SUCCESS POSSIBILITIES OF GRID PARITY IN PARTICULAR CASES IN THE NEW SPANISH REGULATORY FRAMEWORK

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ABSTRACT: During the last 10 years the Spanish photovoltaic market has experienced one of the most important increases worldwide. The continuous raise on the price of the electricity in Spain, as in other European countries, USA and Japan, as well as the decrease of the cost of solar photovoltaic systems along this decade is opening a new way to reach grid parity point in some particular scenarios. A new Spanish legislation is being performed toward self-consumption, and it is in this new context where the grid parity in a wide sense could be achieved.
This work will study different cases in Spain, in order to determine whether grid parity would be possible along 2012.
Keywords: grid parity, self-consumption, photovoltaic, net-metering

1 INTRODUCTION

This work analyzes the possibility of reaching grid parity in some particular cases of energy consumption, as a response to the new regulatory framework that could be approved by Spanish government alongside 2012.

Grid parity is the threshold at which a grid-connected photovoltaic (PV) system supplies electricity to the end user at the same price as grid-supplied [1] (see figure 1). No single point of grid parity is defined for specific countries or regions, it depends on the location, the PV technology used, the efficiency of the system and the retail rate of grid power, among other factors. The grid parity ignores a profit margin for the owner, although the comparison is made with the price of the electricity from the grid. This comparison makes sense from the owner/consumer point of view [2].

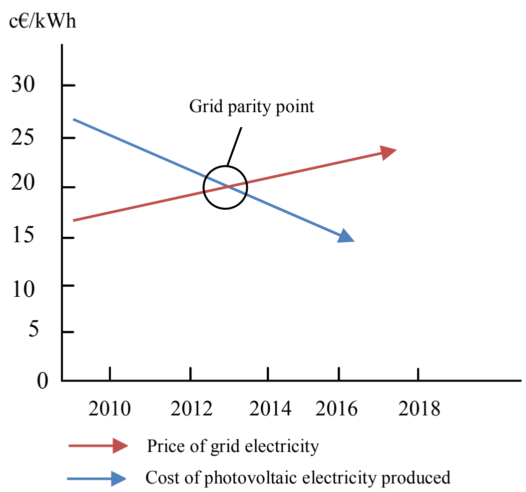

Figure 1: Estimated Spanish grid parity point

Two important concepts related to grid parity are self-consumption and net-metering. Both concepts allow users to consume their own energy production.

Self-consumption is usually defined as the possibility for any electricity consumer to connect his own electricity production system to the grid in order to satisfy its demand and/or to feed the non-consumed electricity to the grid, receiving value for it. Self-consumption schemes include two electricity meters, one for computing the electricity consumed and the other one to compute the electricity injected to the grid.

Net-metering is a special metering and billing agreement between companies and their customers, which facilitates the connection of small, renewable energy-generating systems to the grid. When a net-metering customer's renewable generator is producing more power than that which is being consumed, the electric meter runs backward generating credits, whereas in the case of self-consumption two meters are required; also, when a net-metering customer uses more power than that which is being produced, the meter runs forward normally. In other words, consumers are able to generate and consume their own energy and sell the excess energy produced, or buy it when generation is not enough.

Systems with net-metering legislation and development have some benefits for utilities and consumers. Utilities avoid the administrative and accounting costs of metering and purchasing the small amounts of excess electricity produced by small-scale renewable generating facilities. Consumers benefit by getting greater value for some of the electricity they generate, by being able to interconnect with the utility using their existing utility meter, and by being able to interconnect applying widely-accepted technical standards [3].

2 CURRENT SPANISH LEGISLATION

Since 1997 Spanish legislation has made several references to self-consumption:

Law 54/1997 establishes the possibility of a self-consumption. This law also sets that it is a right for producers to have an access to the grid.

Royal Decree [Regulation published by Executive Order] 661/2007 recognizes the possibility that no net energy will be injected to the grid by a renewable generating plant, as in a total self-consumption installation. The case of a partial self-consumption installation is somehow similar, because in this case part of the production will be injected to the grid and the conditions and disposal techniques must be agreed with the electricity operator.

The Spanish Technical Building Code (*Código técnico de la edificación*) provides the possibility of connecting PV systems in buildings, in a connection point that is not in the distribution company, which would happen in the facilities for total or partial self-consumption [4].

On November 2011 the Spanish government published Royal Decree 1699/2011. This law opens the way to a new legislation about self-consumption and net-metering. This kind of legislation does already exist on some other European countries, such as Germany, Italy and United Kingdom, with different rates and terms.

However, nowadays, no legislation about net-metering is available in Spain.

These are a few examples of recognizing self-consumption in the Spanish legal framework.

On January 2012 a new Royal Decree 1/2012 establishes the feed-in tariff suspension for new renewable electricity production plants, including PV.

In self-consumption terms there are several potential legal barriers derived from the fact that self-consumption is not yet explicitly regulated outside incentive schemes, and electricity markets are not fully liberalized. In Spain it is compulsory to feed-in 100% of production of a grid connected PV system under the ‘Special Regime Scheme" until 2012 [5].

3 MARKET

Royal Decree 1/2012 sets a new framework with tight economy conditions for large installations. Decisions like this show that the market has entered a transition phase to a post incentive era of photovoltaics [6].

Since 2007, the PV market has exploded worldwide due to both, the decrease in prices of panels and installations and to regulatory changes in many countries.

The price of electricity has experienced a huge continuous increase in almost all European countries, particularly in Spain. (see figure 2). In the particular case of Spain, there is a problem, among other factors, known as "the tariff deficit" that seems to indicate a continuation of this trend of rising prices.

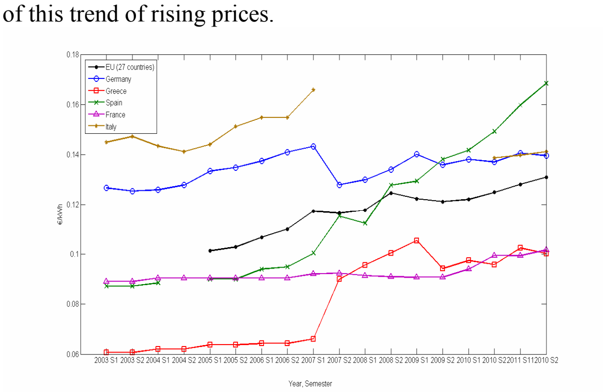

Figure 2: Retail rate of grid power for some European countries. *Source*: own elaboration from Eurostats

Another important term in PV market is drop on the price on manufacturing costs of PV modules; according to UNEP studies these costs have declined by 60% in the period 2008-2011 [7]. The turn-key system prices for grid connected installations range between 1.85€/Wp and 5€/Wp in 2011(see figure 3). In particular cases of residential installations this range is between 2.2€/Wp and 5€/Wp.

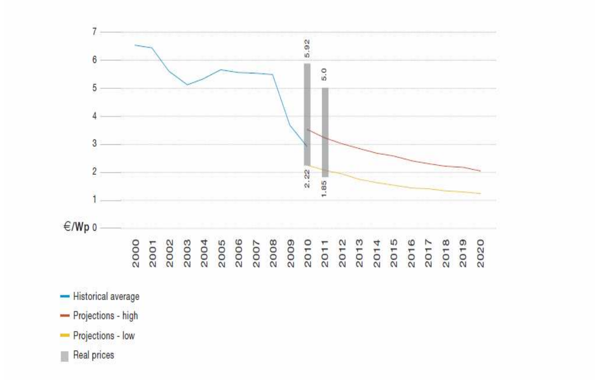

Figure 3: Evolution of photovoltaic solar system price in Europe. Source: EPIA

It is expected that net-metering system in Spain will allow the development of PV in some segments as in residential and commercial one [6] due to this new regulatory framework and market situation

4 ANALYSIS OF CASES

4.1 Tools for analyzing

One of the most important factors to analyze the probabilities of success of the grid parity is the *levelized cost of electricity*, LCOE (Eq. 1).

$$LCOE = \frac{\sum_{t=1}^{n} \frac{I_t + M_t + IF_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{E_t}{(1+r)^t}} \qquad (Eq. 1)$$

where:

LCOE = Average lifetime levelized electricity generation cost (€/kWh)
I_t = Investment expenditures in the year t (€)
M_t = Operations and maintenance expenditures in the year t (€)
F_t = Fuel expenditures in the year t (€)
E_t = Electricity generation in the year t (kWh)
r = Discount rate
n = Life of the system (years)

The LCOE takes into account installation and commissioning costs, operations and maintenance, degradation and lifetime, and the output. It calculates the average value of the total energy produced, revalued at the time of calculation based on forward assessments of inflation and costs of financing [8].

This term shall reduce sharply in Europe in the forthcoming years due to the fact that the cost of PV solar systems, including PV modules, has decreased and the average price of PV modules will be lower by the next decade.

4.1 Particular case

In this framework, analyzing general cases is very difficult, due to several factors that affect the energy production and the profitability such as the location, the

PV technology used, the investment costs and so forth.

Optimal annual values for the performance ratio (PR) factor are between 0.8 and 0.84 [9]. The factors that may affect energy production in PV solar systems are the installation location, orientation, climate, the intensity and duration of solar irradiation, among others. PV solar systems can achieve high yields with detailed planning. On one hand, the components used should be ideally suited to individual requirements. Moreover, attention should be paid on correct sizing and position, to reduce shading as much as possible.

This work analyzes particular cases of small PV solar systems (< 100 kW) with more consumed power than that it is being produced by the system, situated in areas with an annual average sum of global horizontal irradiation of 1530 kWh/m^2 or higher (see figure 4).

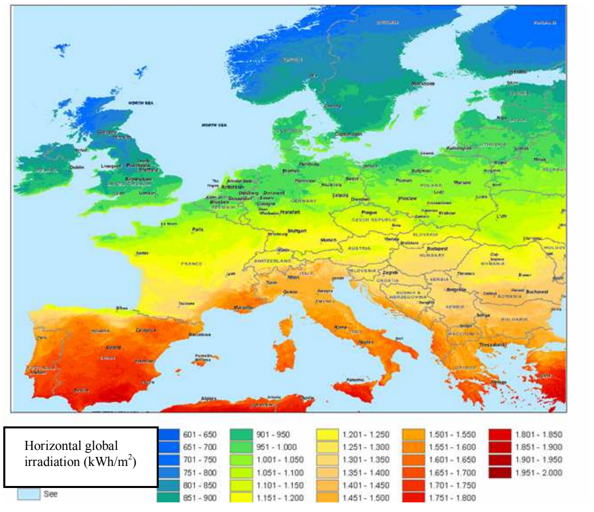

Figure 4: Horizontal global irradiation in Europe. Source: Focus Solar

In order to assess the success possibilities of the grid parity, the study of particular cases is of little interest, due to the differences existing among cases. Our study focuses on a typical PV solar system featuring an average PR of 75% or higher [10].

With the data shown above and with the aim of simplifying it is possible to use a value of 1.5 kWh/Wp·yr for energy yield factor for a small installation in the South of Spain [11].

As mentioned in section 3, a standard value for turn-key system price in residential installations is between 2.2€/Wp and 5€/Wp.

For a typical residential system the PV module retail price accounts for roughly half of the total installed cost. The other half goes to Balance of System (BoS), installation, design, permitting and other miscellaneous costs [12].

Due to that, a value of 3 €/Wp for turn-key system price is a sensible value, given that the average price of a PV module in Europe in July 2011 reached around 1.2 €/Wp.

Table I presents some calculations for different cases, showing the effect of different factors on LCOE value.

Table I: Levelized cost of electricity (LCOE) for a range of energy yield, depreciation time and turn-key system cost

Energy yield (kWh/Wp·yr)	Depreciation time (yrs)	Turn-key system price (€/Wp)	Cost of capital	O&M[a] + other costs (% of initial investment/yr)	LCOE (€/kWh)
1.6	20	3	6	1	0.19
1.4	20	3	6	1	0.22
1.2	20	3	6	1	0.26
1.5	20	3	6	1	0.21
1.5	25	3	6	1	0.19
1.5	30	3	6	1	0.17
1.5	20	5	6	1	0.34
1.5	20	3	6	1	0.21
1.5	20	2.2	6	1	0.15

[a] O&M: Operation and Maintenance

Source: own elaboration

5 RESULTS AND CONCLUSIONS

Table I shows how the LCOE decreases with increasing energy yield. Nevertheless, with normal values for the rest of parameters grid parity is not reachable yet.

According to table I, with current turn-key system prices, PV electricity is not competitive with electricity from the grid. However, with the decreasing trend of PV modules prices, it is expected that grid parity point for particular situations in the South of Spain will be soon possible.

By using grid-connected systems like net-metering, the batteries cost associated to non-connected systems is eliminated. Likewise, from the point of view of the owner-producer, the profit margin related to the owners of electricity power sale systems is removed, and thus, it is not necessary the establishment of industrial profit margin.

The success of grid parity lies on net-metering regulatory framework, due to the possibility of electricity consumption of the grid during the non-operative hours of the PV system and thus, compensate this consumption during diurnal hours by generating credits for the consumer.

With self-consumption and net-metering, the fraction of the energy produced that is self-consumed is not being injected to the grid and it does not affect to Spanish tariff deficit.

To conclude, it should be noted that without net-metering legislation in Spain it is not possible to have a deeper analysis of particular cases.

Further analysis will be performed when the new legislation about net-metering is published, in order to have a better understanding of the success possibilities of Spanish grid parity point.

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