



Economic analysis of investment in the rooftop photovoltaic systems: A long-term research in the two main markets



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ARTICLE INFO

Article history:

Received 11 January 2013

Received in revised form

5 August 2013

Accepted 11 August 2013

Available online 2 September 2013

Keywords:

Photovoltaic systems

Performance ratio

Final yield

Investment

Net present value

Internal rate of return

ABSTRACT

Nowadays, due to incentive policies, the PhotoVoltaic (PV) installations become an economically attractive investment. The different policies aim to reduce the PV installation costs, consequently to the deployment of the market. In recent years, a progressive price decrease of components for PV installations has occurred, according their learning curve: every doubling of the volume implies approximately a cost reduction of -20% . In order to reduce the burden of the incentive rate on the national budget, maintaining the economic margin of the investment attractive for investors, a progressive tariff decline has also taken place. This paper provides a technical-economic analysis of investments in PV systems installed on the rooftop, considering incentive policies, and applies it to some significant case studies in the Countries, in which PV market is the most prosperous (Germany and Italy). The analysis puts into evidence the past and current economic margins of the PV investments since 2006 to 2012. Four case studies from 3 kWp to 1 MWp are examined in detail. The profitability indexes in terms of net present value and internal rate of return, evaluated throughout incentive duration of 20 years, become very interesting above all in Italy (higher than 100% of the installation cost and higher than 10%, respectively) since 2009, when an abrupt decrement in installation cost occurred. In Italy the best profit margins occur for large-size PV plants and are poorly counterbalanced by the decline of the feed-in tariff up to 2012, when a new framework has given a knock to the investments, whereas in Germany the best margins happen for medium-size PV plants and are well adjusted by the feed-in tariff. However, it is predictable that a cut in German feed-in tariff will take place, because the profit margins have been higher in last year than in the previous years.

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1. Introduction

In the past the installation cost of PhotoVoltaic (PV) systems was so high that no economic convenience appeared, with respect to the bill paid to the utilities for the grid electricity. That was the

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reason, for which the stand alone PV systems were the unique applications of this technology in zones where the network was not available as in mountains, islands or rural sites. The increasing costs of fossil fuels, due to the impressive usage around the world, and the consequent concerns on climate change (greenhouse gases, global warming) have pushed the national Governments towards a major employment of Renewable Energy Sources (RES), according to several protocols as e.g. the Kyoto one. Especially in Europe, in the last years, a policy for RES deployment, based on incentive in terms of feed-in tariffs, has been implemented. These tariffs have produced, for the owners of PV systems, such revenues that also the grid connected PV plants have become viable from the economic point of view. Obviously, the money for the incentive is a burden for the community, but, if the mechanism is well done, it can generate many advantages like reduction of installation cost due to economies of scale, clean electricity production, job creation, technological innovation and safe investments. In fact, the main target should be to create a self-sustaining market based on two factors: firstly, the economies of scale [18], i.e., the decrements in cost per unit, that PV companies achieve (about –20%), as the size of the facilities and the usage levels of other inputs increase; secondly, the cost of electricity from fossil fuels which is continuously increasing. After the start-up period, the feed-in tariff should be progressively reduced, in such a way as to reduce the burden on the electricity bill and to hold an attractive performance of the PV investments. Nowadays, Germany and Italy are the main markets in the world for PV installations: in Germany the feed-in tariff is in operation since 2000 with about 30 GW_p of installed power and in Italy since 2005 with about 17 GW_p, after many adjustments. The goal of this paper is to provide a long-term research on the investments in regards to PV plants of active users charged by the retail electricity price with different size and location, roof mounted, in Germany and Italy, according to the variable conditions of the incentives (2006–2012). Such a study permits to determine the particular economic revenues during the time evolution among the various types of PV systems, emphasizing the efficiency of the incentive policies in the two major markets. At this aim, the installation costs of the PV plants, according to size, location and begin of life, have been defined by suitable assumptions; then, the performance indicators in terms of Net Present Value (NPV) and Internal Rate of Return (IRR) have been computed. This work was performed within the “Europe-China Energy Centre” (EC2) project with the support of the Italian Ministry for the Environment, Land and Sea. The Centre is managed by a consortium of nine partners – six European and three Chinese – led by Politecnico di Torino (Italy).

2. The worldwide PV market

Globally, the volume of new PV capacities world-wide rose from 16.6–20.2 GW_p in 2010 to 24.1–27.6 GW_p in 2011 considering a remarkable difference between the installed power and the

grid-connected power (typical delay of some months in Italy). The number of markets reaching more than 1 GW_p of additional capacity during 2011 rose from 3 to 6 [5]. The European share in the global PV arena still remains predominant with more than 75% of all new capacity in 2011. The two biggest markets, Italy and Germany, account for nearly 60% of global market growth during 2010 [20]. The growth rate of PV during 2011 reached almost 70%, with growing contributions from Southern European countries, over 60 GW_p of PV systems were installed at the end of 2011. In Italy and France, specific regulations created strong installation growth in 2010; however, the grid connection was to be counted only in 2011. This effect has included between 3 and 5 GW_p of installations made in 2010 with grid connection taking place in 2011.

Table 1 shows the top markets world-wide, both in terms of grid-connected capacity during 2011 and 2010 and cumulative installed capacity at the end of 2011. It is interesting to note that China, at first place of PV module manufacturers in the world, is becoming an important market in the PV installation.

The growth of the PV market is based on the increasing oil prices and consequent air pollution, on the requirement of environmentally friendly energy generation, and is sustained by the support of the environmentally-conscious public incentives, direct subsidies and Research and Development (R&D) support. Without such support, the industry could not grow to levels that would enable the reduction of the price of electricity generated from photovoltaics to the levels of conventional energy generation [21]. Due to the increasing market volume, performance and reliability of PV systems have become key issues for minimizing business risks and increasing market actors' trust. A more accurate yield prognosis and information on operational availability of PV systems are crucial for investment decisions and market growth. In this context, performance and yield data, reliability statistics and empirical values concerning maintenance are by far more relevant today than in the past.

As previously mentioned, Europe remains the geographic area leader for PV installations. During 2010 Germany represented the most important country in the PV market with around 7.4 GW_p of installed new PV plants, while in 2011 Italy with around 9 GW_p of grid-connected new PV plants had the primacy. Spain, major player in 2008, has installed in the last years only around 400 MW_p per year. The reason is in the incentive policy change, with the introduction of a too low threshold for installations and significant cuts in tariffs. The main novelties of 2010 are in France and Czech Republic. As per France, the installed power during 2011 was around 1.5 GW_p, a very big increase compared to the previous year. Regarding Czech Republic, where the PV market is in the large part constituted by small and medium-sized plants (4.2 MW_p is the size of the largest PV plant built in 2010), the power installed in 2010 was 1360 MW_p, which has permitted to reach USA in the cumulative installed power, however the installation in 2011 has

Table 1
The installed and grid-connected capacity in 2010 and 2011. Source: IEA.

Country	2010 grid-connected capacity (MW)	2010 installed capacity (MW)	2011 grid-connected capacity (MW)	2011 installed capacity (MW)	2011 cumulative installed capacity (MW)
Italy	2321	5900	9000	5500	12500
Germany	7406	7406	7500	7500	24,700
China	520	520	2000	2000	2900
USA	887	887	1600	1600	4200
France	716	716	1500	1500	2500
Japan	986.8	986.8	1100	1100	4700
Spain	389	389	400	400	4200
Total in the world	16,629	20,208	27,650	24,150	67,350

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