Energy Policy 117 (2018) 279–294

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Sale of profitable but unaffordable PV plants in Spain: Analysis of a real case

J.C. Lomas[a], E. Muñoz-Cerón[b,d,*], G. Nofuentes[c,d], J. de la Casa[c,d]

[a] Gerión Ingeniería S.L., Cl San Antón 72, 5th Floor, Office 18, 18005 Granada, Spain
[b] IDEA Research Group (Research and Development in Solar Energy), Department of Graphic Engineering, Design and Project, University of Jaén, Campus las Lagunillas s/n. Building A3, Office 212, 23071 Jaén, Spain
[c] IDEA Research Group (Research and Development in Solar Energy), Electronics and Automation Engineering Department, University of Jaén, Spain
[d] Center for Advanced Studies in Energy and Environment (CEAEMA), University of Jaén, Spain

ARTICLE INFO

Keywords:
Performance
Grid-connected PV system
Promotion policy
Profitability
Feasibility
Liquid asset

ABSTRACT

The Spanish photovoltaic industry was stunningly successful during 2007–2010, fostered by a favourable feed-in tariff system. Nevertheless, the cost overrun of this promotion policy led to government legislation against existing PV plants. Although these investments will be profitable when the subsidy ends, according to the last law enacted in Spain (IRR = 7.4%), either a massive sale to vulture funds or the abandonment of PV plants is being planned. Owners are unable to cover the loans through which they were originally financed. In this scenario, investors find it more profitable to cancel all operational expenditures and allocate this working capital to cover their loans, although this measure implies a 22% energy reduction.

This study analyses a representative Spanish PV plant based on real energy and economic data. The analysis shows the turn from an attractive IRR = 10.14% to a situation with limitations where the owner injects money annually to overcome potential bankruptcy of the investment. This paper reflects the influence of promotion policies in the profitability of PV plants. Additionally, the adverse legal framework in Spain identifies a profitable but unaffordable scenario, highlighting the differences between the economic and financial performance of a PV investment.

1. Introduction

The photovoltaic (PV) industry is currently leading in installation rates in the renewable energy sector and its accumulative power is increasing exponentially (International Energy Agency, 2016a; Jaeger-Waldau, 2016). In some countries, PV technology is playing a major role in its penetration of the electricity generation mix and the future forecast is even more optimistic as this trend is expected to rise (International Energy Agency, 2016b; Fraunhofer ISE, 2015).

This promising scenario exists worldwide, but special attention should be given to the USA, South America, and MENA countries because they play a role as a driving force in the PV sector (International Energy Agency, 2016a). Moreover, in these countries, PV plants are beating records in terms of electricity generation prices; that is, the unitary electricity price generated with PV systems has dramatically decreased in recent years compared to that from similar existing PV plants. For example, in Spain, the levelized cost of electricity (LCOE) for PV systems installed in 2007 was in the range of 240 – 420 €/MWh (discount rate, d = 3.8%) (Talavera et al., 2016) and in the USA, LCOE2007 was around 270 $/MWh (d = 7%) (United States Department of Energy, 2017). Meanwhile, in the last international auction tenders from 2015 and 2016, the generation price has been around 35€/MWh in Mexico, 29.9€/MWh in the United Arab Emirates, and even 29.1 $/MWh in Chile (Dezem, 2016; Hirtenstein, 2016a; Photon.info, 2016), which confirms the maturity of this technology.

These records have been so meaningful that this industry is switching from grid-parity, where the cost to generate a PV electricity unit can be compared to the retail electricity tariff that the user pays the utility company, to a situation of generation-parity, where the cost of generating a PV electricity unit is similar and can compete with production prices of other sources of energy, including those from non-renewable origins. For example, if previous PV electricity cost figures are compared with those of non-renewable energy sources, the difference is over a third for coal plants in Dubai, where it is expected to generated electricity at around 4.5 c$/kWh (Hirtenstein, 2016a), or a half price reduction in Chile (Dezem, 2016).

Some reports identify LCOE for PV in the range of 46.5 $/MWh to 110.5$/MWh for 2016 in the USA, whilst the solar thermal minimum range is 134.6 $/MWh or for wind-offshore is between 125.1 $/MWh and 201.4$/MWh. Regarding non-renewable sources, advanced nuclear

* Corresponding author.
E-mail addresses: clomas@gerion.es (J.C. Lomas), emunoz@ujaen.es (E. Muñoz-Cerón).
URL: https://www.gerion.es (J.C. Lomas).

https://doi.org/10.1016/j.enpol.2018.03.014
Received 30 March 2017; Received in revised form 19 January 2018; Accepted 6 March 2018

lies within a range of 95.9 − 104.3 $/MWh, and conventional combined cycle is around 52.4–83.2$/MWh (US EIA, 2017). Other reports assign a PV LCOE of 35–180 $/MWh for 2015, 29–114 $/MWh for wind onshore, or 53–168 $/MWh for gas (VGB PowerTech E.V.V, 2015). Of course, these LCOE values depend on the location of the energy source (Joseph Salvatore, 2013)

The most remarkable achievement was reaching this electricity generation unitary price with no direct subsidies or retribution schemes, though it could seem contrary to past trends (Bolinger et al., 2015).

Despite this favourable context, European countries, and specially Spain, have shifted from a prevailing position to a marginal one in terms of PV installation rates and accumulated capacity (International Energy Agency, 2016a). Therefore, it is interesting to analyse the reasons for this slowdown in the Spanish PV industry from a realistic approach based on measured data from real PV owners. This study analyses and describes a representative sample from a Spanish investor's perspective.

The current astonishing worldwide penetration rates of PV technology and its corresponding low generation prices have been possible as a consequence of the maturity of the technology, which has produced a dramatic decrease in manufacturing expenditures, and therefore in the installation investment cost, which has a direct influence in the electricity generation price. Nevertheless, this level of maturity has been fostered by promotion policies that have accelerated the reduction in PV energy cost (International Renewable Energy Agency, 2014a). These supporting policies, which are mostly defined at the national level, mainly materialised through different subsidy schemes that supported either the installation investment cost or, most commonly, the energy generated (International Renewable Energy, 2012; International Renewable Energy Agency, 2014b). The ultimate objective of these policies was to stimulate manufacturing and to optimise installation procedures, with the purpose of reducing costs through a large-scale deployment. Therefore, the development of PV technology could be considered a policy-driven market (Lacchini and Rüther, 2015; Winkler et al., 2016).

Notwithstanding the current situation, European countries in general, and Spain in particular, were pioneers in defining subsidy systems (European Photovoltaic Industry Association, 2014; Dusonchet and Telaretti, 2015). Among all the possible supporting schemes, the feed-in tariff (FiT) (Jenner et al., 2013) is the most widespread in Europe, which meant a real boost for the penetration rates of this technology, placing countries such as Spain at the forefront of the technological development of the photovoltaic industry.

Nevertheless, a massive promotion of such supporting policies implied a cost overrun for national administrations in many cases (Ciarreta et al., 2014; López Polo and Haas, 2014), obligating governments to legislate to contain these expenditures (Del Río and Linares, 2014). Principally, subsidies for future installations have already been cancelled, with the aggravating circumstance that in some countries, this regulation to restrain cost overruns has been applied retrospectively (Fouquet and Viktoria Nysten, 2015; Pyrgou et al., 2016).

One of the countries where these retroactive measures have had a major impact is Spain, and hence, it is interesting to thoroughly analyse its extent based on real data. Determining the effect and consequence that these retroactive measures have caused to thousands of Spanish investors (ANPIER, 2015; Cala, 2013) is paramount for developing improvements in current regulations or in definitions of prospective regulations in other countries which take Spain as a model.

This study provides a brief description of the Spanish PV framework evolution, and analyses a real case of the effects of retroactive measures on a representative photovoltaic investment from 2007. For this analysis, Spain is a suitable scenario due to its widely known frequent, controversial, and changing regulatory framework for the PV industry (Talavera et al., 2016; Urbina, 2014). This study undertakes a detailed analysis of the energy and economic performance of a PV plant as an example for most PV plants in Spain. It could be observed that a profitable PV installation, in terms of energy production and Internal Rate of Return (IRR), could result in a situation where the owner of the plant is forced to either sell it to external investors or refinance the existing debt.

This study complements, with real energy and economic data, other research that proposes different scenarios analysing the effect of retroactive measures based on simulated or theoretical assumptions. It can also serve as a proven record of the differences between the economic and financial performance of an investment (de la Hoz et al., 2014). The economic dimension of an investment is the result of an analysis of the profitability parameters such as the net present value (NPV) or the IRR. On the other hand, the financial feasibility of a project deals with its annual liquid assets, where expenses should be subtracted from incomes to identify possible deficits in the annual accounting. When the economic variables show a positive value, i.e. the NPV is positive and the IRR is higher than the weighted average cost of capital (WACC), it may induce investors to make a certain investment, but if the financial dimension of the project identifies a negative cumulative annual liquidity scenario, the project, although economically viable, is financially unfeasible.

Similar to other studies in which policy implications and risk management are an important issue to consider or in other studies examining the implications of a FIT on solar deployment (Chapman et al., 2016; Sommerfeld et al., 2017; Zhang et al., 2017), the results of this paper could be very valuable to potential investors, as a changing regulatory framework can turn a profitable scenario into a non-feasible one. Therefore, this study could contribute to future policy recommendations as an example of lessons learnt (Gatzert and Vogl, 2016; López Polo and Haas, 2014) similarly to other studies carried out in Spain (Ciarreta et al., 2011; Del Río and Mir-Artigues, 2012; Talavera et al., 2016),

2. Spanish context

From 2007 to 2010, and supported by a favourable legislative framework (del Río González, 2008), renewable energies in Spain reached unprecedented success, placing the country's PV industry as a worldwide model of technological development and installation rates (International Energy Agency, 2010; EuroObserv'ER, 2013; Montoya et al., 2014).

Since 2007, most of the investments made in Spain concerning electrical power supply system installations focused on renewable energy sources (Girard et al., 2016), where the power of these sorts of systems multiplied and their contribution to the total power installed in the country shifted from a 25% to a 37% share (Eurostat, 2017; REE, 2017). Likewise, the evolution of PV systems led to its representation of around 3% of the energy produced in the Spanish electricity generation mix, with peaks up to 4.5% during the summer months (REE, 2017). In the case of PV technology, the endorsement in May 2007 of Royal Decree (RD) 661/2007, which regulated the production of electricity with renewable energy sources and created a specific economic subsidy payment mechanism through a FiT scheme (Ministry of Industry Energy and Trade. Government of Spain, 2007), was a wake-up call for investors. Under this RD, around 75% of the current PV power existing in Spain was installed as the decree established a very favourable and profitable scenario for this technology (de la Hoz et al., 2016).

During the time under analysis in this study (2007–2015), Spain had no other promotion policies for PV grid-connected systems than the FiT. Previously, there were some tax deductions or subsidies to decrease the upfront investment for PV plant (Asociación de la industria fotovoltaica, 2008). Subsequently, during mid − 2017, there have been two tender auctions for the promotion of renewables plants in general (Bellini, 2017; Díaz-López, 2017; Reuters, 2017a, 2017b)

In order to obtain the maximum remuneration considered in RD 661/2007, most PV plants followed a similar arrangement; that is, a