



Review

Prospects of photovoltaics in southern European, Mediterranean and Middle East regions



M. Hadjipanayi*, I. Koumparou, N. Philippou, V. Paraskeva, A. Phinikarides, G. Makrides, V. Efthymiou, G.E. Georghiou

FOSS Research Centre for Sustainable Energy, PV Technology, Department of Electrical and Computer Engineering, University of Cyprus, 1678, Nicosia, Cyprus

ARTICLE INFO

Article history:

Received 18 September 2015
Received in revised form
23 December 2015
Accepted 28 January 2016
Available online xxx

Keywords:

Photovoltaics
Levelized cost of electricity
Grid parity
Grid integration
Net metering
Self-consumption

ABSTRACT

This review investigates the potential of photovoltaics in southern Europe and Middle East/North Africa in terms of PV status and policies/initiatives for PV market development in the region. In some Sunbelt countries, PV has become a competitive alternative for electricity generation resulting from a combination of high solar resource, decreasing PV system costs and high fuel prices. The PV levelized cost of electricity has fallen in some regions to 0.08 €/kWh whilst retail electricity prices are almost three times higher in some cases attesting to the ideal conditions in the region for PV uptake. In grid parity regions of south Europe, incentives such as feed-in-tariffs have served their purpose. Net metering and self-consumption are proving to be good solutions for driving effectively the PV market as evidenced for the case of Cyprus. In MENA countries, the renewables policy landscape, although still at an exploratory phase, is rapidly developing providing the backbone for a large number of new PV projects. This reflects the region's commitment to meet its ambitious national targets regarding PV. Overall, the timing for the whole region is excellent to achieve energy sustainability, once better policies are adopted and challenges regarding grid integration and reliability are addressed.

© 2016 Elsevier Ltd. All rights reserved.

Contents

1.	Introduction – PV overview	59
2.	PV status in southern Europe and MENA countries	59
2.1.	Characteristics of the region	59
2.2.	Cost of electricity in the region	60
2.3.	Levelized cost of electricity (LCOE) for PV in the region	61
2.4.	PV installed capacity in the region and project overview	62
3.	Initiatives for PV implementation and market boosting in the region	63
3.1.	Southern Europe	63
3.1.1.	Cyprus	63
3.1.2.	Italy	64
3.1.3.	Portugal	65
3.1.4.	Greece	65
3.1.5.	Spain	65
3.1.6.	France	66
3.2.	MENA region	66
3.2.1.	Jordan	66
3.2.2.	Egypt	67
3.2.3.	Israel	67

* Corresponding author.

E-mail address: hadjipanayi.maria@ucy.ac.cy (M. Hadjipanayi).

4. Innovative research in PV technology and GRID and market integration	68
5. Conclusions	70
Acknowledgements	72
References	72

1. Introduction – PV overview

Photovoltaic (PV) technology has grown over the past decade at a remarkable rate – even during difficult economic times – mainly due to successful policy measures for promotion of the technology such as the Feed-in-Tariff scheme (FIT) and major cost reduction in PV system installation. Overall, in 2014 there were 177 GWp of PV installed globally [1,2], of which 86.7 GWp were installed in Europe alone [3]; these figures render PV as the third most important renewable energy source (RES) in terms of globally installed capacity after hydropower (1000 GW) [2] and wind power (369.6 GW) [2]. Already, large-scale centralized PV electricity generation is a reality on a global scale e.g. two 550 MWp (each) PV parks in California (Desert Sunlight Solar Farm in Riverside County and Topaz Solar Farm in San Luis Obispo County) which can each supply enough energy to power 160,000 average Californian homes. Moreover, PV has reached a stage where anyone can become an electricity producer using their own rooftop. Therefore, in addition to large PV parks, a movement towards extensive small-scale distributed generation is also underway, which with appropriate advanced inverters can improve the overall security of supply while utilizing useful unused areas (building roofs, covers, etc.). Today, PV represents at least 1%¹ of the global electricity supply [4]. Although PV installations have exhibited a slowdown in Europe in 2013 [1,5,6], which continued in 2014, Europe continues to lead the world in total regional operating capacity and in solar PV's contribution to electricity supply. 3.5% of the electricity demand and 7% of the peak demand of the continent is now covered by PV, thus, Europe is still on track to achieve 12% of the electricity demand by 2020 [7]. On the other hand, Middle East North African (MENA) countries, despite their abundant fossil fuel reserves, are making significant investments in PV projects and renewables in general, as well as leaps in improving their sustainable energy policies thus gradually developing the foundation for a booming market in the region.

Based on the trends observed [2,5], it is evident that PV technology is on the way to becoming a major source of power generation for the world covering the power supply needs of millions of households. The main challenges that remain to be overcome in order to achieve this are the further reduction of the technology cost, the improvement of the efficiency and energy yield of the systems, tackling reliability issues, achieving effective grid and market integration, whilst making PV part of our built environment. This review addresses the particular issue of the potential and prospects of PV technology in some representative countries in southern Europe, the Mediterranean, and the Middle East as regards the PV status, energy policies and initiatives for boosting the PV market, and PV research outlook.

The structure of the review is the following: Section 2 discusses the characteristics of the region in terms of solar resource and level of dependence on fossil fuel for gross electricity generation, followed by a discussion on the cost of electricity in the region (both retail electricity prices and levelized cost of electricity for PV), the

PV installed capacity and the national renewable energy targets. Section 3 addresses the initiatives for PV implementation and market boosting in the region highlighting the differences in schemes due to country specificities (policies, strategies, level of RES adoption and PV penetration, finances, etc.) as well as inferring the progression of initiatives as the technology and market of PV mature. Sections 4 and 5 address innovative research conducted in the region on PV and grid integration, respectively, which projects a research perspective from the region on timely issues relating to PV technology and its effective integration in tomorrow's grid. Finally, Section 6 concerns the conclusions of the review.

It should be noted that the selection criteria for the country profiles portrayed in this review included covering a broad geographical spread of both large and small countries (including islands), of regions leading renewable energy implementation and policy adoption as well as regions still lagging behind, of countries highly dependent on fossil fuel imports and others exhibiting an abundance of oil resources. Additionally, availability of recent data and information regarding the topic of this review (more relevant to MENA countries) was also a criterion.

2. PV status in southern Europe and MENA countries

2.1. Characteristics of the region

PV technology is particularly promising for **southern Europe** mainly due to the high solar resource experienced, which in some regions can exceed 2000 kWh/m² annually. This is evident from the JRC PVGIS on-line tool [8] which provides the annual solar resource (kWh/m²) and the annual AC energy yield (kWh/kWp) for horizontally mounted PV systems for the countries of mainland and southern Europe. The solar electricity generated in the region is even further improved by optimal placement of PV modules, as calculated in Ref. [9]. An example of the annual solar irradiation levels experienced in this area and the annual PV power produced for an optimal placement of the PV modules is given in Table 1 for six south European regions.

Despite the high potential for PV implementation and high-penetration of the technology in the energy mix of Mediterranean countries, the region is still highly dependent on fossil fuel imports particularly the islands which typically exhibit an isolated electricity network. An example is Cyprus which currently has no interconnections with other neighbouring countries and is strongly dependent on oil imports constituting 29% of the total imports of the island (2013) and costing around 1.4 billion Euros annually [11] which translates into a very significant energy trade deficit in GDP terms [12]. An analysis of the gross electricity generation % (per fuel/other type) for eight south European countries is shown in Table 2.

On the other hand, the MENA region is characterized by a large availability of fossil fuel reserves, which are however unevenly distributed among the countries. Thus high dependence on conventional fuel types for electricity generation is exhibited in both net oil-importing regions (e.g. Jordan, Israel, Morocco, etc.) and net oil-exporting regions (e.g. Kuwait, Egypt, Libya, etc.). This is also attested in Table 3 which shows the % of generated energy as a

¹ Based on 18,400 TWh of electricity consumption [4].

Download English Version:

<https://daneshyari.com/en/article/6765858>

Download Persian Version:

<https://daneshyari.com/article/6765858>

[Daneshyari.com](https://daneshyari.com)