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Analysis of the success of feed-in tariff for renewable energy promotion mechanism in the EU: lessons from Germany and Spain

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Abstract

Directive 2009/28/CE establishes the obligation for the EU to reach a share of renewable energies on energetic consumption of 20% in 2020. Likewise, European regulation fixes different promotion mechanisms for the various production technologies. Member states have freedom to choose the mechanism that can be best in their individual case.

In this paper, we analyze the main characteristics and the results of the promotion mechanisms of renewable energy used in the two European countries leaders in terms of installed capacity and production of renewable energy (Germany and Spain). This research paper can serve as the basis for the design of regulation in other countries given that it highlights the main advantages of a feed-in tariff system. We acknowledge financial support received from Xunta de Galicia through SEC100020PR.

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1. Introduction

The promotion of renewable energy is a key concept in European Union (EU) by both environmental and economic reasons. This energy contributes to the securing of the objectives established by the Kyoto Protocol. Besides, it allows the obtaining of various social-economic advantages, such as the diversification of energy offer, the creation of employment, the improvement of opportunities of regional and local development and the creation of a solid domestic industry (Moreno and López, 2008).

In this context, the participation of governments is necessary in the initial phase of the introduction of the new production technologies. It will allow to secure their development and to protect them from the direct competition of conventional technologies. This governmental support can be justified from two points of view: the correction of the negative externalities derived from the use of fossil fuels and the stimulation of the technical/technological change (Menanteau et al., 2003).

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Given the characteristics described, the development of mechanisms that promote renewable energy is required. In this context, the objective of this paper is to determine the success factors of such mechanisms that have allowed Germany and Spain to become leaders in terms of installed power and production capacity in renewable energy in the EU. For this purpose, the paper is structured in the following way: firstly, we study the main characteristics of the different mechanisms of renewable support used in the EU. Later, we analyze the promotion policies of this type of production technology in Germany and Spain. After that, we compare these policies for the different types of renewable energy (wind, thermal and solar photovoltaic and biomass) and we show the results derived from their application in both countries. Finally, based on the previous sections, we present the main conclusions of the paper.

2. The debate of renewable energy policy

Directive 2009/77/CE gives freedom to each member state to choose the mechanism of renewable energy promotion that can be better suited to its intrinsic characteristics. A revision of these measurements, in the EU, shows the establishment of three types of mechanisms: a) feed-in tariffs, b) competitive auctions and c) the quotas of negotiable green certificates.

The feed-in tariffs entail that renewable energy generators have right to sell all their production in the electricity network and to obtain, in exchange, retribution based on a fixed price or, alternatively, on the daily price of electricity market plus an incentive that compensates the environmental value. It has been applied in Germany, Spain or Denmark, for example.

In the case of the competitive auction system, the regulator reserves a proportion of market for the production of renewable energy and develops a competitive system within generators that use these resources. Distributors have the obligation of acquiring the produced quantity in that reserved market. It is the cases of Italy or Sweden.

The objective of the system based on quotas of negotiable green certificates is that produced energy from renewable sources can be converted in an integral part of the electricity market. For this, the government establishes the obligation for distributors to acquire a certain percentage of their supply from renewable energy (fixed quota of electricity); this percentage generally increases over time. It has been applied in France or Latvia.

EU countries have introduced various support mechanisms for renewable production technologies and, therefore, there is no consensus regarding which instrument is most suitable. However, experience shows that the development of a feed-in tariff system, that allows guaranteeing an attractive profitability for renewable installations is effective in the promotion of the renewable energies. It is the case of Germany or Spain which have introduced this mechanism from the first phases of the promotion of this type of production technologies, and this has allowed them to occupy the first two places in the EU in installed capacity and production of renewable energy.

3. Analysis of the policies of renewable energy promotion in Germany

Germany is the leader in renewable energies given 10% market share of renewable in 2008 (with estimated forecasts of 20% in 2020). This country has the first position in terms of installed capacity in wind energy and the second position in photovoltaic solar energy. The success of the establishment of renewable energies in Germany has been given, in great extent, by the development of a legal and political framework that allowed for the introduction of pioneering policies in renewable energy (such as the Renewable Energy Act or the Renewable Energies Heat Act). However, the beginning of the promotion of this type of technologies was developed in 1974, after the petroleum crisis. During a decade and half, this policy consisted, almost exclusively, in the promotion of research. From 1979, the first efforts are made towards promoting the demand of renewable energies through the use of tariffs. The government, through the National Competition Law, forces distributors to purchase the electricity produced from renewable energy sources. By the end of the eighties, as a consequence of the increasing worry surrounding the greenhouse effect, various new policy measures are established for the creation of markets of renewable production technologies. Within them, we can highlight “the Wind Program with 100/250 Mw”, “the Program of 1.000 Solar Roofs” and the establishment of a feed-in tariff system as promotion measures of certain renewable production technologies (established in 1990) (see Table 1). With this regulatory framework, electricity companies have to connect the generators of renewable energy in the network and acquire the electricity. The main objective is to balance the conditions of renewable energies by developing feed-in tariffs that considered the external generation costs of conventional energy.

Later, the Renewable Energy Act (EEG) of 2000 (amendment take place in 2004 and in 2009), had the basic purpose of increasing the proportion of renewable energy in the electricity supply. In this new regulatory

framework, producers of renewable energy receive a fixed payment during fifteen or twenty years for the produced energy and distributors have the obligation to give them priority in their supply. The value of the feed-in tariff will be established with respect to the type of renewable energy and its location (see Table 2).

Table 1. Feed-in tariffs established in the regulatory framework, 1 January 1991-1 April 2000 (in pfennings²)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Wind, solar energy (90% of sale price)	16,61	16,53	16,57	16,93	17,28	17,21	17,15	16,79	16,52	16,13
Biomass until 5 Mw (75%. After 1994, 80%)	13,84	13,78	13,81	14,11	15,36	15,3	15,25	14,92	14,69	14,34
Hydraulic until 0,5 Mw (75%. After 1994, 80%)	13,83	13,78	13,81	14,11	15,36	15,3	15,25	14,92	14,69	14,34
Hydraulic after 0,5 Mw until 5 Mw (65%)	11,99	11,94	11,97	12,23	12,48	12,43	12,39	12,12	11,93	11,65

Source: Lauber and Mez (2004)

Table 2. Feed-in tariffs with the Renewable Energy Act³ (in hundredth part of Euro/kwh)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Hydraulic											
Until 500 kw	7,67	7,67	7,67	7,67	7,67	7,67	7,67	7,67	7,67	7,67	7,67
From 500 kw to 5 Mw	6,65	6,65	6,65	6,65	6,65	6,65	6,65	6,65	6,65	6,65	6,65
Biomass											
Until 500 kw	10,23	10,23	10,1	10	9,9	9,8	9,7	9,6	9,5	9,4	9,3
From 500 kw to 5 Mw	9,2	9,2	9,1	9	8,9	8,8	8,7	8,6	8,5	8,4	8,3
From 5 Mw to 20 Mw	8,69	8,69	8,6	8,5	8,4	8,3	8,3	8,2	8,1	8	7,9
Wind	9,1	9,1	9	8,8	8,7	8,6	8,4	8,3	8,2	8,1	7,9
Solar	50,6	50,6	48,1	45,7	43,4	41,2	39,2	37,2	35,3	33,6	31,9

Source: Lauber and Mez (2004)

4. Analysis of the promotion policies of renewable energy in Spain

Spain is the second European country with higher installed power and production in renewable energy. Its success in the promotion of these production technologies is given, in a great extent, by the regulatory framework used. It is also based on a feed-in tariff system. In 1980, Law 82/1980 of Energy Conservation has the basic objective of improving the energetic efficiency and reducing foreign dependence. Subsequently, the National Energy Plan 1990-2000 establishes incentives for cogeneration and energy production from renewable sources.

Table 3. Fixed premiums in the Spanish electricity industry (sales to market) (in hundredth part of Euro/kwh)

Production Technology	1999	2000	2001	2002	2003	2004	2005	2006	2007	2007	2007	2007
									R.D. 436	R.D. 661	R.D. 661	R.D. 661
										Reference	Upper limit	Lower limit
Photovoltaic solar												
< 5 Kw	36	36	36	36	36							
> 5 Kw	18	18	18	18	18							
<= 100 Kw						a	a	a	a			
> 100 Kw and <= 10 Mw						18,738	19,059	19,912	19,912			
> 10 Mw and <= 50 Mw						18,738	19,059	19,912	19,912			
Thermal solar	0,03	0,03	0,03	12	12	18,738	19,059	19,912	19,912	25,4	34,397	25,403
Wind												
Tierra <= 5 Mw	3,16	2,87	2,87	2,89	2,66	3,603	3,665	3,829	3,829	2,929	8,494	7,127
Tierra > 5 Mw y <= 50 Mw						3,603	3,665	3,829	3,829			
Mar <= 5 Mw						3,603	3,665	3,829	3,829	8,43	16,4	
Mar >= 5 Mw												
Biomass												
Energy crops	3,04	2,76	2,76	2,78	3,32	3,603	3,655	3,829	3,829	11,529	16,63	15,41
Biomass from agricultural wastes										8,211	13,31	12,09
Biomass from forestry wastes										8,211	13,31	12,09

a Photovoltaic solar plants under RD 661 and below 100 kw under RD 436 does not have the premium option.

Source: Del Río (2008)

The development of the Law 54/1997 entails the liberalization of the Spanish electricity industry. The objective is to guarantee the electricity supply at a low price and to minimize the environmental impact of this activity. Royal Decree 436/2004 and 661/2007 allow producers of renewable energy to choose between two possibilities: a) to sell their surplus of electricity energy to a distributor in exchange for an amount equal to the feed-in tariff calculated as a

² 100 pennings = 0,51 Euros.

³ The amount of the feed-in tariffs is changed by the two amendments made in the Renewable Energy law in 2004 and 2009. The main changes are commented in section 5 (analysis of the main renewable production technologies).

percentage of the medium or reference electricity tariff every year or b) to sell their production surplus in the electricity production market or through a bilateral contract in exchange for the negotiated market price, an incentive for their participation and a fixed premium. A reference premium and the upper and lower limits are established for every renewable production technology that participates in the market (see Table 3).

Later, Royal Decree 1578/2008 establishes a new tariff system for photovoltaic solar energy. It is based on the location of this type of plants: plants located on covers (type I) and plants located on the ground (type II). Order ITC/1723/2009 establishes an actualization of the tariffs and the premiums based on cogeneration and wastes. Likewise, Royal Decree 1614/2010 establishes a restriction of the equivalent hours of functioning in wind production and thermal solar installations with the right to receive the premium. It also updates the quantity of their premiums.

5. Comparison between the results of applying a feed-in tariff in Spain and Germany: characteristics and results

In Table 4, we show the main characteristics of the regulatory frameworks of renewable energy promotion applied to the main production technologies in Germany and Spain.

Table 4. Comparison of the promotion policies of renewable energy in Germany and Spain (I)

Renewable production technologies	GERMANY	SPAIN
WIND	<p>2008. Installed capacity: 23.903 Mw. Demand supply: 7,95%.</p> <p><u>Legislation:</u></p> <ul style="list-style-type: none"> - <i>Tariff support system</i> (1991). It entails a wind expansion and technological learning in the industry (1989: 20 Mw-1995: 1.100 Mw). - <i>Renewable Energy Act</i> (2000) (and its amendments of 2004 and 2009). This regulation establishes attractive premiums for on-shore wind (initial tariff: 8,03 Euro cents/kwh and, from 2008, 5,07 Euro cents /kwh) for a time period between five and twenty years depending on the location. Likewise, it fixes especial premiums for off-shore wind (base tariff: 6,07 Euro cents /kwh) and repowering. <p><u>Complement of regulatory framework:</u></p> <ul style="list-style-type: none"> - Cooperation between enterprises, institutes of research and development and universities: advances in technology and in the operation of wind turbines, - German education system establishes specialties that favor the experience, quality and know-how of employees. 	<p>2008. Installed capacity: 16.704 Mw. Demand supply: 11%.</p> <p><u>Legislación:</u></p> <ul style="list-style-type: none"> - <i>R.D.2818/1998, R.D. 436/2004, R.D. 661/2007.</i> <p>These regulations allow for wind expansion by establishing two options for generators of this production technology - the sale of its electricity at a regulated tariff or its entrance in the market with a reward based on the market price plus a premium (this Royal Decrees also fixes a minimum and maximum profitability)-</p> <ul style="list-style-type: none"> - <i>R.D.1614/2010.</i> It establishes a limitation of the equivalent hours of functioning of wind plants with right to premium (2.589 hours/years for the on-shore wind). Likewise, this regulation entails a reduction of the reference premium of 35% for wind energy that has recourse to R.D. 661/2007 and those installations with more than 50 Mw. <p><u>Complement of regulatory framework:</u></p> <ul style="list-style-type: none"> - Creation of competitive companies that are nowadays active in the international technology markets.
PHOTOVOLTAIC SOLAR	<p>2008. Installed capacity: 6.109 Mwp.</p> <p><u>Legislation:</u></p> <ul style="list-style-type: none"> - <i>Tariff support system</i> (1991). Results are not as satisfactory as in the case of wind energy because the value of the premium (initial amount: 8,5 Euro cents /kwh) is not even near production costs for this technology. - <i>Program of 1.000 Photovoltaic Solar Roofs</i> (1991-1995). The objective of this program was the use of alternative resources not developed by the regulatory framework. - <i>Program of 100.000 Photovoltaic Solar Roofs</i> (1999). - <i>Renewable Energy Act</i> (2000) (and its amendments of 2004 and 2009). This regulation supposes an increase of premium (with a new amount of 57 Euro cents /kwh) for compensating the incentive loss of the Program of 1 00.000 Photovoltaic Solar Roofs. These characteristics entail a boom in the investment of this type of renewable technologies which supposes that the second amendment of the Act (2009) establishes a reduction of the tariff between 8% and 10% in 2010 and, later, a value of 10% annually. <p><u>Characteristics:</u></p> <ul style="list-style-type: none"> - Important development of small installations because the 	<p><u>Año 2008.</u> Installed capacity: 3.404 Mwp.</p> <p><u>Legislation:</u></p> <ul style="list-style-type: none"> - <i>R.D.2818/1998, R.D. 436/2004, R.D. 661/2007.</i> <p>This regulation fixes an incentive system based on premiums for the promotion of photovoltaic solar energy.</p> <ul style="list-style-type: none"> - <i>R.D.1578/2008.</i> It establishes a new premium system for this production technology. The amount depends on their location: on covers or on ground. Likewise, installations are classified with respect to their position, construction material and use. It entails the promotion of smaller photovoltaic systems (on cover) by establishing a higher premium (34 Euro cents /kwh with regard to 32 Euro cents /kwh for installations of greater size). In the case of ground installations, a unique tariff is fixed with the aim of avoiding problems related with the energy differential and stimulating those projects that maximize their efficiency from a technological and economic perspective. When objectives were reached, the premiums are reduced every three months.

	first amendment of the Renewable Energy Act (2004) supposes higher premiums to this type of installations.	
THERMAL SOLAR	<p>2008. Installed capacity: 7.921 Mwth.</p> <p><u>Legislation:</u></p> <ul style="list-style-type: none"> - <i>Incentive Program for the Market</i> (1999). It seeks to promote the generation of solar energy for heating water and for domestic heating uses. With this end, the Federal Office of Economy and Exportation Control (BDEFA) supported, through the establishment of subsidies, those SMEs and other private that invested in this technology. However, subsidies were periodically cut off so this process was frequently interrupted. - <i>Renewable Energy Heat Act</i> (2008). This regulation gives security to investments in this type of production technology by establishing a constant annual budget of up to 500 million Euros (2009-2012). Likewise, this law introduces the obligation for new buildings to cover a minimum percentage of heating consumption from renewable energy. 	<p>2008. Installed capacity: 1.024 Mwp.</p> <p><u>Legislation:</u></p> <ul style="list-style-type: none"> - <i>R.D.2818/1998, R.D. 436/2004, R.D. 661/2007</i>. They establish an incentive system based on premiums for the promotion of this production technology. - <i>New Technical Code of Building (CTE)</i> (2006). This new regulation turns Spain in one of the countries with the most advanced solar legislation (EREC, 2008). The importance of this legislation is given by the success of previous solar municipal regulation. The CTE include the following main areas: structure security in the construction, security and health, sustainability and energetic efficiency of the construction. The last part (Basic Document of Energy Saving) goes beyond the minimum level of implantation of European Directive on the construction energy management. So, it includes the obligation of covering 30%-70% of domestic demand of hot water with thermal solar energy. - <i>Promotion Plan of Renewable Energy 2005-2010</i>. This plan entails, from 2008, the development of financial incentives for the promotion of these thermal solar plants (the subsidy covers the 37% of the overall costs of the project). - <i>R.D.1614/2010</i>. This regulation establishes a limitation of the equivalent hours of functioning in the thermal solar plants with the right to receive the premium. It will vary depending on the technology they use.
BIOMASS	<p>Germany has a high potential of biomass resources and R&D in Europe.</p> <p><u>Legislation</u></p> <ul style="list-style-type: none"> - <i>Renewable Energy Act</i> (2000) (and its amendments of 2004 and 2009). It establishes a premium system which varies with respect to production capacity of the plant. Likewise, it fixes an additional reward depending on the specific origin of the biomass material used and on whether the plant combines heat generation and electricity. 	<p>The development of this production technology has not been, up to date, as important as expected in Spain.</p> <p><u>Legislation:</u></p> <ul style="list-style-type: none"> - <i>R.D.2818/1998, R.D. 436/2004, R.D. 661/2007</i>. This regulation fixes an incentive system based on premiums for biomass production.

Source: Elaborated using information from The Renewable Energy Act (2009, 2004, 2000), Law 54/1997 of the Spanish Electricity Industry, R.D. 436/2004 and R.D. 661/2007.

From the characteristics of the regulatory framework of Germany, analyzed before, we show the main results derived from their application:

- This regulation has allowed Germany to *increase the renewable energy quota* in the electricity consumption from 6% in 2000 up to 15% in 2008 (Büsgen and Dürrschmidt, 2009).
- *Increase in employment* in the renewable energy industry. The creation of employment can be estimated in around 280,000 jobs in 2008. Almost 60% of these have been created as result of the Renewable Energy Act (most of these jobs were developed in the wind industry) (BMU 2008).
- This regulatory framework is a key concept for the *environmental protection* of Germany. The emissions of CO₂ have been reduced in 57 million tons until 2007 (Büsgen and Dürrschmidt, 2007).
- Reduction in costs and quality improvements. The expansion of renewable energy has allowed for higher opportunities for cost reductions. Likewise, the technological development has led to more efficient and reliable renewable energy installations.

In the case of Spain, the characteristics of the regulatory framework, presented in Table 4, also show various positive aspects for the Spanish economy (Deloitte-APPA, 2009):

- *Positive contribution of renewable energies to GDP in Spain*. The increase of the industry of renewable energies in the period 2005-2008 can be valued as 55% in terms of GDP.
- Development of the *research, development and innovation*. The high increase of some renewable production technologies has entailed the creation of an important industry of equipment and fabrication components with an innovative profile.

- This regulatory framework is a fundamental concept in the *environmental protection* of Spain. The emissions of CO₂ have been reduced in around 23,6 million tons over the period 2005-2010.
- *Increasing of employment* in the renewable energy industry. The creation of employment can be sized at almost 120,722 jobs until 2008 (around 62% of them are direct jobs).

6. Conclusions

Over the last years, the EU is living a rather intensive development process of renewable energies. This entails certain environmental profits, such as the lower carbon emissions of this type of technology and their sustainability with regard to fossil energy sources.

In this context, the participation of the government in the initial phase of renewable energies is necessary for securing their development and protecting them from direct competition from conventional technologies. However, there is not a consensus about which mechanism is the most efficient.

In this paper, we analyze the main characteristics and results obtained with legislation relating to the promotion of this type of production technologies in the cases of Germany and Spain. We have selected these two countries because they are the two first European states in installed power and production of renewable energy. Both countries have chosen to implement a premium system for the promotion of renewables. This mechanism allows producers of this type of energy to obtain, along with the electricity market price, an incentive that compensates the environmental value of activity.

Results in these EU countries show an important economic-social boost. So, in both cases, the development of the renewable energy entails: a) an element of environmental protection (by means of the reduction of pollutant emissions, b) a considerable increase of employment, c) a positive contribution to GDP, d) the development research, investment and innovation with the consequent creation of an important industrial fabrication sector. Therefore, we can say that the establishment of a feed-in tariff system allows for the development of these production technologies (especially wind and photovoltaic solar energy).

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