SPAIN

1.1 Introduction

1.1.1 Objective of the case study

The present case study is developed as part of the European Environment Agency (EEA) project 'Energy Support and Innovation'. The key objective of this case study is to explore in some depth the relationship between support measures applied to all forms of energy and the innovation process in the renewable energy sector. More specifically, the key research question is: How do energy support measures affect the market conditions for renewable energy technologies and hence innovation in the renewable energy sector?

Within this project, the effect on innovation is mainly measured in terms of the market deployment of renewable energy technologies, although other indicators have been used to describe the state of play concerning other phases of the innovation process such as research and market development. The structure of the case study is as follows:

Sub-sections 1.1.2 and 1.1.3 provide a brief overview on the key features of the country's economy and energy system and overall market conditions for renewable energy technologies. Section 1.2 includes a quantitative overview of the energy support measures in place, distinguishing between conventional energy sources and renewable energy sources (RES) and their development over time during the period 2005 to 2011. Sub-section 1.3.1 discusses progress concerning the deployment of renewable energy technologies and the 2020 outlook. Because a successful innovation process presupposes that effective and efficient policies are in place, an assessment of the effectiveness and efficiency of renewable policies in place is provided in Sub-sections 1.3.2 and 1.3.3. Subsequent sections provide additional insights on the innovation process in the renewable sector (research and development (R&D), employment, etc.). Finally, for a successful innovation process, the economic, innovation and sector-specific policy objectives need to be coherent and reinforce each other. Therefore, a brief analysis of policy coherence is included in Section 1.5. The analysis covers the period from 2005 to 2011. Relevant developments prior to 2005 and more recent ones are reflected as much as possible.

1.1.2 Key features of the Spanish energy system

Spain's gross domestic product (GDP) per capita amounted to EUR 20 300 in 2012 (Eurostat, 2013). Spain's population has grown by more than 11 % since 2000. After more than a decade of rapid economic growth, growth slowed from 3.5 % in 2007 to 0.9 % in 2008, followed by a decrease in GDP of 3.7 % in 2009. It subsequently stabilised at around – 0.1 % in 2010 and + 0.7 % in 2011. Unemployment has increased from 8 % in 2007 to 25 % in 2012 (Eurostat, 2013). The share of the services sector in the economy was 70 % of gross value added (GVA), followed by industry (17 %) and agriculture (3 %).

Table 1 Key economic indicators for Spain

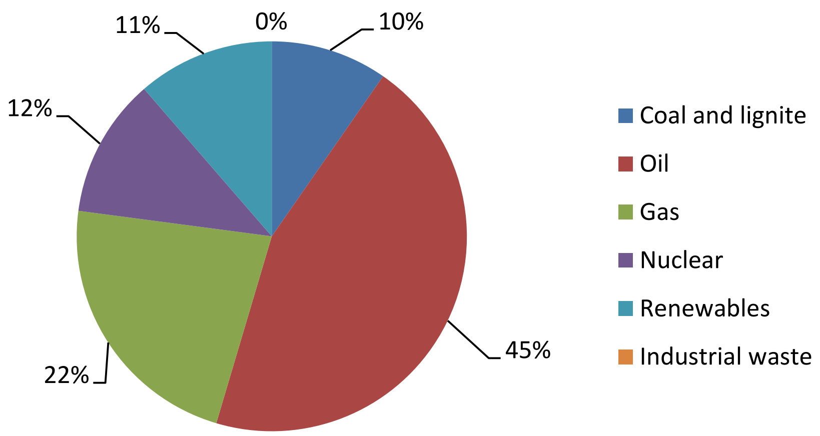
	2005	2006	2007	2008	2009	2010	2011	2012
Energy intensity (gross inland consumption, kg oil equivalent, per €1 000 of GDP)	159	153	149	144	137	137	135	
GDP per capita, real (€2 005)	21,000	21,500	21,800	21,700	20,700	20,600	20,600	20,300

Unemployment as % labour force	9 %	9 %	8 %	11 %	18 %	20 %	22 %	25 %
GDP share agriculture, forestry, fishing, mining (% GVA)	3 %	3 %	3 %	3 %	3 %	3 %	3 %	n.a.
GDP share industry (% GVA)	18 %	17 %	17 %	17 %	15 %	16 %	17 %	n.a.
GDP share commercial services (% GVA)	64 %	64 %	65 %	66 %	68 %	69 %	70 %	n.a.
Primary energy consumption imports–exports electricity (%)	0 %	0 %	0 %	– 1 %	– 1 %	– 1 %	0 %	n.a.

Source: Eurostat (2013)

In 2011, Spain's primary energy consumption was dominated by oil (45 %), followed by gas (22 %) and nuclear (12 %). RES had a share of 11 % in 2011 (see Figure 1).

Figure 1 Primary energy consumption by share of fuel in 2011



Source: EEA indicator ENER 26 based on Eurostat data extracted on 28 February 2013[1]

The country greatly depends on imports for some three fourths of its total primary energy supply (TPES). These imports include all oil, natural gas and most coal.

An important feature and key challenge is the tariff deficit in the Spanish electricity market. The deficit is mainly a result of regulated end-user prices that do not reflect generation costs (Marañóna and Morata, 2011). At the end of 2012, the total deficit was EUR 25.5 billion (Couture and Bechberger, 2013). According to the Spanish National Reform Programme (NRP), addressing the tariff deficit is one objective of Spanish energy policy. This should be underpinned by various measures, such as suspending 'economic incentives for new renewable energy facilities'. Spain remains 'firm[ly] … commit[ted] … to the fight against climate change and the achievement of an increasingly sustainable energy system' (NRP-ES, 2013b: 39) and sees a key role for renewable energies in the transition to a low-carbon economy (NRP-ES, 2013a: 43). This is also reflected in economic policy that identifies 'growth that respects the environment and combats the effects of climate change' as a

[1] An updated version of ENER26 with 2012 data is available at: http://www.eea.europa.eu/data-and-maps/indicators#c5=&c7=all&c0=10&b_start=0.

specific strand of action under the 2013 European Semester priority 'Promoting growth and competitiveness for today and tomorrow' as set out by the European Commission (2013: 7).

1.1.3 Overall market conditions for renewable energy technologies

The Spanish renewable energy market was very attractive to investors until 2010 because it offered a stable framework for reasonable profits (Ragwitz et al., 2012). The feed-in tariff (FIT) and feed-in premium (FIP) schemes have been identified as a key reason. Ragwitz et al. (2012) have calculated an electricity market preparedness indicator for all renewable electricity technologies, reflecting the overall market structure and progress with market liberalisation ([2]). In 2010, Spain was among those Member States with the highest score.

Changes to renewable energy support schemes (see below for further details) negatively affected market demand. In addition, administrative changes created further hurdles to renewable energy projects. Since 2009, all projects that expected to benefit from FITs or FIPs had to 'pre-register' to allow the government better control of projects that were in the pipeline (Winkel et al., 2012). Moreover, an access toll was introduced that obliged energy generation companies to pay for access to the transport and distribution networks based on the amount of energy dispatched in the network. For the onshore wind sector the relative share of system services costs including grid extension/reinforcement costs as well as balancing costs was among the highest in Spain besides Denmark and the Netherlands (Ragwitz et al., 2012).

The caps as included in the Renewable Energy Plan 2005–2010 and the emergency measures in 2010 did put a limit on overall market demand and introduced a significant level of uncertainty in the market. This affected particularly the early stage of project development, since it was not clear which level of FIT or FIP would be available for the project. The moratorium of 2012 further increased uncertainty and capped demand. The abolishment of the FIP system in early 2013 is expected to have a major impact on market demand, although official numbers are not available yet.

Spain has introduced several institutional innovations that have been replicated in other countries. Spain was the first country to introduce a variable FIP system for wind energy, FITs for concentrated solar power (CSP) and a bonus system for power plants that can provide reactive power to the grid (Couture and Bechberger, 2013).

1.2 Quantitative overview of public support to all energy forms

This section provides a comprehensive overview of the public support available to all energy forms. After describing the different forms of public support available, a quantitative overview is provided in Table 2.

1.2.1 Direct transfers

[2] The electricity market preparedness indicator considers gate closure time, share of electricity traded at the spot market, number of companies with more than 5 % share in the national retail market, number of companies with more than 5 % share in generation capacity/wholesale market, and share of transmission system operators that are ownership unbundled (Ragwitz et al., 2012).

Fossil fuels

Operating aid to coal producers

The principal form of aid is transfer payments by the government to private coal companies to compensate them for the difference between their operating costs and the prices at which they sell their output to local power plants (which are negotiated directly).

European Union (EU) Member States agreed in 2010 to gradually phase out coal subsidies by 31 December 2018 ([3]).

Operating aid to HUNOSA

The Spanish government has been providing financial assistance to the coal industry for several decades. Support is usually granted as part of a series of overarching, pluri-annual plans that aim at progressively rationalising and downsizing the Spanish coal industry. The estimates included in the database under this heading pertain to the amount of support granted to HUNOSA to cover its operating costs. HUNOSA is a major state-owned producer of hard coal in the central Asturian basin.

Subsidy for the interbasin trade of coal

This programme benefits electricity companies through budgetary transfers that support the transport of coal across basins.

Adjustment aid to coal producers

This item comprises transfers made by the Spanish government to private coal producers to cover social costs and contractual obligations arising from the restructuring of the coal-mining sector. The programme provides certain non-profit organisations — along with coal miners and their families — with budgetary transfers to help address the social and technical costs that stem from the decline of the coal-mining sector.

Inherited liabilities

Inherited liabilities aid can be used to pay benefits to former miners and cover the costs of mine closures. Aid is also available to finance mine closures, for industrialisation projects and for developing infrastructure in the affected mining regions.

Funding for coal stockpiles

This measure provides funding to power plants to support their constitution of coal stockpiles. Those stockpiles are meant to guarantee over 720 hours of power generation. Plants are, however, specifically required to accumulate domestic coal.

Capacity payments for conventional power plants

[3] Council Decision of 10 December 2010 on state aid to facilitate the closure of uncompetitive coal mines (2010/787/EU).

A flat-rate compensation for conventional power plants (hydro, coal, gas and oil) remunerates these power plants for the power generation capacity they make available in the electricity system. The annual payment per megawatt (MW) is reviewed annually and adjusted for the availability of each technology. In 2012, the annual payment was EUR 5 150/MW. Adjusted for the availability per technology, the remuneration varied between EUR 4 640/MW and EUR 1 220/MW in 2012. In 2012, the capacity payments totalled EUR 191 million (CREG, 2012).

Investment aid for conventional generation facilities with a capacity > 50 MW

Conventional power generation units with a capacity > 50 MW are eligible for a capacity payment for the first 10 years of operation. The payment level is adjusted each quarter by the transmission system operator (TSO). In 2012, these investment aids amounted to EUR 651 million (CREG, 2012).

Renewable energy sources

Feed-in tariffs and feed-in premiums

Until end-January 2012, when a moratorium was put in place, operators of new renewable power plants had to choose between two options (Winkel et al., 2012; Schallenberg-Rodriguez and Haas, 2012): a FIT and a FIP paid on top of the wholesale electricity price. The scheme covered all major renewable energy technologies except for solar photovoltaics (PV), which was eligible for FITs only. Most wind energy projects opted for the FIP. The level and duration of support depended on the technology and the size of the project. The FIPs were subject to a cap and floor system. In the event a certain capacity threshold was reached, the FITs and the FIPs were adjusted. For offshore wind projects a specific tendering procedure was in place (Winkel et al., 2012). The FITs and FIPs options were also available for high-efficiency cogeneration using either biomass or biogas.

From 2010 renewable electricity generators were required to pay a fee of EUR 0.50 per megawatt-hour (MWh) for electricity fed into the grid, with the aim of reducing overall public support expenditure for RES. Based on an annual renewable electricity generation of around 89 terawatt-hours (TWh) in 2011 (Eurostat, 2013), the revenues from this tax would have amounted to around EUR 44.5 million. In addition, there was a cap on the amount of kilowatt-hours (kWh) eligible for compensation from the FIT and FIP system for wind, solar PV and solar thermal power installations. Once the limit was reached, the excess electricity generated would be sold at the wholesale electricity market price without any additional support in that year.

More specifically, the following changes were introduced for wind energy and solar PV (Winkel et al., 2012; IEA, 2012). For wind energy plants with a capacity of over 50 MW the FIP was reduced by 35 % compared to 2010 values until the end of 2012. Moreover, there was a cap on operation hours that are eligible for the FIP. Any excess income needed to be repaid by the operator within three months of the government's request. For solar PV, the FIT was reduced by between 5 and 45 % depending on the size of the plant and the amount of eligible hours was capped. Furthermore, the incentives for CSP were reduced significantly.

In February 2013, the FIP system was abolished. This will affect mainly operators of wind and biomass power plants, which benefitted most from this system. In addition, an extra premium of up to EUR 0.7 ct/kWh for repowered wind farms, old wind farm installations that are upgraded by more recent wind energy technologies, was abolished.

Total annual expenditures for the FIT were EUR 798 million in 2005 and increased to EUR 6,128 million in 2012 (see Table 2).

Table 2 Feed-in tariff and feed-in premium payments for renewable electricity, 2005–2012 (*thousand EUR*)

	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Solar	13,996	39,891	194,819	990,830	2,633,894	2,835,560	2,708,430	3,540,224
Solar PV						2,650,688	2,281,528	2,613,838
Solar thermal						184,872	426,901	926,386
Wind	612,785	865,815	194,819	1,155,818	1,619,203	1,964,347	1,710,865	2,049,615
Hydro	111,955	149,567	1,003,575	147,033	234,063	296,975	206,040	186,123
Biomass	59,094	75,132	146,946	129,669	224,542	243,453	281,366	352,312
Total	**797,830**	**1,130,405**	**1,540,160**	**2,423,349**	**4,711,703**	**5,340,336**	**4,906,701**	**6,128,275**

Source: CNE (2013) ([4])

1.2.2 Fiscal preferences

Fossil fuels

Fuel tax reductions

This tax provision provides both the farming and mining sectors with a reduced rate of excise tax on petroleum products.

Fuel tax exemptions

The Spanish tax code exempts certain users from the fuel tax that is normally levied on sales of petroleum products. Major eligible activities include aviation, navigation and railway transport.

Fuel tax partial refund

This tax provision was introduced in 2006 and provides eligible tax payers with a partial refund of the special tax on hydrocarbons (Impuesto Especial sobre Hidrocarburos) provided diesel fuel is used for commercial activities like farming and livestock. The amount of the refund shall be equal to the rate of EUR 78.71/thousand litres. This measure was implemented in order to offset the increase in costs of agricultural production due to rising oil prices.

Renewable energy sources

Full tax exemption for biofuels under the hydrocarbons tax

[4] Between 2005 and 2009 no differentiation was made between solar PV and solar thermal installations.

From 2005 biofuels were exempted from the hydrocarbons tax on transport fuels that were EUR 0.278/litre for diesel and EUR 0.371/litre for gasoline. This exemption expired on 31 December 2012. The zero tax rate was applicable to biofuels in the transport sector and biomethanol and biodiesel used for heating purposes.

Tax credit for use of renewable energy in buildings

From 1 May 2011 to 31 December 2012 a tax credit for investments related to the use of renewable energy or similar measures in buildings was available for taxpayers ([5]).

1.2.3 Transfer of risk to government

No relevant measures were identified within the scope of this report.

1.2.4 Other fiscal measures

No relevant measures were identified within the scope of this report.

1.2.5 Non-fiscal measures

Building code ([6])

Since 2006 there is an obligation for any new or renovated building to integrate solar PV or solar thermal systems in place. The specific requirements depend on the climatic zone, the surface of the building, and the type and use of the building. Local and regional governments can go beyond theses minimum requirements (Winkel et al., 2012). This provision mainly stimulated the deployment of solar thermal systems.

Priority grid access

In Spain, renewable energy plants are statutorily entitled to priority access to, connection to and use of the grid. Renewable electricity is granted priority dispatch in the electricity markets at no cost, provided the stability and security of the grid infrastructure can be maintained. However, developers of renewable electricity power plants in Spain are often faced with ‘excessive grid connection lead-times’ (Sonvilla et al., 2012) and ‘significant connection costs’ (Sonvilla et al., 2012). Delays in grid connection are often caused by non-harmonised administrative procedures for grid connection across different regions. At distribution level, grid connection costs are high because of ‘deep’ connection costs, which means that costs related to the connection of a new power plant have to be borne entirely by the developer of the new power plant.

Mandatory biofuels targets

[5] Taxpayers whose income was below EUR 71,007.20 per year were entitled to a tax credit equal to 20 % of all investments related to the use of renewable energy or similar measures in building of their residence. For incomes below EUR 53,007.20 per year, the annual deduction was subject to a maximum of EUR 6,750. For incomes between EUR 53,007.20 and 71,007.20 per year, the annual maximum deduction was: EUR 6,750 minus 0.375 multiplied with (income minus EUR 53,007.20). The maximum deduction between 1 May 2011 and 31 December 2012 shall not exceed EUR 20,000.

[6] Although most EU countries have in recent years put in place new building codes, Spain is an early mover in this area (already in 2006, long before red was adopted and entered into force) and this is therefore considered a relevant factor stimulating innovation/deployment in this sector.

In 2007, the Spanish government adopted a mandatory target of 5.83 % biofuel use in transport by 2010 with an interim target of 3.4 % for 2009 and an indicative target of 1.9 % for 2008. In 2011, the Spanish Government adjusted the existing mandatory biofuel consumption goals for the years 2011–2013 as previously set in the National Renewable Energy Action Plan (NREAP). According to the new target, biofuel should reach 6.2 % of total transportation fuel in 2011 and 6.5 % in 2012-2013, as compared to the initial target of 6.1 % by 2013. The biofuel content target for diesel is 6 % by 2011 and 7 % by 2012 and 2013; and for gasoline 3.9 % in 2011 and 4.1 % in 2012 and 2013 (IEA, 2012).

Quota obligation for biofuels

To reach the mandatory biofuels targets, a quota obligation for biofuels was introduced in 2009. The quota system obliges whoever feeds fuels in the national system (retail and wholesale operators) as well as consumers relying on sources other than retail and wholesale operators to feed in or consume a certain amount of biofuels every year. This amount is established in percentage, and compliance is monitored by the National Energy Commission (Comisión Nacional de la Energía (CNE)) based on certificates. At the end of each year, obligated parties must turn in the certificates corresponding to their biofuel sale/consumption. The CNE checks compliance and collects fees for non-compliance from obligated parties. The penalty fees paid by the parties that did not reach their quota are redistributed among the parties that sold or consumed more biofuels than their set quota. These amounts are redistributed in proportion to the amount of biofuels that complying parties have sold or consumed in addition to their set quota.

1.2.6 Summary

Table 3 provides a quantitative overview on support measures for all energy sources.

Table 3 Quantitative overview on support measures for all energy sources (EUR million)

	2005	2006	2007	2008	2009	2010	2011
Direct transfers							
Conventional fossil energy sources							
Operating aid to coal producers	296	284	284	267	253	250	231
Operating aid to HUNOSA	89	85	85	85	80	76	72
Subsidy for the interbasin trade of coal	4	7	7	11	14	13	0
Adjustment aid to coal producers	42	20	35	40	40	10	6
Inherited liabilities	258	275	290	303	328	336	327
Funding for coal stockpiles	8	3	3	3	6	13	0
Capacity payments for conventional power plants	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Investment aid for conventional power plants	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Renewable energy sources							
Feed-in tariffs/premiums	798	1 130	1 447	2 423	4 712	5 340	4 907
Fiscal preferences							
Conventional fossil energy sources							
Fuel tax reductions	604	727	669	661	827	1368	666
Fuel tax exemptions (petrol/diesel)	547	607	613	634	642	590	394
Fuel tax partial refund	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	170
Renewable energy sources							
Fuel tax exemptions (biofuels)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Non-fiscal measures							
Biofuels quota system	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Note: n.a. = not available

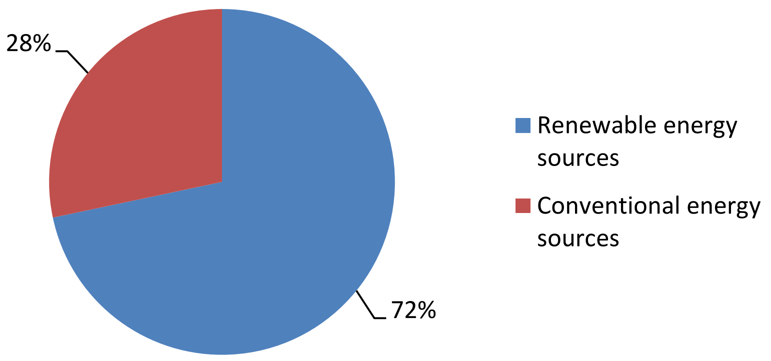
Source: Own compilation

In 2011, the latest year in the period analysed and for which most complete data are available, 28 % of energy support measures were spent on conventional energy sources, while 72 % were spent on RES in the form of FITs and FIPs (see

Figure 2). However, it is important to note that this overview does not take into account tax exemptions for biofuels as well as capacity payments and investment aid payments for conventional electricity generation capacity, for which no data are available for the period 2005–2011. The latter amounted to EUR 842 million in 2012. Moreover, corporate tax deduction for innovative activities available for all energy sources ([7]) is not included in the above overview as no data were available.

[7] For more details, see http://erawatch.jrc.ec.europa.eu/erawatch/opencms/information/country_pages/es/country?section=PolicyMix&subsection=FiscalPolicies online.

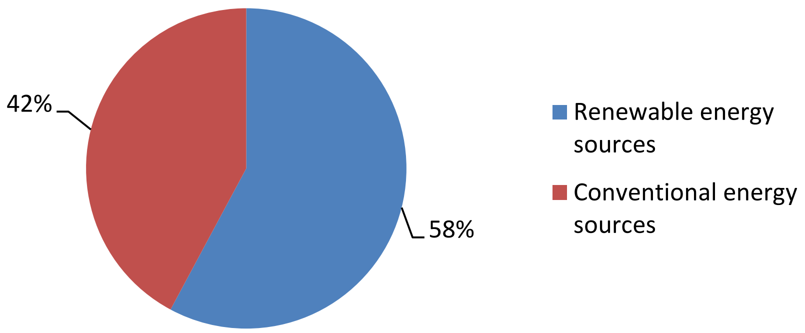
Figure 2 Split of energy support measures between fossil fuels and renewable energy sources in 2011



Source: EEA

For the period 2005–2011, 42 % of energy support was spent on conventional energy sources and 58 % on RES.

Figure 3 Split of energy support measures between fossil fuels and renewable energy sources in the period 2005–2011

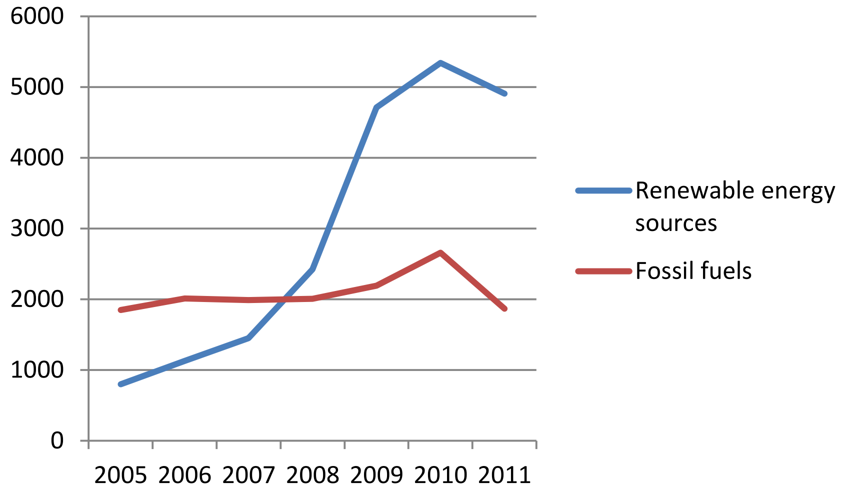


Source: EEA

There is a need to distinguish between the funding sources for each of the support measures. Whereas many of these measures are funded from the state budget, payments under the FIT/FIP scheme, the most important scheme for the support of RES, is funded via a levy on final consumers. Over the period 2005–2011, for RES the most important support measure was the FIT/FIP scheme with a total expenditure of more than EUR 20 billion, representing 100 % of the total payment for renewables identified in this study. For fossil fuels, the most important support measure was fuel tax reductions worth EUR 5.5 billion, representing 36 % of the total payments for conventional sources, followed by fuel tax exemptions worth EUR 4 billion representing 26 % of the total payment. Hence, while RES benefited mostly from direct payments, conventional energy sources received most support via fiscal preferential treatments.

While the summary overview for the year 2011, based on the data available, shows that considerably more financial support was available for RES than for fossil fuel, it is important to put this in context by considering the development of support measures in the energy sector over a longer time span. In 2005, the first year of analysis in this case study, nearly double the amount of support was spent on fossil fuels compared to RES (see Figure 44).

Figure 4 Split of energy support measures between fossil fuels and renewable energy sources over time, 2005–2011 (*million EUR*)



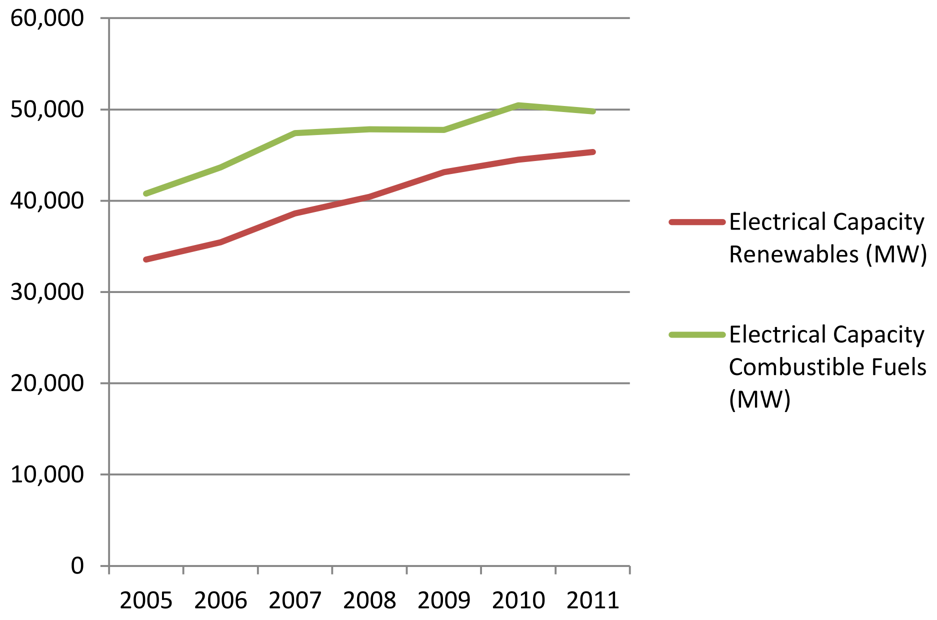
Source: EEA

Going even further back in time, many conventional energy sources have benefited from various support measures helping to build an energy system based on large-scale conventional power plants. RES do not only compete at the technology level with well-established conventional technologies but also at the level of support structures (including institutional). Support measures for RES are one element to help RES to increase their share in the energy mix. Against this background, it is not surprising that the total expenditure on support measures for RES is higher than that spent on conventional energy sources in recent years given the political objective to increase the share of RES in final energy consumption.

Despite the strong increase in support for RES, conventional power plants still benefited from important support payments via capacity payments and investment aid payments. This may explain why conventional generation capacity continued to grow despite a decrease in electricity demand of 6 % in 2009 and a strong increase in renewable electrical capacity in the same time period (see

Figure 5).

Figure 5 Electrical capacity, 2005–2011 (*MW*)



Source: Eurostat (2013)

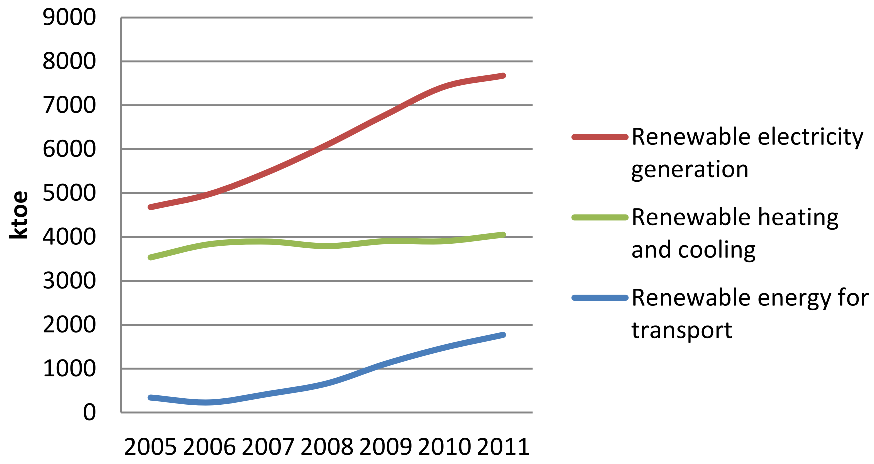
1.3 Effectiveness and efficiency of national support schemes for the deployment of renewable energy technologies

Before analysing the effectiveness and efficiency of the national support schemes for renewable energy, the following sub-section outlines key developments in renewable energy deployment between 2005 and 2011.

1.3.1 Developments in renewable energy deployment

Renewable energy generation in the electricity and the cooling and heating sector increased from around 8,000 thousand tonnes of oil equivalent (ktoe) in 2005 to over 13,000 ktoe in 2011. While the renewable heating and cooling output remained fairly stable with slight increase from around 3 500 ktoe in 2005 to 4 000 ktoe in 2011, renewable electricity generation nearly doubled from 4 600 ktoe to 7 600 ktoe in 2011 (see Figure 66).

Figure 6 Renewable energy generation, 2005–2011 (*ktoe*)

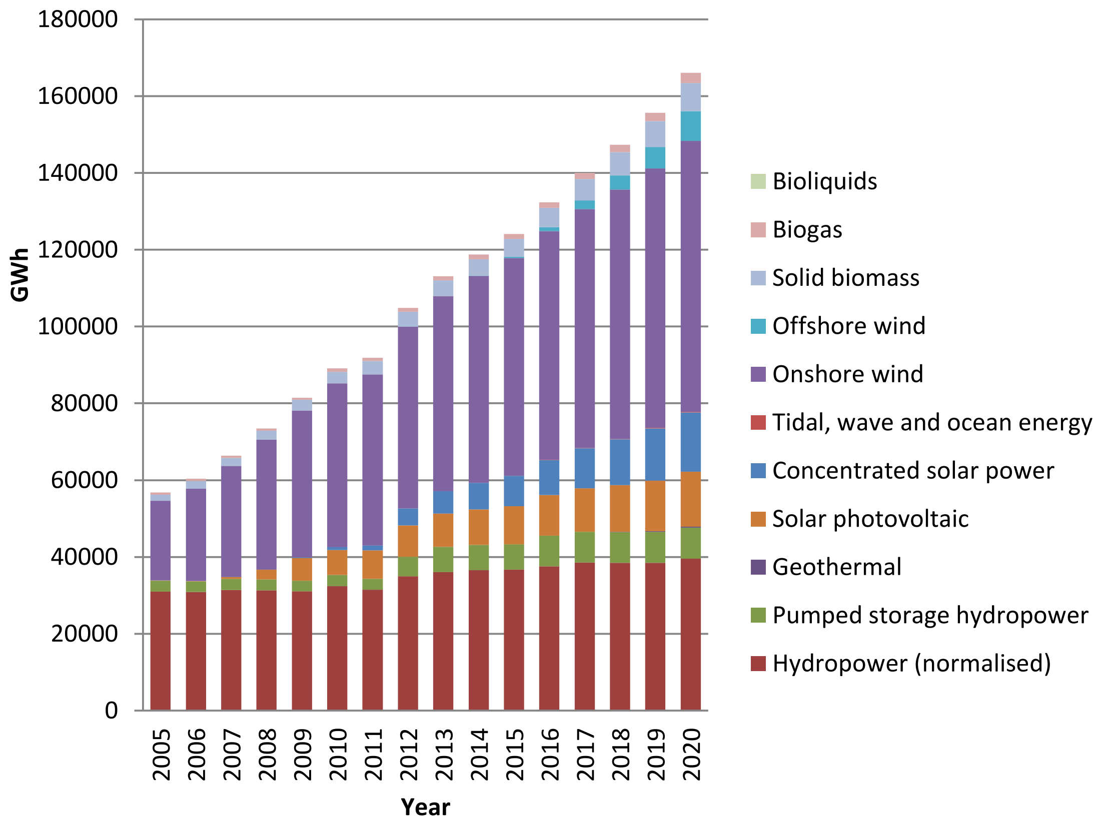


Source: EEA (2013)

For the renewable electricity sector,

Figure 77 shows that the output from wind power plants more than doubled from just over 20,000 gigawatt-hours (GWh) in 2005 to nearly 45,000 GWh in 2011. Electricity generation from solar PV grew by a factor of 157 from below 50 GWh in 2005 to over 7 000 GWh in 2011.

Figure 7 Renewable electricity generation (2005–2011) and NREAP projection (2012–2020) (*GWh*)

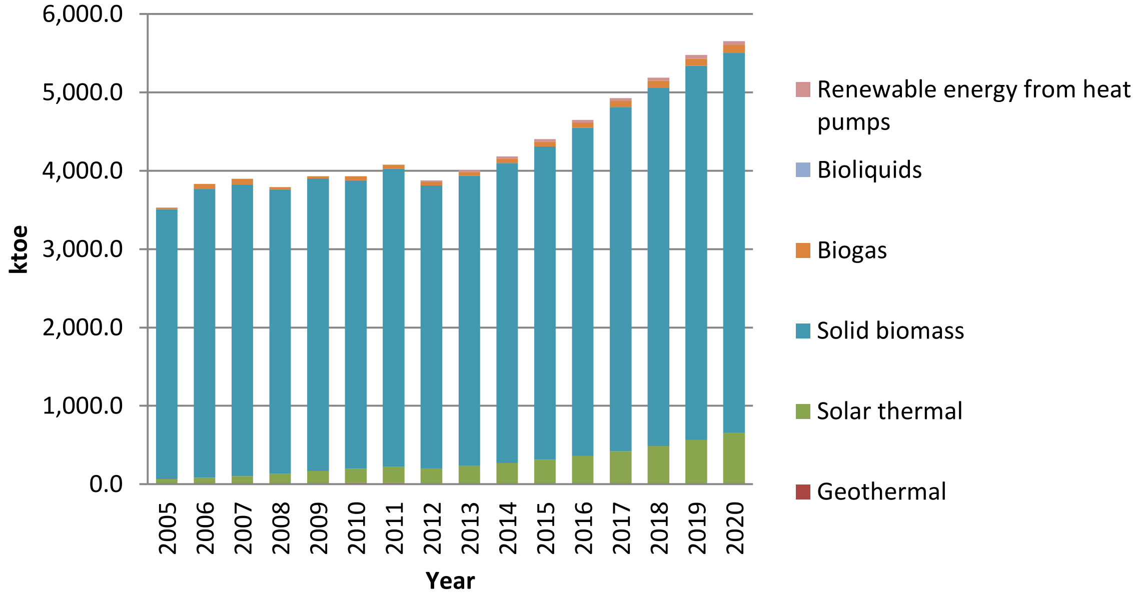


Source: Eurostat (2013), EEA (2013) and ECN (2011)

In the heating and cooling sector the highest contribution by far comes from solid biomass, which is expected grow further to reach the 2020 target (see

Figure 88).

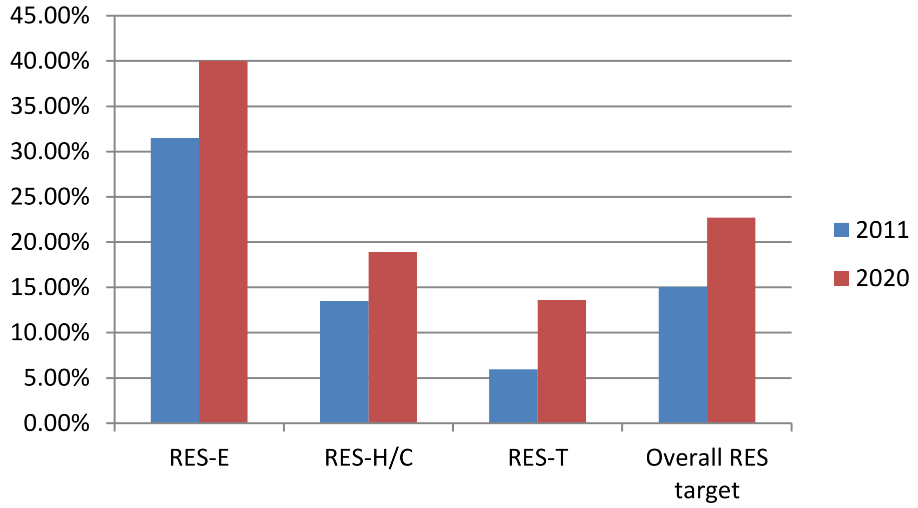
Figure 8 Renewable heating and cooling generation (2005–2011) and NREAP projection (2012–2020) (*ktoe*)



Source: Eurostat (2013), EEA (2013) and NREAP (2011)

In 2011, the share of RES in gross final energy consumption was around 15 %, which is higher than the indicative target for the 2011–2012 period of 11.0 % (EEA, 2013). Renewable electricity had a share of 31.5 %, renewable heating and cooling of 13.5 %, and renewable transport of around 6 % (Eurostat, 2013). This compares well with the binding renewable energy target for Spain of 20 % under the Renewable Energy Directive (2009/28/EC) and sectoral targets of 40 % for renewable electricity, 18.9 % for renewable heating and cooling, and 13.6 % for transport (see Figure 99).

Figure 9 Share of renewable energy in final energy consumption for each sector (2011 vs. 2020 target)



Source: Eurostat (2013) and NREAP (2011)

The last progress report published by the European Commission under the Renewable Energy Directive in March 2013 notes that Spain with a total renewable energy share of 13.8 % in 2010 overachieved its interim target of 10.9 % for that year (EC, 2013a). The effectiveness and efficiency of Spanish support schemes for RES are analysed in more detail in the following sub-sections.

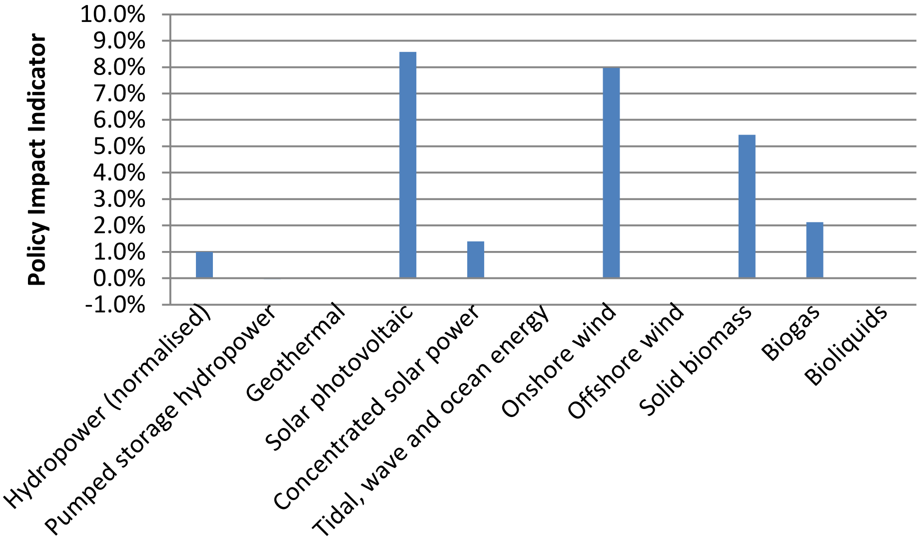
1.3.2 Policy effectiveness

The Policy Impact Indicator (PII) shows to what extent the remaining gaps to a future target for RES have been reached per year. It is defined as follows:

Policy Impact Indicator = additional generation in a given year divided by the difference between the generation in 2005 and the potential defined by the policy target.

As the generation in 2005 is used as a basis to calculate the remaining gap against the target set for 2020, an average yearly policy impact of over 6.5 % during the 15 years between 2005 and 2020 would be required to meet the 2020 target. For Spain, the policy impact is measured against the 2020 renewable energy targets for each technology as specified in the Spanish NREAP under the Renewable Energy Directive. For renewable electricity, the average PII between 2006 and 2011 shows that the highest impact in terms of additional electricity generation per year was achieved for solar PV and onshore wind with an average PII of around 8 % (see Figure 100). Solar PV and onshore wind were those technologies that advanced most in closing the gap between actual electricity generation in 2005 and the technology-specific 2020 target as set out in the NREAP. On average, the remaining gap was reduced by 8 % in each year between 2006 and 2011. If these growth rates were to be continued, solar PV and onshore wind would overachieve their technology-specific targets. While these results indicate for solar PV and onshore wind that the policy in place has been very effective, the policy in place appears ineffective for most other technologies with very little progress toward reaching the technology-specific targets. This is of particular concern for those technologies that are expected to grow significantly until 2020, in particular CSP (see Figure 111).

Figure 10 Average Policy Impact Indicator for renewable electricity technologies, 2006–2011

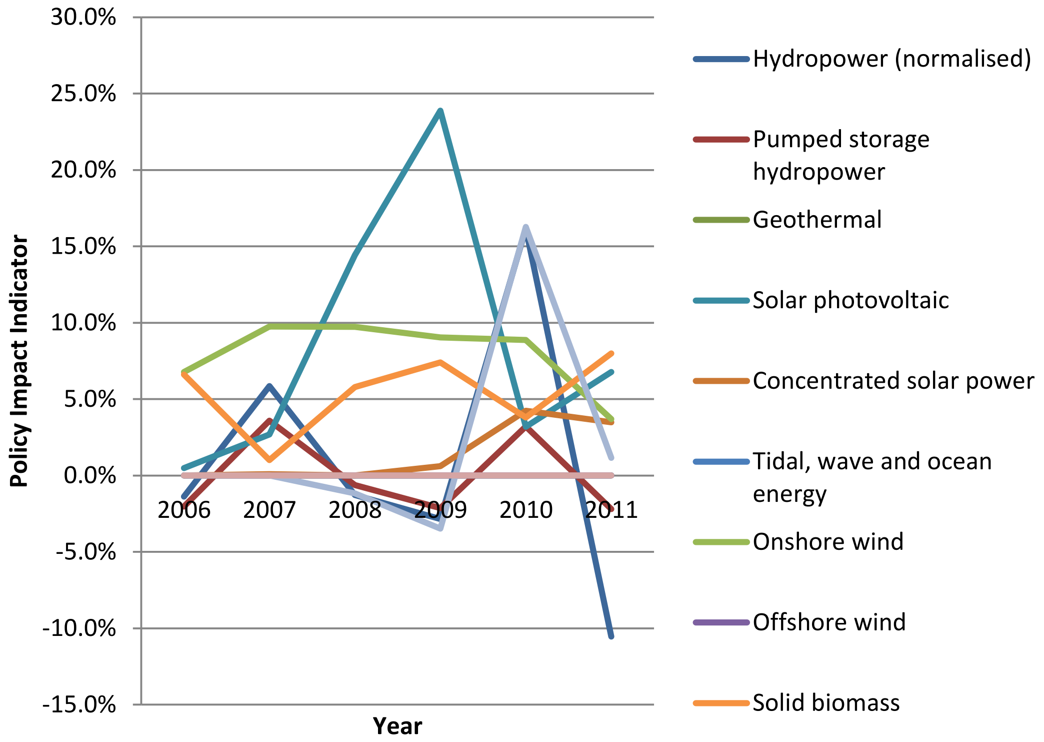


Source: EEA

The PII varies strongly on a yearly basis during the time period analysed. It is comparatively stable for onshore wind power close to 10 % until 2010, but dropped to just above 3 % in 2011. The PII was zero in 2005 for solar PV but increased to nearly 24 % in 2009 followed by a decline to around 4 % in 2010 (see Figure 111). The strong fluctuations for solar PV can be explained by two main factors: changes to the support system over time and strong cost reductions in the PV sector. The peak in solar PV growth in 2008/2009 is mainly due to the Royal Decree 661/2007, which came into force in May 2007. It contained a target of cumulative installed capacity for solar PV installations receiving a FIT and FIP, and stipulated that once 85 % of this target was reached only those installations that registered in the following 12 months would receive the original incentive level. As a result, more than 3 000 MW of solar PV capacity were installed in the following 12 months (IEA, 2012). By contrast, the analysis shows that CSP picked up from nearly 0 in 2009 to around 4 % in 2010 and 2011, reflecting the support introduced for CSP. This is of particular importance in the Spanish context given the expected contribution of this technology to the 2020 target (see

Figure 79).

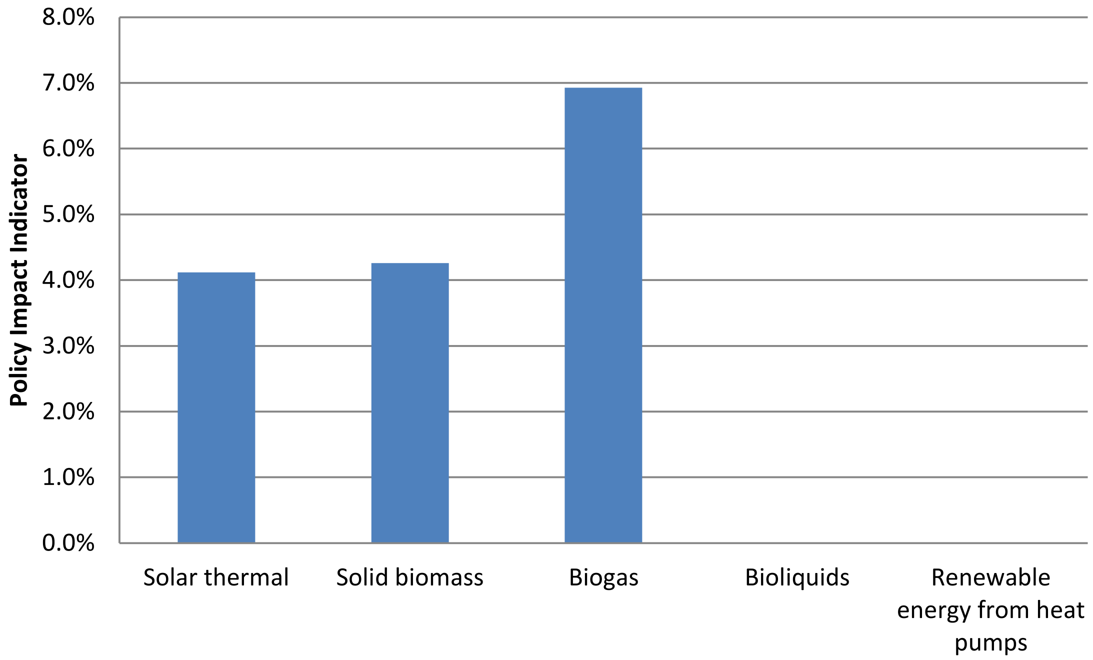
Figure 11 Yearly Policy Impact Indicator for renewable electricity technologies, 2006–2011



Source: EEA

For the heating and cooling sector, the average PII between 2006 and 2011 was around 4 % for solar thermal and solid biomass and 7 % for biogas. No progress was made to increase the share of bioliquids and renewable energy from heat pumps in the period 2006–2011. These calculations show that while there is good progress in the heating and cooling sector it is not sufficient to meet the set targets for this sector. The improvement of the policy effectiveness is of particular relevance for solar thermal and solid biomass as these two technologies are expected to contribute most to the renewable heating and cooling target in 2020 (see Figure 122).

Figure 12 Average Policy Impact Indicator for renewable heating and cooling technologies, 2006–2011

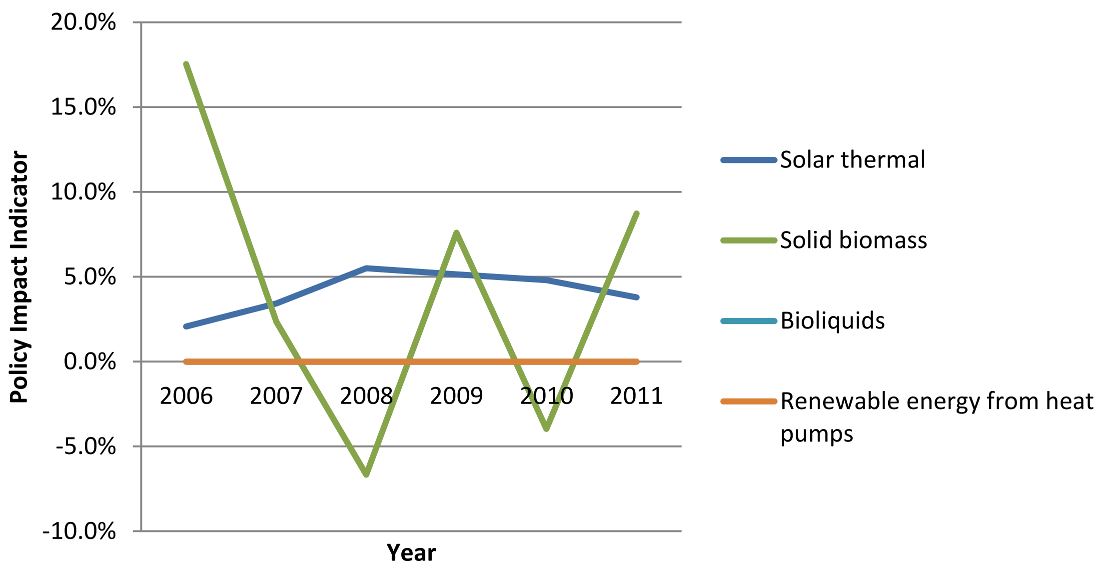


Source: EEA

The yearly PII for renewable heating and cooling shows an increase in policy effectiveness for solar thermal in 2006 and 2007 and a decrease in more recent years. The yearly PII for biomass (solid biomass and biogas) varied very strongly, possibly because of supply constraints.

Figure 13 Yearly Policy Impact Indicator for selected renewable heating and cooling technologies, 2006–2011 ([8])

[8] Geothermal not included due to lack of verified data and biogas not included due to very strong yearly fluctuations.



Source: EEA

Overall, Spanish renewable energy policy can be considered as rather effective over the analysed period, particularly for technologies such as solar PV, onshore wind and biogas. The growth rate for key technologies such as solar PV and onshore wind in the electricity sector as well as solar thermal and biomass in the heating and cooling sector was on average higher or close to the rate needed to reach the 2020 targets. However, strong yearly fluctuations point to a lack of policy consistency over time. Changes recently introduced to the Spanish FIT/FIP support scheme (see section 1.2.1 above) are, however, also a response to high costs of the support scheme. The next sub-section will analyse the cost efficiency of the Spanish FIT/FIP support scheme.

1.3.3 Policy efficiency

Whereas the PII shows how the overall policy and regulatory framework in place stimulates renewable energy deployment against a set target, the Total Cost Indicator (TCI) shows the cost for a specific renewable energy support scheme. It is defined as follows:

Total Cost Indicator = how much a country spends in addition to the market price for energy to get an x amount of additional generation from a renewable technology.

For this purpose, the amount of annual FIT/FIP payments is compared to the wholesale value of the total annual electricity generation. For Spain, the payments under the 'special regime' (see Table 2) are compared to the wholesale value of total annual electricity generation. The yearly average wholesale price in Spain varied quite strongly between 2005 and 2011 (see Table 4). This affects the calculations of the TCI with respect to the value of total annual electricity generation and has impact on the FIT/FIP expenditure.

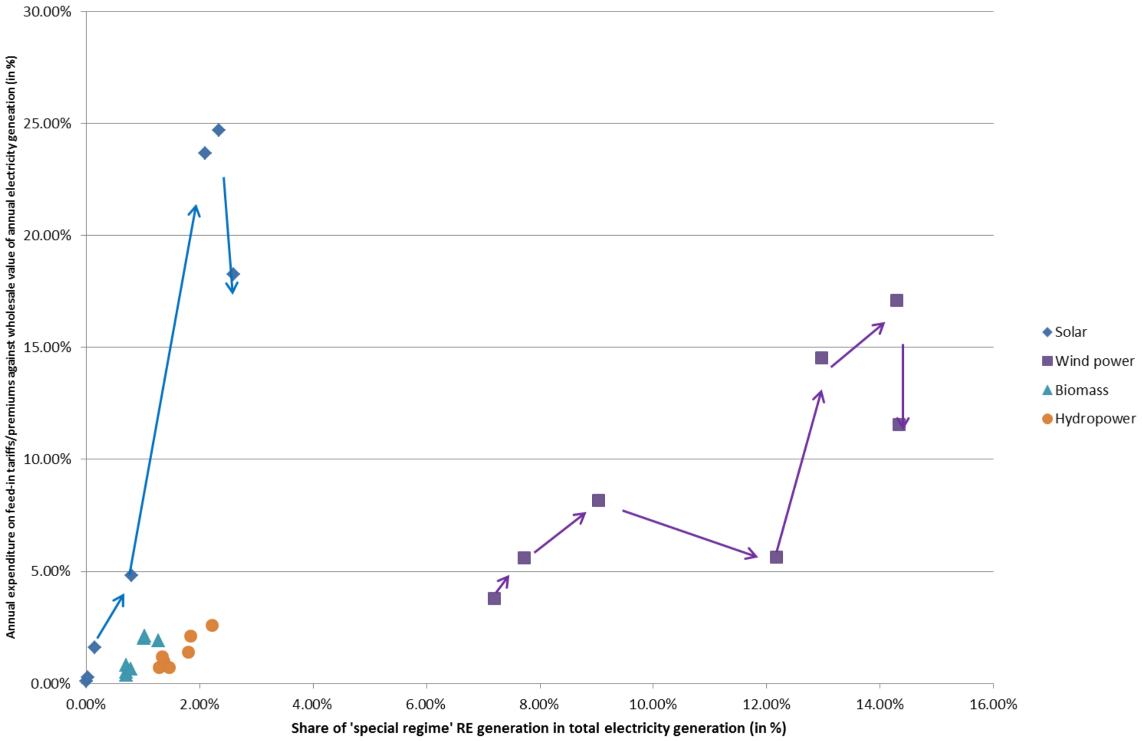
Table 4 Average wholesale price per MWh (Real prices,EUR, Market: ES-OME)

2005	2006	2007	2008	2009	2010	2011
54.82	51.52	40.25	65.49	37.81	38.08	50.82

Source: EMOS (DG ENER, 2013)

The TCI for Spain is illustrated in Figure 14. It shows that between 2005 and 2011 the share of biomass electricity and hydropower electricity in total electricity generation and the support payments compared to the total wholesale value of total annual electricity generation remained fairly stable. By contrast, electricity generation from solar more than doubled from 2008 to 2009 (2.6 % of total electricity generation), while the value of FIT/FIP payments for solar electricity as a share of the wholesale value of total annual electricity generation jumped from around 5 % to nearly 24 % bearing in mind the strong difference in average wholesale price in these 2 years. For wind energy, the share in total electricity generation increased from around 7 % in 2005 to around 12 % in 2008, with the FIT/FIP payments representing 5.6 % in 2008 of the wholesale value of total electricity generation. In 2009, the wind energy share was nearly 13 % in total electricity consumption and FIT/FIP payments represented a value of nearly 15 % of the wholesale value of total electricity generation in that year. The arrows in Figure 14 show the development over time for solar and wind energy. The differences in TCI for each technology reflect the different technology costs. Given the higher costs for solar PV as compared to onshore wind, it is not surprising that it requires more financial resources to add the same amount of electricity output from solar PV as compared to onshore wind. At the same time, the analysis for the period 2005–2011 indicates that the policy in place became too costly compared to the achieved output, in particular for solar PV but also for onshore wind.

Figure 14 Total Cost Indicator for ‘special regime’ renewable electricity in Spain, 2005–2011



Source: EEA

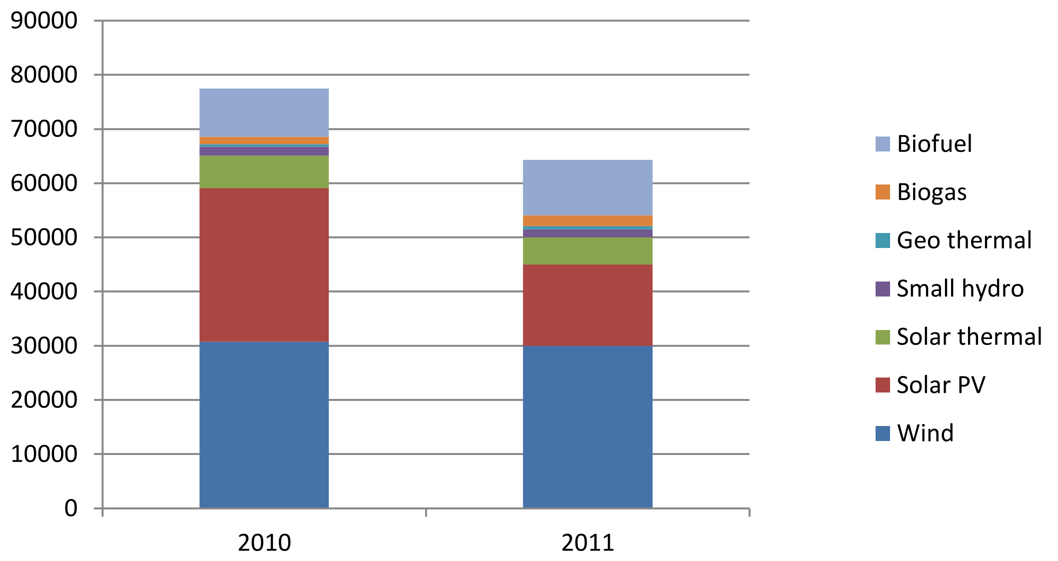
It is important to note that the calculation of the TCI cannot specifically show the effect of lower wholesale prices that occur due to higher penetration of renewable electricity, also known as the ‘merit order effect’. However, the merit order effect can have a significant impact on wholesale electricity prices (e.g. Würzburg et al., 2013). Under certain circumstances the benefits in terms of reduced wholesale price can outweigh the costs for FIT payments, as was shown for wind electricity in Spain (Sáenz de Miera et al., 2008). A further investigation of the merit order effect is, however, outside the scope of this report.

1.3.4 Impact on the renewable energy sector

The high effectiveness of renewable energy support schemes in Spain is reflected in the fact that the renewable energy sector emerged as a significant economic sector in Spain in the period 2005–2011. According to calculations by the Spanish Renewable Energy Association (APPA), the renewable energy sector contributed around EUR 10 billion to the Spanish economy, equivalent to 0.95 % of GDP in 2011 (APPA, 2012).

According to EurObserv'ER (2012), in 2010 and 2011 there were 77,450 and 64,300 jobs, respectively, in the key renewable energy technology sectors with the highest share of employment in the wind energy sector followed by the solar PV sector (see Figure 15). In the solar PV sector, employment nearly halved between 2010 and 2011, declining from 28 350 to 15 000. The figures show a strong correlation to the support measures in place. For onshore wind and solar PV, for which employment numbers were highest, support measures were most effective. Recent reduced effectiveness is reflected in declining employment numbers.

Figure 15 Employment in the renewable energy sector per technology

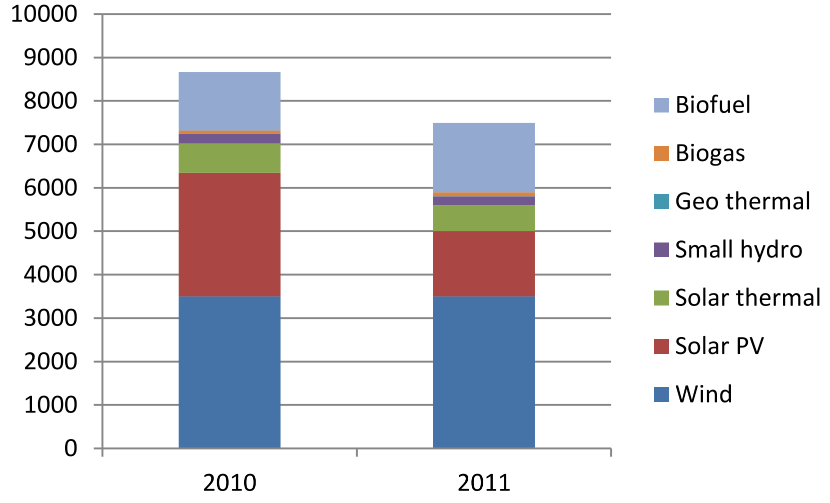


Source: EurObserv'ER (2012)

Total turnover in these sectors dropped from EUR 8.7 billion in 2010 to EUR 7.5 billion in 2011 (EurObserv'ER, 2012). The share in turnover was similar to the share in employment (see

Figure 16).

Figure 16 Turnover of the renewable energy sector (*million EUR*)



Source: EurObserv'ER (2012)

In addition to a strong domestic market in the past, the Spanish renewable energy sector also performed strongly on export markets, with a positive trade balance since 2006 (APPA, 2012).

Besides a supportive policy and institutional framework, as discussed above, various drivers for the success of establishing a strong RES sector have been identified. Factors include Spain's home market size in terms of cumulative installed wind capacity, high-quality wind potential, learning effects, economies of scale and R&D efforts, local acceptance, technology pioneers (entrepreneurs), support from financial institutions and local content requirements, which have helped the creation of the Spanish wind turbine manufacturing industry (del Río and Unruh, 2007; Lewis and Wiser, 2007). At the end of 2004, Spain was the second largest wind energy market globally in terms of cumulative installed wind capacity, with 3 of the global top 11 wind companies being Spanish (Gamesa, Ecotecnia and EHN/Ingetur); 73 % of the installed turbines in Spain were made by domestic companies (Lewis and Wiser, 2007). In 2012 there remained one Spanish manufacturer (Gamesa) in the global top 10 wind manufacturers, with a market share of 6.1 % (REN21, 2013).

As compared to the onshore wind energy sector, the solar PV sector developed only later despite a very good resource potential (del Río and Unruh, 2007). Main barriers for solar PV were high investment costs and the lack of a favourable legal framework. One of the key drivers for the development of solar PV was the increase in guaranteed FITs in 2004.

Another important driver for the Spanish renewable energy sector was the increasingly strong interest of the incumbent electricity utilities in the sector as expressed in significant investment in the sector (Meyer, 2007).

1.4 Assessment of innovation processes in the renewable energy sector

The analysis in the previous section showed how effective and efficient the FIT/FIP scheme was in stimulating the deployment of renewable energy technologies and establishing a sizeable renewable energy sector. This section looks beyond the deployment phase and assesses to what extent earlier stages in the innovation cycle such as R&D and demonstration have been important in this process.

1.4.1 Rationale and objectives of innovation policies

Spain's State Innovation Strategy (E2i) for 2010–15 aims to promote and create structures to improve the use of scientific knowledge and technological development with the objective to change Spain's production model (OECD, 2012). Overall, one objective is to achieve a more integrated approach between technology and innovation activities and scientific research. Beginning of 2013, the Council of Ministers approved the Spanish Science, Technology and Innovation Strategy and the State Plan for Scientific and Technical Research and Innovation, which aims to help achieve these objectives (La Moncloa, 2013). A new State Research Agency was created to ensure better coordination. The Centre for Development of Industrial Technology (CDRI) deals with funding for industrial and innovative activities nearer to the market. For the promotion of green innovation, including renewable energy technologies, an Environmental Technology Platform (PLANETA) has been created to ensure better coordination between public and private research organisations (OECD, 2012).

The overall objective identified in the Science, Technology, and Innovation Strategy 2013–2020 is to promote the scientific, technological and business leadership of Spain and to increase innovation capacities of the Spanish society and economy (Gobierno de España, Ministerio de Economía y Competitividad, 2013: 5). The scientific, technological and business leadership in strategic areas (biotechnology, energy and information and communication technologies (ICT)) (Gobierno de España, Ministerio de Economía y Competitividad, 2013: 15) is considered as one of the strengths of the Spanish Science, Technology and Innovation Strategy.

Three of the 18 specific objectives of the Spanish Science, Technology, and Innovation Strategy 2013–2020 are directly relevant for renewable energy technologies. These objectives are as follows (Gobierno de España, Ministerio de Economía y Competitividad, 2013: 16 et seqq.):

- energy security as well as safe, sustainable and efficient-energy models (specific objective 13);
- intelligent, sustainable and integrated transport (specific objective 14);
- climate action, resource efficiency and raw materials (specific objective 15).

In relation to specific objective 13, the Strategy specifies the aim of sponsoring the transition to a secure, sustainable and competitive energy system that reduces the dependency on fossil fuels under a scenario in which, at the same time, there is a shortage of these fuels, an increased demand at global level and impacts of the dependency on fossil fuels on climate change. The specific objective requires a broad coordination between energy policies, policies promoting research, technology and innovation, and industrial policies. Public administration and business should cooperate with a view to eliminating existing technological and regulatory barriers and to establishing an appropriate framework of distribution of costs and risks associated with the development of the new energy system. Energy and environmental sustainability is an element that should be considered in all steps of building construction, including innovations in the areas of efficiency and better resource use.

As part of the European Semester the National Reform Programme (NRP-ES, 2013a) identifies the promotion of innovation and new technologies as a specific strand of action under the 2013 European Semester priority 'Promoting growth and competitiveness for today and tomorrow' set out by the European Commission (2013: 7). In this context, one of the objectives is to limit budget cuts in research, development and innovation spending (RDI) (NRP-ES, 2013a: 32 et seqq.).

In relation to the Europe 2020 Strategy target to increase R&D expenditure in the EU to 3 % of GDP, the NRP-ES (2013a: 41) presents 'Research, development and technological innovation … [as] the driving force behind a model of sustainable, competitive and high-quality growth' and a priority area of public spending (NRP-ES, 2013b: 38 ([9])). R&D activities should benefit from a 'more efficient allocation of stable resources' (ibid.).

The 2013 Innovation Union Scoreboard (IUS) for the EU concluded that Spain was a 'moderate innovator' with a below average performance and ranked 16th among all EU Member States (EC, 2013b). The IUS points to the relative strengths of the research system and observes a strong decline in venture capital investments and a relative weakness in firm investments and entrepreneurship.

Spain's gross domestic expenditure on R&D (GERD ([10])) has grown from 1.12 % of GDP in 2005 to 1.39 % of GDP in 2010 with an annual average increase of 5.3 % in this period, but dropped again to 1.33 % of GDP in 2011 (OECD, 2012). GERD per capita (in current USD purchasing power parity (PPP)) grew from 307 to 428 between 2005 and 2011, but declining from 448 in 2008.

1.4.2 Drivers for innovation in the RES sector

The Spanish R&D budget for renewable energy technologies increased continuously from around EUR 28 million in 2005 to nearly EUR 49 million in 2010. In 2011, the R&D budget for renewable energy technologies nearly tripled to EUR 132 million (see

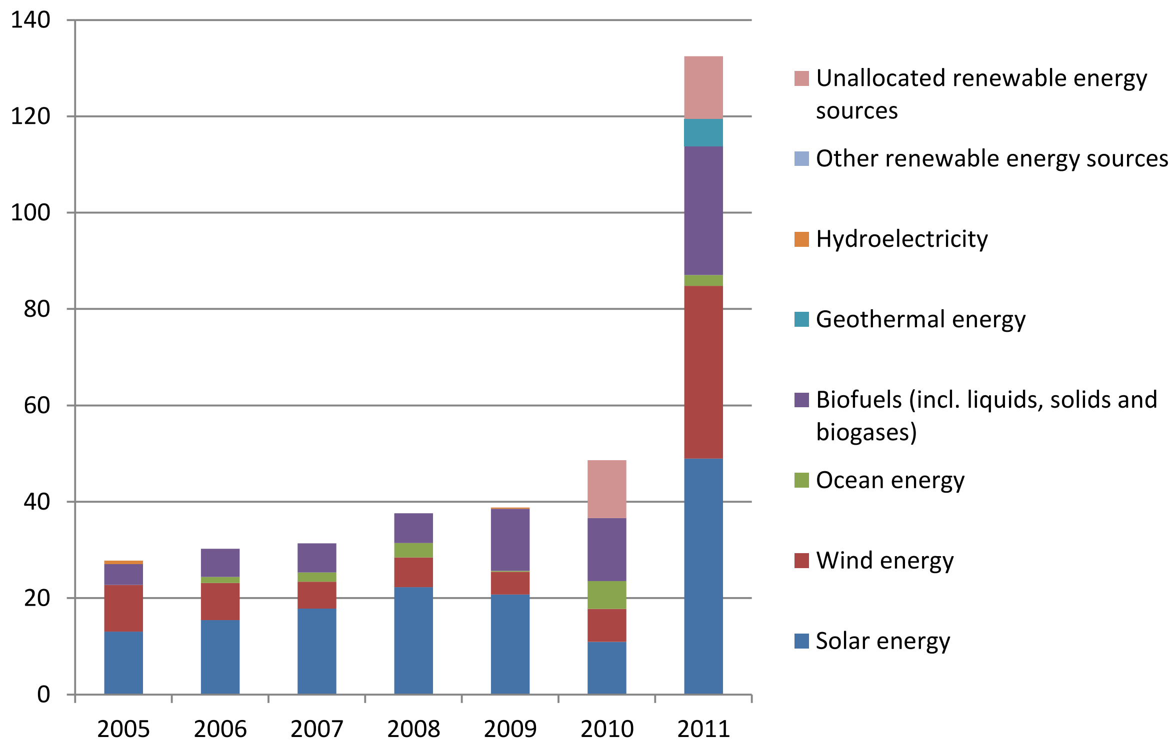
---

[9] Parts of the original NRP-ES text are in bold.

[10] Gross domestic expenditure on R&D is total intramural expenditure on R&D performed on the national territory during a given period (OECD, http://stats.oecd.org/glossary/detail.asp?ID=1162).

Figure 177). The highest R&D budget was allocated to solar energy (around EUR 49 million), followed by wind energy (around EUR 36 million) and biofuels (around EUR 28 million).

Figure 17 Total R&D for renewable energy technologies, 2005–2011 (*million EUR*, 2012 prices and exchange rates)

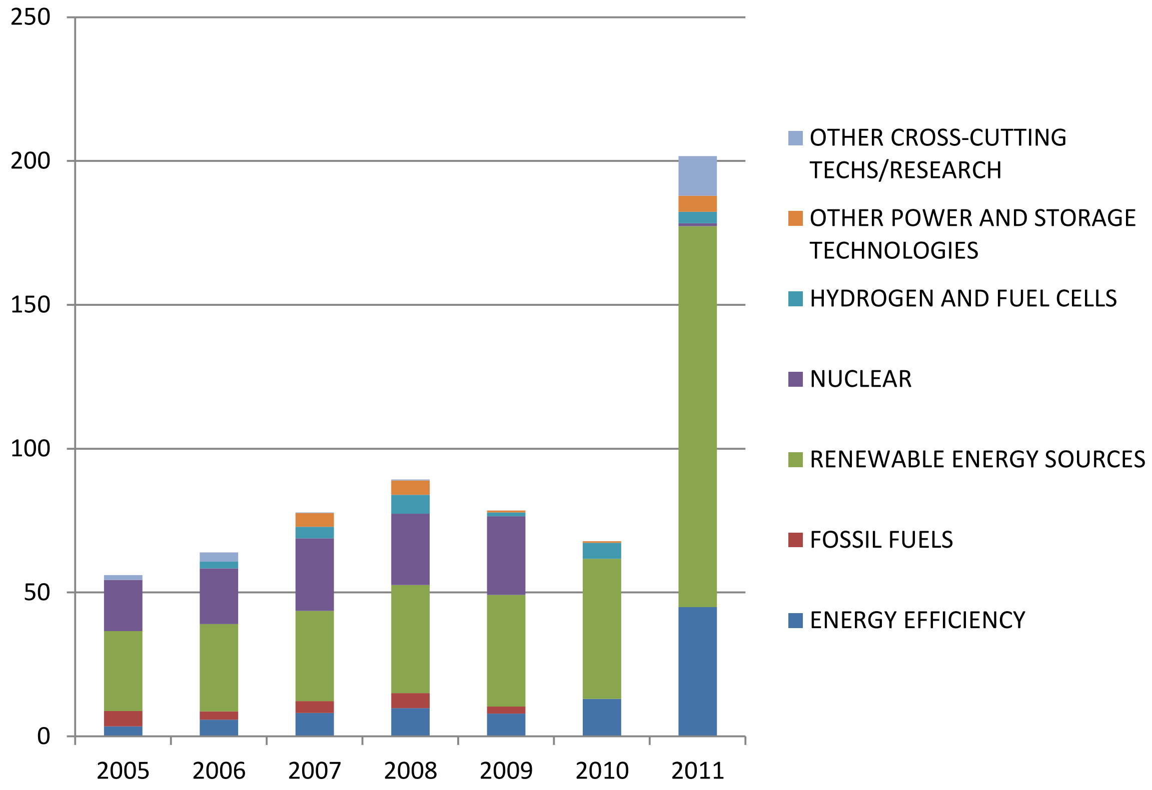


Source: IEA (2013)

Comparing the R&D budget for RES to the R&D budget for other energy areas helps to better understand its value and relevance. The comparison shows that since 2005 renewable energy technologies had the highest share among all energy technologies with 50 % of resources allocated (see

Figure 188). While the renewable energy share decreased to 40 % in 2007 it increased to 72 % in 2010 and was 66 % in 2011. It is worth noting that the R&D budget for energy efficiency increased from 6 % in 2005 to 22 % in 2011, the hydrogen and fuel cells from 0 % to 8 % in 2010 (2 % in 2011), while it decreased for nuclear from 32 % in 2005 to 0 % in 2010 and 2011.

Figure 18 Total energy R&D budget per technology group, 2005–2011 (*million EUR*, 2012 prices and exchange rates)

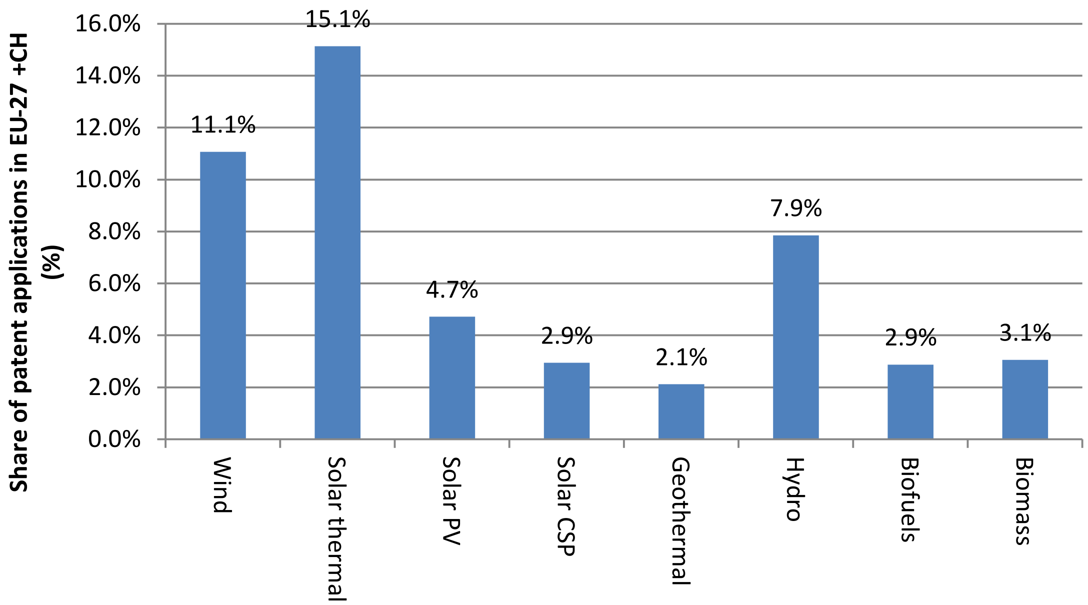


Source: IEA (2013)

Spain has a high share in patent applications for solar thermal energy, wind energy and hydropower (see

Figure 19). Wind energy was the renewable electricity technology that benefited from the most effective policy framework in the period 2006–2011 (see section 1.3.2), which may have stimulated R&D. Concerning solar PV and CSP on the other hand, despite the fact that both technologies were strongly supported in Spain, the policy support did not result in high shares of patent applications.

Figure 19 Share of renewable energy technology patent applications in EU-27 +Switzerland (2006–2010, in %) ([11])



Source: OECD patents database

The strong increase in the R&D budget for renewables combined with the significant cut-backs in the support scheme for market deployment indicates a strategic shift in Spanish renewable energy policy away from market deployment and more focus on the early stages of the innovation stage.

1.5 Coherence of renewable energy policies with other relevant policies

In this section, we discuss the coherence of energy policies with other relevant policies. Coherence is assessed in terms of the degree to which there is an absence of major conflicts between policy areas concerning objectives/targets and the degree to which policies reinforce their effects (i.e. synergies) and minimise negative trade-offs.

1.5.1 Energy and renewable energy policy objectives

The 2007 Spanish Climate Change and Clean Energy Strategy defined the aim to 'fulfil the commitments of Spain in matters of climate change and support to clean energies, while improving at the same time, social welfare, economic growth and environment protection' (Gobierno de España, Ministerio de Medio Ambiente, 2007: 10).

[11] Patent applications filed under the Patent Cooperation Treaty. 2010 is the latest year for which data were available.

In relation to the electricity sector, the Spanish NRP states the aim to ‘address… the tariff deficit’, underpinned by various measures in 2012, such as suspending ‘economic incentives for new renewable energy facilities’ (NRP-ES, 2013b: 36). Spain is “firm[ly] … commit[ted] … to the fight against climate change and the achievement of an increasingly sustainable energy system’ (NRP-ES, 2013b: 39) and sees a key role for renewable energies in the transition to a low-carbon economy” (NRP-ES, 2013a: 43).

There is a potential incoherence of the Spanish energy policy objectives formulated in 2007 and the renewable energy policy objective to address the tariff deficit by suspending economic incentives, as reflected in the NRP-ES (2013b), in particular if the objective is implemented as a sudden suspension of economic support not only to new but also to already existing renewable energy facilities. This can create major uncertainty in the market. At the same time, this needs to be seen in the context of a potential strategic shift from deployment to R&D and technological innovation.

1.5.2 Coherence (renewable) energy and economic policy objectives

The NRP-ES identifies ‘Growth that respects the environment and combats the effects of climate change’ (2013a: 79; 2013b: 73) as a specific strand of action under the 2013 European Semester priority ‘Promoting growth and competitiveness for today and tomorrow’ set out by the European Commission (2013: 7).

The NRP-ES presents measures aimed at reinforcing the objective of the Spanish tax system to use energy resources more efficiently (2013a: 26). The Spanish Ley de Desindexación de la Economía Española (Law on De-indexing of the Spanish Economy) (NRP-ES, 2013a: 57) aims at ‘neutralising the effect of variables that do not depend on economic fundamentals on successive rounds of price and wage formation that can affect the competitiveness of the Spanish economy’ (NRP-ES, 2013b: 53). This could potentially lead to an improvement of the competitiveness of Spanish renewable energy technologies on the international market without the renewables sector being targeted specifically by this objective.

Spain is planning to adopt a law on regeneration and urban renewal (NRP-ES, 2013b: 69) aimed at increasing energy efficiency besides other objectives of economic and social policy (NRP-ES, 2013a: 80).

The Spanish economic policy objectives are largely coherent with the energy and renewable energy policy. The economic policy objectives identified in the official document point towards support schemes that would favour energy efficiency improvements.

1.5.3 Coherence (renewable) energy and innovation policy objectives

The overall objective identified in the Science, Technology, and Innovation Strategy 2013–2020 is to promote the scientific, technological and business leadership of Spain and to increase innovation capacities of the Spanish society and economy (Gobierno de España, Ministerio de Economía y Competitividad, 2013: 5). The scientific, technological and business leadership is highlighted for three strategic areas (biotechnology, energy and ICT) and is considered one of the strengths of the Spanish Science, Technology and Innovation Strategy.

Three of the 18 objectives of the Spanish Science, Technology, and Innovation Strategy 2013–2020 that are relevant for this discussion are:

- energy security as well as safe, sustainable and efficient energy models (specific objective 13);
- intelligent, sustainable and integrated transport (specific objective 14);
- climate action, resource efficiency and raw materials (specific objective 15).

In relation to specific objective 13, the Strategy specifies the aim of sponsoring the transition to a secure, sustainable and competitive energy system that reduces the dependency on fossil fuels under a scenario in which, at the same time, there is a shortage of these fuels, an increased demand at global level and impacts of the dependency on fossil fuels on climate change. The objective requires a broad coordination between energy policies, policies promoting research, technology and innovation, and industrial policies. Public administration and business should cooperate with a view to eliminating existing technological and regulatory barriers and to establishing an appropriate framework of distribution of costs and risks associated with the development of the new energy system. Energy and environmental sustainability is an element that should be considered in all steps of the building process and of innovation in the areas of efficiency and better resource use.

The NRP-ES (2013a) identifies the promotion of innovation and new technologies as a specific strand of action under the 2013 European Semester priority 'Promoting growth and competitiveness for today and tomorrow' set out by the European Commission (2013: 7). In this context, one of the objectives is to limit budget cuts in RDI spending (NRP-ES, 2013a: 32 et seqq.).

In relation to the Europe 2020 Strategy target to increase R&D expenditure in the EU to 3 % of GDP, the NRP-ES reads 'Research, development and technological innovation is the driving force behind a model of sustainable, competitive and high-quality growth' (2013a: 41) and a priority area of public spending (NRP-ES, 2013b: 38 ([12])). Further more, NRP-ES suggests that R&D activities should benefit from a more efficient allocation of stable resources.

There is no incoherence between the Spanish innovation policy objectives and the energy and renewable energy objectives presented in the 2007 Spanish Climate Change and Clean Energy Strategy and the main thread of the energy and renewable energy policy objectives presented in the NRP-ES (2013b). The innovation policy objectives point towards support for innovation underpinning the transition to a secure, sustainable and competitive energy system and contributing to the objectives of energy security, as well as safe, sustainable and efficient energy models.

1.5.4 Issues to be considered concerning policy coherence

While most of the Spanish energy, renewable energy, economic and innovation policy objectives are by and large coherent, the potential incoherence of energy and renewable energy policy objectives needs to be further investigated in relation to the implementation of the aim to address the tariff deficit by suspending economic incentives for new renewable energy facilities, also in the light of the Spanish target under the Renewable Energy Directive (2009/28/EC).

[12] Parts of the original text are in bold.

Annex I presents a detailed inventory of energy, renewable energy, economic and innovation policy objectives.

1.6 Conclusions

Spain has been a long-time frontrunner in renewable energy in Europe. In 2011, the share of RES in gross final energy consumption was around 15 %, which is higher than the indicative target for the 2011–2012 period of 11.0 % (EEA, 2013).

However, in recent years the renewable energy sector has been confronted with a large overhaul of existing support measures for RES. As a consequence, the renewable energy transition has lost its momentum in Spain.

In 2005, the first year of analysis in this case study, nearly double the amount of support was spent on conventional fuels compared to RES. In 2011, less than one third of all support was spent on conventional fuels (EUR 1.94 billion) compared to over two thirds that were spent on RES (EUR 4.9 billion). As opposed to the support for conventional fuels, the support for RES was not financed directly from the state budget, but in the form of FITs and FIPs financed by final energy consumers.

Over the period 2005–2011, for RES the most important support measure was the FIT/FIP scheme with a total expenditure of more than EUR 20 billion, representing 100 % of the total payment for renewables identified in this study. For fossil fuels, the most important support measure was fuel tax reductions worth EUR 5.5 billion, representing 36 % of the total payments for conventional sources, followed by fuel tax exemptions worth EUR 4 billion representing 26 % of the total payment.

The policy framework for electricity production from renewables was effective particularly for onshore wind and solar PV, technologies for which the PII was above the 6.5 % threshold necessary for meeting the 2020 target. For other technologies such as CSP, offshore wind, biogas and biomass further effort would be required in order to ensure that the 2020 targets are met. When it comes to renewable electricity, the PII for Spain compares well with the one for the Czech Republic and the Netherlands for solar, onshore wind and to some extent for biomass (see also discussion in the full report). The situation is more nuanced for heating and cooling technologies where the Spanish PII compares relatively well with the other countries only for biomass. Concerning the renewable policy efficiency measured using the TCI, the Spanish policy seems to have been rather inefficient for solar PV and to a much lesser extent for onshore wind. The TCI for Spain compares well with the rest of the countries for onshore wind and it is slightly better than the Czech Republic for solar PV (but still quite high for the share this technology contributed in total electricity generation; for more discussion see the full report).

Thanks to favourable overall market conditions, the Spanish renewable energy sector has developed very strongly, contributing to 0.9 % of GDP and employing approximately 65 000 people in 2011. Due to lack of data it is not possible to draw conclusions on the impact of support measures on the different stages of the innovation cycle in the Spanish renewable energy industry. While deployment of RES appears as a main driver for the Spanish renewable energy sector in the past, recent changes to the renewable energy support schemes and the strong increase in the R&D budget for RES indicate a strategic shift in focus towards early stages of innovation in Spain, possibly to retain some of the export opportunities. Like in the case of the Czech Republic, employment in the solar industry seems to be more volatile despite generous support (until recently).

While most of the Spanish energy, renewable energy, economic and innovation policy objectives are by and large coherent, the potential incoherence of energy and renewable energy policy objectives needs to be further investigated in relation to the implementation of the aim to address the tariff deficit by suspending economic incentives for new renewable energy facilities. Under current market conditions it is very unlikely that Spain will achieve its 2020 renewable energy target.

References

APPA, 2012, *Study of the macroeconomic impact of renewable energies in Spain*, Spanish Renewable Energy Association (APPA).

CNE, 2013, *Régimen especial de producción de energía eléctrica en españa : Informe mensual de ventas de energía del régimen especial*, Comisión Nacional de la Energía (National Energy Commission). .

CREG, 2012, *Study (F)121011-CDC-1182 on 'capacity remuneration mechanisms'*, 11 October (http://www.creg.info/pdf/Etudes/F1182EN.pdf) accessed 2 September 2013.

Couture, T. and Bechberger, M., 2013, *Pain in Spain: New retroactive changes hinder renewable energy*, Renewable Energy World.

del Río, P. and Unruh, G., 2007, 'Overcoming the lock-out of renewable energy technologies in Spain: The cases of wind and solar electricity', *Renewable and Sustainable Energy Reviews*, (11) 1498–1513.

EC, 2013a, Report from the commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Renewable energy progress report (COM(2013) 175 final) (http://ec.europa.eu/energy/renewables/reports/doc/com_2013_0175_res_en.pdf) accessed 6 June 2013.

EC, 2013b, Communication from the European Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: 2013 European Semester: Country-specific recommendations — Moving Europe beyond the crisis (COM(2013) 350 final) (http://ec.europa.eu/europe2020/pdf/nd/2013eccomm_en.pdf) accessed 6 June 2013.

ECN, 2011. Renewable Energy Projections as Published in the National Renewable Energy Action Plans of the European Member States: Spreadsheet. L.W.M. Beurskens, M. Hekkenberg and P. Veltman. 28 November, 2011.

EMOS (DG-ENER). Energy Market Observatory & Statistics. http://ec.europa.eu/energy/observatory/emos/emos_en.htm. Accesses July 24, 2013.

EurObserv'ER, 2012, *The state of renewable energies in Europe*, 12th EurObserv'ER Report, Edition 2012.

Eurostat 2013 *Statline database*. Url: http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database. Accessed June 24, 2013.

Gobierno de España, Ministerio de Economía y Competitividad, 2013, *Estrategia Española de Ciencia y Tecnología y de Innovación 2013-2020* (http://www.idi.mineco.gob.es/stfls/MICINN/Investigacion/FICHEROS/Politicas_I+D+i/Estrategia_espanola_ciencia_tecnologia_Innovacion.pdf) accessed 16 July 2013.

Gobierno de España, Ministerio de Medio Ambiente, 2007, *Spanish Climate Change and Clean Energy Strategy* (http://www.magrama.gob.es/es/cambio-climatico/publicaciones/documentacion/cle_ene_pla_urg_mea_tcm7-12478.pdf) accessed 17 July 2013.

IEA, 2012, IEA/IRENA Joint Policies and Measures Database, International Energy Agency, Paris.

IEA (2013), "RD&D Budget", IEA Energy Technology R&D Statistics (database). doi: 10.1787/data-00488-en

La Moncloa, 2013, *New Spanish Science, Technology and Innovation Strategy until 2020*, Gobierno de España, La Moncloa, 24 January (http://www.lamoncloa.gob.es/IDIOMAS/9/Gobierno/News/2013/20130124_Science_Technology_Strategy.htm) accessed 17 July 2013..

Lewis, J. I. and Wiser, R. H., 2007, 'Fostering a renewable energy technology industry: An international comparison of wind industry policy support mechanisms', *Energy Policy*, (35) 1844–1857.

Marañóna, M. and Morata, A., 2011, 'Tariff deficit in retail electricity markets in Spain', *Network Industries Quarterly*, (13) 23–26.

Meyer, N. I., 2007, 'Learning from wind energy policy in the EU: Lessons from Denmark, Sweden and Spain', *European Environment*, (17) 347–362.

NRP-ES, 2013a, *Programa nacional de reformas – Reino de España – 2013* (http://ec.europa.eu/europe2020/pdf/nd/nrp2013_spain_es.pdf) accessed 11 July 2013.

NRP-ES, 2013b, National reform programme – Kingdom of Spain – 2013 (provisional translation ([13])) (http://ec.europa.eu/europe2020/pdf/nd/nrp2013_spain_en.pdf) accessed 11 July 2013.

OECD, 2012, *Science, Technology and Industry Outlook 2012*, Organisation for Economic Co-operation and Development, Paris. (http://www.oecd.org/sti/oecdsciencetechnologyandindustryoutlook.htm) accessed 11 July 2013.

Ragwitz, M., et al., 2012, *RE-Shaping: Shaping an effective and efficient European renewable energy market*, a report compiled within the European research project RE-Shaping (http://www.reshaping-res-policy.eu) accessed11 July 2013.

[13] The only official version of the Spanish National Reform Programme is the original version in Spanish (NRP-ES, 2013a).

REN21, 2013, *Renewables 2013: Global Status Report*, Renewable Energy Policy Network for the 21st Century (REN21) (http://www.ren21.net/Portals/0/documents/Resources/GSR/2013/GSR2013_lowres.pdf) accessed 16 July 2013.

Sáenz de Miera, G., del Río, P. and Vizcaíno, I., 2008, 'Analysing the impact of renewable electricity support schemes on power prices: The case of wind electricity in Spain', *Energy Policy*, (36) 3345–3359.

Schallenberg-Rodriguez, J. and Haas, R., 2012. Fixed feed-in tariff versus premium: A review of the current Spanish system. Renewable and Sustainable Energy Reviews 16, 293–305.

Sonvilla, P. M., Piria, R., Binda Zane, E., Bracker, J. F. and Bauknecht, D., 2012, *Integration of electricity from renewables to the electricity grid and to the electricity market – RES-INTEGRATION, National report: Spain*, Eclareon, Öko-Institut e.V.

Winkel et al., 2012. Renewable Energy Policy Country Profiles : 2011 version. Thomas Winkel, Max Rathmann, Mario Ragwitz, Simone Steinhilber, Jenny Winkler, Gustav Resch, Christian Panzer, Sebastian Busch, Inga Konstantinaviciute. Prepared within the Intelligent Energy Europe project RE-Shaping. Contract no.: EIE/08/517/SI2.529243

Würzburg, K., Labandeira, X. and Linares, P., 2013, *Renewable generation and electricity prices: Taking stock and new evidence for Germany and Austria*, Economics for Energy, WP FA03/2013.

Annex I Inventory of energy, renewable energy, economic and innovation policy objectives

Thematic area	Policy objective	Coherence between policy objectives	Source
	'internal' coherence between different energy policy objectives		
Energy	- to 'fulfil the commitments of Spain in matters of climate change and support to clean energies, while improving at the same time, social welfare, economic growth and environment protection'	+	Gobierno de España, Ministerio de Medio Ambiente, 2007b: 10
	- 'fight against climate change and the achievement of an increasingly sustainable energy system'		NRP-ES, 2013b
	coherence with energy policy objectives		
Renewable Energy	- to 'address… the tariff deficit' by suspending 'economic incentives for new renewable energy facilities'	-	NRP-ES, 2013a
	- a key role for renewable energies in the transition to a low-carbon economy	+	NRP-ES, 2013b
	coherence with energy and renewable energy policy objectives		
Economic policy	- 'Growth that respects the environment and combats the effects of climate change'	+	NRP-ES, 2013b
	- 'neutralis[ing] the effect of variables that do not depend on economic fundamentals on successive rounds of price and wage formation that can affect the competitiveness of the Spanish economy'	+	
	- 'stabilising vehicle fuel prices'	out of the scope of the case studies	
	coherence with energy and renewable energy policy objectives		
Innovation	- to promote the scientific, technological and business leadership of Spain and to increase innovation capacities of the Spanish society and economy	O	Gobierno de España, Ministerio de Economía y Competitividad,

			2013
	- energy security as well as safe, sustainable and efficient energy models	+	Gobierno de España, Ministerio de Economía y Competitividad, 2013
	- transition to a secure, sustainable and competitive energy system that reduces the dependency on fossil fuels	+	
	- broad coordination between energy policies, policies promoting research, technology and innovation, and industrial policies	+	
	- establishing an appropriate framework of distribution of costs and risks associated with the development of the new energy system	+	
	- energy and environmental sustainability is an element that should be considered in all steps of the building process and of innovation in the areas of efficiency and better resource use	+	