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Assessing the benefits and costs of renewable electricity. The Spanish case

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ABSTRACT

The aim of this paper is to provide an assessment of the benefits and costs of the deployment of RES-E, electricity from renewable energy sources (RES-E) in Spain between 2002 and 2011. The benefits refer to reductions of CO_2 emissions and fossil-fuel imports. These are compared to the costs of public support for RES-E deployment granted through the feed-in-tariff system (FIT). Three different methods have been applied for this purpose: the operative margin factor, the build margin factor and a combination of both. The results show that the benefits of RES-E promotion have outweighed the overall costs of RES-E deployment, although significant variation can be observed across technologies. While those benefits have been higher than the costs for on-shore wind and small hydro, this is not the case with the solar technologies. The costs have been significantly higher than the benefits in the case of solar photovoltaics and slightly higher in the case of solar thermoelectric.

Contents

Abbreviations: BM, Build margin factor; CCGT, Combined-cycle gas turbines; CDM, Clean Development Mechanism; CM, Combined margin factor; CNE, Spanish National Energy Commission; EU ETS, European Union Emission Trading System; FIT, Feed-in-tariff system; IPCC, Intergovernmental Panel on Climate Change; LHV, Low Heating Value; MINETUR, Spanish Ministry of Industry, Energy and Tourism; NREAP, National Renewable Energy Action Plan; OM, Operating margin factor; PV, Solar photovoltaic; RES-E, Renewable energy sources; SCC, Social Cost of Carbon; TOE, Tonnes of oil equivalent; UNFCCC, United Nations Framework Convention on Climate Change

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1. Introduction

In the last years, many articles in the specialised economic press have stated that renewable electricity and the promotion scheme used in Spain to support them (feed-in tariffs or FITs) are "too costly". The main reasons have been a solar boom-and-bust cycle, which led to a tremendous growth in solar photovoltaic (PV) deployment and a large increase in the associated costs of supporting the diffusion of this technology [1]. This reduced the legitimisation of support for all renewable energy technologies, and was a major factor behind the *"sine die moratorium"* of the support system (FIT) in January 2012, after Royal Decree Law 1/2012 [2]. Plants installed after such date will not receive the FIT, which will only be granted to existing plants.

These claims about the excessive costs of supporting electricity from renewable energy sources (RES-E) focus on one side of the overall picture, without taking into account that, in addition to those costs, RES-E brings considerable socioeconomic and environmental benefits in terms of CO_2 emissions reductions and substitution of fossil-fuel imports. The main issue is, then, whether the costs of supporting RES-E deployment are worth paying, given its social, economic and environmental benefits.

The aim of this paper is two fold:

(a) To quantify in monetary terms some of the environmental and socioeconomic benefits of RES-E deployment in Spain in the 2002–2011 period. The environmental benefits refer to the CO_2 emissions avoided as a result of such deployment, whereas the socioeconomic benefits for the country refer to the reduction of fossil-fuel imports.
(b) To compare those benefits with the costs of public support for RES-E deployment granted through the FIT system.

This is a main topic at a time when support for RES-E has been questioned, leading to the aforementioned *"sine die moratorium"*. RES-E deployment has been publicly promoted in Spain since 1994 after Royal Decree 2366/1994 [3], using a feed-in tariff (FIT) system, with partial reforms in 1998, 2004, 2007, 2008 (only for solar PV) and 2010. The Special Regime (under which RES-E and cogeneration are promoted) is currently regulated by Royal Decree 661/2007 [4], which was approved in 2007. RES-E generators have had two alternatives to sell RES-E. One is to sell the electricity directly to the grid. In this case, generators would receive a regulated tariff. Another option has been to sell the electricity through the market operator. RES-E generators would then receive the daily market price of electricity plus a renewable energy premium. In 2008, the Royal Decree 661/2007 was replaced by Royal Decree 1578/2008 only for solar PV [5], which classified solar PV installations into two groups: ground-mounted and roof installations. Annual capacity targets were set and regulated tariffs were reduced every year according to the evolution of installed capacity. Under this flexible degression scheme, support levels and capacity targets were set in a circular manner. If the capacity in the previous quarter increased too much, then the support levels were reduced in order to trigger a smaller capacity increase.[1]

In addition, Law 15/2012 set a tax on electricity production on all sources of electricity generation, including renewable energy plants (a 7% rate) [7]. Recently, Royal Decree-Law 2/2013 has stated that renewable energy plants can only opt for the regulated tariff option (i.e., not the premium one) [8].

[1] For a detailed overview of the functioning of the Spanish FIT, see Refs. [1,6].

Remuneration levels (under both alternatives) have been different for different renewable energy technologies, i.e., lower for the cheapest and higher for the more expensive ones. The total costs for the four renewable energy technologies considered in this study (small hydro, wind, solar PV and solar thermoelectric) increased slowly in the first half of the period, from 996 M€ in 2002 to 2691 M€ in 2007. They reached 4827 M€ in 2007 and 6369 M€ in 2008, and then increased gradually until 2011 (7439 M€) (see Table 6 for further details). The substantial increase from 2006 to 2007 can be attributed to both solar PV and wind, whereas the trend from 2007 to 2008 can only be attributed to solar PV. In 2008, this large increase in the total policy costs led the government to approve Royal Decree 1578/2008, which put a limit (quota) on the amount of solar PV which could be eligible for support and implemented the aforementioned flexible degression scheme. In 2010, three regulations were enacted (Royal Decrees 1565/2010 and 14/2010 and Royal Decree Law 1614/2010), which limited the number of hours of RES-E generation which would be eligible for support, limited the period over which plants could receive the remuneration (instead of lifetime) and reduced the remuneration levels by applying correction factors (0.65 for wind and between 0.95 and 0.55 for solar).

Finally, as mentioned above, the FIT has been suspended *sine die* for new installations after Royal Decree Law 1/2012, although this regulation is not retroactive, i.e., those plants being registered before January 2012 will continue to receive the FIT support levels established in previous regulations (Royal Decree 1578/2008 for solar PV installations and Royal Decree 661/2007 for the rest).

The four technologies selected for this study, jointly account for 93% of all RES-E installed capacity in Spain in 2011 (excluding large hydro). Wind and solar are also the technologies whose deployment has increased most during the 2000–2011 period. They are also the ones being expected to increase most in the short and medium terms, according to the Spanish National Renewable Energy Action Plan (NREAP) [9] submitted to the European Commission to comply with the Renewable Energy Directive (Directive 28/2009/EC).

Several articles have tried to quantify in monetary terms the benefits associated to the deployment of renewable electricity [10–12]. Some authors claim that environmental and non-environmental externalities should be considered when taking decisions on energy matters [13–16]. In fact, internalising those externalities requires a robust and exhaustive quantification of those external costs [17]. This valuation and internalisation is deemed necessary for making efficient social choices. Several papers have focused on the environmental externalities avoided by renewable energy deployment [18–21]. Owen [22] shows that,

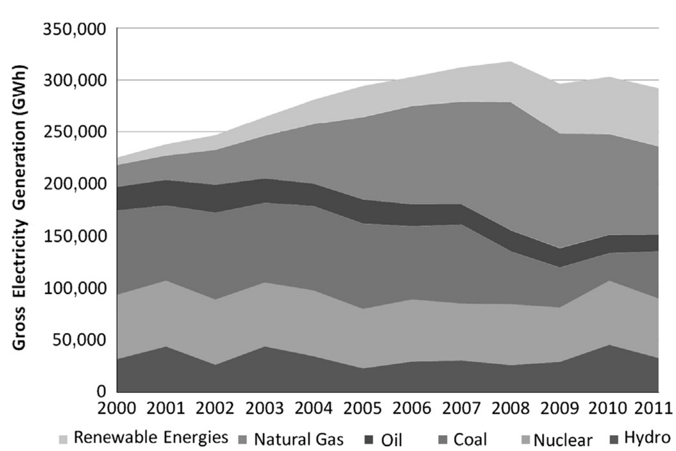

Fig. 1. Evolution of the electricity mix in Spain 2000–2011 [26,27]
Source: MINETUR [26,27].