revised according to the results of the pilot projects. The adopted renewable technologies by the government will

be deployed on a large scale for the third phase of the program (2015–2020–2030) as summarized in Table 1 [10].

To meet this target, several centralized utility-scale grid connected PV stations are projected for the next decade. However, this

Table 1  
Algerian renewable energy program (2015–2020–2030).

Technology	2015–2020 [MW]	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

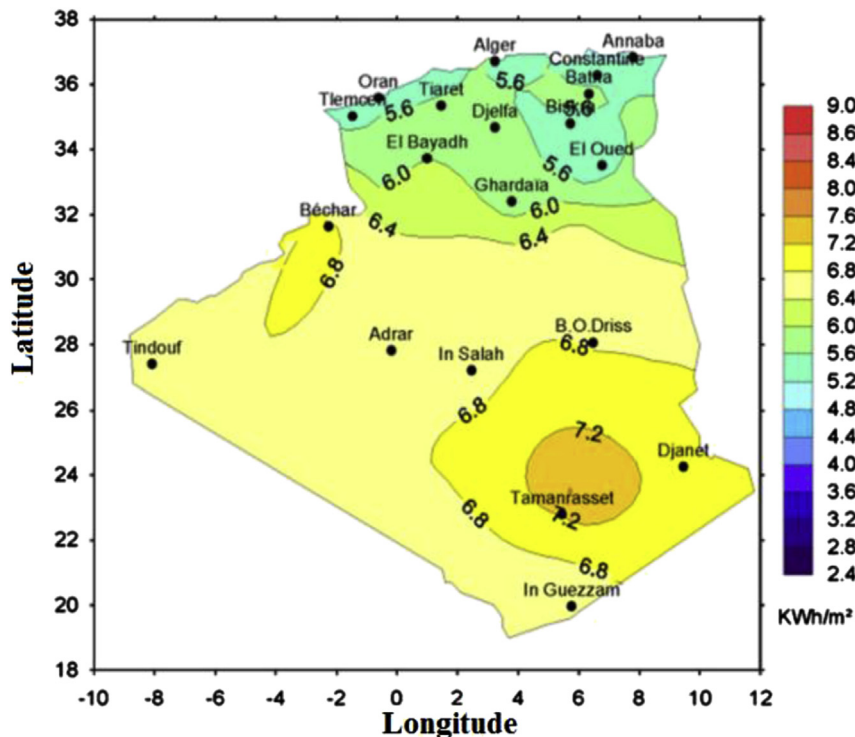


Fig. 2. Global horizontal solar radiation in Algeria.

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