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An economic valuation of renewable electricity promoted by feed-in system in Spain

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ABSTRACT

This paper provides an economic valuation of RES-E promoted by the Spanish feed-in system. First, supported RES-E is evaluated in terms of CO_2 emissions avoided when they are introduced in the Spanish electricity market instead of other potential polluting energy sources. And secondly, these positive environmental externalities of supported RES-E are compared with the funds they received from the Spanish feed-in system, in order to estimate the economic balance of this support system. The estimate for 2011 shows that approximately 10% of premiums paid to promote RES-E could be explained, from an economic point of view, by the monetary value of CO_2 emissions avoided by not using alternative energy sources, as coal and combined cycle. Furthermore, the economic evaluation of National Energy Commission (CNE [Spanish acronym]) proposal that links the energy sources responsible for CO_2 emissions to finance the support system of RES-E, confirms that the monetary value of CO_2 emissions avoided when using promoted RES-E is nearly 70% of the revenues from the sale of allowances allocated to polluting technologies in the last National Plan of Emission Allowances in 2011. Promotion of RES-E over the use of fossil energy sources, must take into account not only the costs of their implementation, but also the overall balance of their use.

1. Introduction

Given the relative socioeconomic and environmental benefits linked to the deployment of electricity from renewable energy sources (RES-E), its public promotion has become a priority on the agendas of governments in almost all EU Member States [1] and [2].

In the last two decades, feed-in tariff system has emerged as one of the most popular policies for supporting RES-E [3–7], although as [8] and [9] have pointed out, the efficiency of the support mechanisms vary depending on the stage of development of the renewable technologies and the detail of the regulations.

In Spain, the support system results from the regulatory developments that have taken place since the publication of Law 54/1997 of 27 November 1997 concerning the Electricity Industry [10], which incorporated Directive 96/92/EC [11] and the subsequent regulations that liberalized the Spanish power market.[1]

The Spanish power generation market is partitioned into two categories consisting of an ordinary regimen (OR) and a special regimen (SR). The SR includes facilities with an installed capacity not exceeding 50 MW as the primary energy derived from renewable energy, biomass, biofuel and waste, as well as production plants employing high performance cogeneration techniques. The OR encompasses other production plants such as those using conventional thermal technologies based on coal, fuel oil, natural gas, nuclear and combined cycle power generation, as well as hydroelectric generation technologies not included in the SR.

Therefore, both SR and OR includes RES-E, but only generators of RES-E included in SR (SR/RES-E) have the right to choose between subjecting their production to a fixed feed-in tariff system (fixed-FIT) that guarantees the market price, or selling the produced electricity in the open electricity market and receiving the market price plus an administratively-determined premium [16]. In fact, all SR/RES-E can be sold in the electricity market (getting an additional premium) except for solar photovoltaic that nowadays, can only apply for the fixed-FIT system.

This dual support system was initially introduced in Spain by the Parliament of Spain, Royal Decree. 2818/1998, of December 23, 1998 [12] and has led to a large deployment of RES-E [17]. However, this dual incentive system based on fixed FIT and premiums schemes for

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[1] Royal Decree 2818/1998 of 23 December 1998 [12], Royal Decree 436/2004 of 12 March 2004 [13], Royal Decree 661/2007 of 25 May 2007 [14] and Royal Decree 1578/2008 of 26 September 2008 [15].

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SR/RES-E has put pressure on the existing financial deficit of the Spanish electricity system [16] and [4]. As a consequence of that, this support system for RES-E has been recently revised with the establishment of a moratorium on new feed-in tariffs stipulated in the Royal Decree-Law 1/2012, of January 27, 2012 [18]. Moreover, economic difficulties in the Spanish coal sector and the negative financial situation of the Spanish economy have provoked that National Energy Commission (CNE) recently asks for a review of the Spanish support system for RES-E. Specifically, the CNE proposed, in their Report on the Spanish Energy Sector [19], that part of the total amount of premiums paid to SR/RES-E should be funded with revenues from the sale of emission allowances allocated under the National Plan of Emission Allowances (PNA [Spanish acronym]) for 2008–2012 [20].

This paper shows the convenience of taking into account the economic valuation of positive environmental externalities of SR/RES-E, in the design and promotion of an optimal resource structure for electricity generation.[2] With this information, the policy maker would provide additional arguments to the use of this particular support system that has become very effective in the Spanish RES-E deployment.

Similar to what [21] do when they incorporate all externalities in a full cost approach, this paper evaluates positive environmental externalities of SR/RES-E and compares them with the funds that they receive from the feed-in system, in order to estimate an economic balance of using this support system.[3]

The main aim of this paper is to estimate the environmental costs that would come out if the actual supported RES-E were removed from the Spanish electricity market. In this case, the environmental cost is assumed as the cost opportunity of using polluting technologies instead of SR/RES-E, and therefore, it might be considered as the positive environmental externality of using SR/RES-E.

This approach is developed in two steps. First, the alternative electricity energy resources that can substitute the SR/RES-E are calculated based on the availability criterion. Second, the CO_2 emissions increase that would come out from the alternative electricity energy resources is calculated.

Once the positive environmental externalities of SR/RES-E are calculated, they are compared with funds received from the feed-in system. The objective is to estimate the economic balance of using SR/RES-E, as the difference between premiums paid to SR/RES-E and the monetary value of CO_2 emissions avoided when they are not surprised. Both estimations have been calculated for 2011.

The second aim of this paper is the economic assessment of the proposal of National Energy Commission (CNE [Spanish acronym]) to link the energy sources responsible for CO_2 emissions to the finance of SR/RES-E.

The structure of the paper is as follows. After this introduction, Section 2 describes the database sources used for calculating the economic balance of SR/RES-E. Section 3 presents the methodology used for the replacement of SR/RES-E with other available technologies. Section 4 outlines the results, while Section 5 discusses the results and their implications for future energy policy amendments. Finally, conclusions are provided in Section 6.

2. Database

The economic balance of SR/RES-E technologies in the Spanish power sector is obtained by calculating the difference between the monetary value of the premiums paid to SR/RES-E generators and the monetary value of CO_2 emissions avoided when these technologies are incorporated in the Spanish energy electricity mix instead of other polluting technologies.

Given that the electricity generation system in Spain has been subjected to continuous regulatory changes, and the scheme of green electricity promotion has been recently modified, the economic balance has been estimated for 2011, the most recent year with data available.

For the calculation of CO_2 emissions avoided as a consequence of using SR/RES-E, some assumptions have been made.

First, the positive externalities generated by SR/RES-E, expressed in terms of CO_2 emissions avoided, have been estimated by considering what would have occurred in the Spanish electricity sector if the SR/RES-E technologies had not been implemented. In this case, electricity generated by SR/RES-E has been substituted by real alternative energy sources, both included in the OR, as well as by non-renewable energies included in the SR. In this substitution process, instead of increasing linearly the alternative technologies, they have been chosen following the criterion of availability, i.e. the SR/RES-E have been substituted only by those technologies which have scope for increased production, or stated in a different way, those technologies which have a “thermal gap”.

Specifically, after this analysis, coal and combined cycle thermal power generation have been chosen based on the following considerations:

- Nuclear power plants were used at close to 99% capacity in 2010 and 2011 [22], with little room to increase production in view of their low operational flexibility.
- Cogeneration under the SR (thermal generation based on renewable resources) is not included in our replacement because it is closely linked to the industry it serves, and therefore does not have possibilities to increase production and replace SR/RES-E.
- Hydroelectric power plants are subject to rainfall variations and therefore the hypothetical increase required in production to replace SR/RES-E cannot be guaranteed. Fuel oil power plants nowadays occupy a residual place in the Spanish electricity generation ranking, representing in 2011 just 2.60% of the total gross power generation according to [22]. In addition, the availability of these plants is strongly influenced by operational downtime. In fact, in 2011, such plants were unavailable for 49% of the annual operating time [22].
- Power generation plants using coal and combined cycle technology had a very low utilization rate in 2010 and 2011 compared to their actual production capacity (24.3% and 45.5% for coal, and 31.9% and 25.1% for combined cycle systems, respectively) which gives them significant potential to provide additional output to replace SR renewable technologies [22].[4]

Concerning the databases used for the final monetary valuation of CO_2 emissions avoided by the use of SR/RES-E, the following information is pertinent. First, it was necessary to know the

[2] Although they are not under consideration in our economic balance calculations of SR/RES, there are other positive externalities besides the positive environmental externalities of SR/RES-E in terms of CO_2 emissions avoided, such as, positive health impacts. Moreover, their contribution to the security of energy supply and the diminishing of the energy dependence is also very important in Spain.

[3] If the economic balance of using SR/RES-E was calculated taking into account not only the CO_2 emissions avoided but also other advantages, and are compared with the premiums they receive, it would be taken into consideration that although SR/RES-E technologies are actually more expensive than the fossil fuels technologies, the advantage of using them is the innovation incorporated in these technologies, that will certainly provide more cost effective performance results in the future.

[4] Another advantage of these technologies is their high flexibility to meet demands peaks, as noted in Refs. [23] and [24].