Renewable and Sustainable Energy Reviews 46 (2015) 166–177

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

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

Analyzing the impact of cost-containment mechanisms on the profitability of solar PV plants in Spain

Pere Mir-Artigues [a,1], Emilio Cerdá [b,2], Pablo del Río [c,*]

[a] Energy Sustainability Research Group, University of Barcelona/UdL, Spain
[b] Universidad Complutense, Spain
[c] Consejo Superior de Investigaciones Científicas (CSIC), Spain

A R T I C L E I N F O

Article history:
Received 9 July 2014
Received in revised form
30 November 2014
Accepted 2 February 2015
Available online 13 March 2015

Keywords:
Cost-containment
Renewable energy
Feed-in tariffs
Solar PV
Public support

A B S T R A C T

From mid-2007 to September 2008, the Spanish PV sector experienced an investment boom, which led to a ten-fold increase in solar PV deployment. The concern of the government about the large increase in the associated support costs through a feed-in tariff led to the implementation of several cost-containment regulations. These included a cap on the electricity generation being eligible for support, a grid access charge, a generation charge, a shortening of the support period and the updating of tariffs below the consumer price index. The aim of this paper is to analyze the impact of those cost-containment mechanisms on the profitability of solar PV plants in Spain. The results show that these measures have had a moderate impact on the profitability of those plants, which is still relatively high, with internal rates of return which are always above 7% in all the simulated cases. However, their impact is mediated by different features of the plant, including the levels of the initial investment (upfront costs), borrowing and operation and maintenance (O&M) costs. It is also mediated by policy variables (such as changes in the tariff-updating method and the level of the grid-connection charges) and by other variables, e.g., the interest rates of loans. The specific impact of each of the cost-containment measures has also been analyzed. Our findings show that the generation charge has the greatest impact, followed by the change in the tariff-updating mechanism, the generation cap, the shortening of the support period and the grid access charge.

Contents

* Corresponding author. Tel.: +34 916022560.
E-mail addresses: peremir@econap.udl.cat (P. Mir-Artigues), ecerdate@ccee.ucm.es (E. Cerdá), pablo.delrio@csic.es (P. del Río).
[1] Tel.: +34 973703212.
[2] Tel.: +34 913942339.

http://dx.doi.org/10.1016/j.rser.2015.02.005
1364-0321/

1. Introduction

Given the alleged environmental and socioeconomic benefits of electricity from renewable energy sources (RES-E), their public promotion has become a policy priority for governments all over the world [1]. However, governments in countries with either a substantial penetration of RES-E or a recently large increase in RES-E deployment are concerned about the total costs of the policy, i.e., unitary support costs times the level of deployment. The solar PV boom in several European countries is a case in point [2].

Therefore, limiting those costs has become a policy priority both for developed and developing countries [3]. This has particularly been the case for those countries which have used feed-in laws for renewable energy support. As it is well-known, *feed-in laws* provide for preferential prices per kWh generated and are usually combined with a purchase obligation by the utilities. The most relevant distinction is between feed-in tariffs (FITs) and feed-in premium systems (FIPs). The former provides total payments per kWh of RES-E whereas a payment per kWh on top of the electricity wholesale-market price is granted under FIPs. Feed-in laws (both types) are the most widespread instrument in the world. 62 Countries apply some type of feed-in system [4]. 23 of those are EU countries.

Being a price-based instrument, a main problem of feed-in laws is that, since they set a price (support level) and let renewable energy investors and generators respond to this price, uncontrolled increases in renewable energy capacity or generation may result. In turn, this may lead to a large increase in support costs. The setting of the level of remuneration by the government depends on knowledge about the costs of the technologies, which is mainly in the hands of RES-E investors. These have an incentive to inflate those costs in order to receive a higher remuneration. This well-known problem of asymmetric information usually leads to higher than necessary support costs (see [5–7]).

The increase in support costs can be especially dramatic for technologies with a significant potential for cost reductions over time, such as solar PV. This has been the case in Spain, where total support costs for solar PV increased thirteen-fold between 2007 and 2009, from 194 million euros (M€) to 2629 M€. The unitary costs of support increased from 39 €/MWh in 2007 to 42 €/MWh in 2009. This has certainly put a burden on electricity consumers. The government reacted by adopting policy measures aimed at reducing those total costs (see [8,9] for further details).

Some alternatives to control the costs of the policy exist and these measures can be implemented ex-ante, i.e., when the policy is designed but before it is adopted. These alternatives include generation caps, capacity caps, periodic revisions of support levels, total budget caps and degression (both traditional and flexible) (see [10] for further details). However, in some countries, and particularly in Spain, cost-containment measures have been applied ex-post, i.e., after the policy had been implemented and investments had been made. Therefore, they are deemed retroactive by the renewable energy sector, which has argued that the profitability of their investments has substantially been reduced. The aim of this paper is to analyze the impact of some of those cost-containment measures on the profitability of solar PV plants in Spain.

Abstract discussions on the pros and cons of cost-containment mechanisms for RES-E support schemes have been common in the literature, both in general (see, e.g., [11,12,3,2,10,13]) and, more specifically, with respect to the Spanish case (see, e.g., [8,9]). However, the impact on the profitability of specific plants has not received a comparable attention. A notable exception is [14], which assesses the cost reductions achieved by the cost-containment measures approved in the period 2010–2012, although the authors briefly analyze the overall impact of those measures on the profitability of solar PV plants. Instead, our paper mainly focuses on the impact of cost-containment measures on net cash flows and profitability, and provides a more disaggregated analysis at the plant level, assessing the specific effect of each cost-containment regulation and taking into account different features of the plants.

Accordingly, this paper is structured as follows. The next section describes the solar PV boom in 2007–2008 which led to the later implementation of cost-containment measures and provides an overview of those cost-containment regulations. Section 3 discusses the methodology which has been used to analyze the impact of those measures on a solar PV plant. This analysis is carried out in Section 4. The paper closes with some concluding remarks.

2. The solar PV boom and cost-containment measures

2.1. The photovoltaic boom in 2007–2008

The solar PV sector experienced an unprecedented spike in investments between 2007 and 2008. Solar PV generation capacity jumped from 146 MW in 2006 to 3398 MW in 2008, with investment in Spain's solar PV market accounting for more than 40% of the world's total solar installations in 2008. The boom in PV capacity led to a parallel upsurge in costs. In 2009, solar PV received 56% of all support provided to renewable electricity in Spain, despite providing only 12% of Spain's renewable electricity [19]. A main, although certainly not the only factor leading to this boom was the support policy that had been implemented, i.e., a FIT system. Several regulations are relevant for solar PV before the cost-containment measures were implemented (Table 1).

Spain's FIT policy began with the Electricity Sector Law, introduced in 1997 (Law 54/1997). A preferential price for electricity fed by RES-E plants into the grid was adopted a year later, i.e., in Royal Decree 2818/1998. Solar PV developers were able to choose between a FIT or a FIP. The deployment levels of solar PV were stable but low and remuneration levels were revised annually [15].

In 2004, the first amendment was made, with Royal Decree 436/2004. This change came in response to criticisms from RES-E