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Keywords Renewable energy; Electricity; Scenarios; Subsidies; EU energy and climate policy, Spain; Italy

JEL Classification H23, Q42, N74, O13, Q28

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Energy subsidies at times of economic crisis: A comparative study and scenario analysis of Italy and Spain

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Abstract
From 2005-2012, Spain and Italy saw significant investment in renewable energy, most notably in onshore wind and solar, driven by generous subsidies, the expectation of rising carbon prices and falling renewables (especially solar panel) costs. As a result of the Global Financial Crisis, both countries were faced with massive fiscal deficits and were forced to curtail their renewable support schemes, although these efforts took several years to take effect after the onset of the initial crisis. Ironically, both Spain and Italy incurred the lion's share of their liability for renewables support after the onset of the crisis particularly because of the rapid drop in costs of solar PV panels, while subsidy levels remained high. In spite of changes to their support regimes, Italy is likely to meet its 2020 climate and renewable targets, whereas Spain is unlikely to meet its 2020 renewables target based on current trajectories. Following a comparative historical survey of the two large EU member states, we present a scenario analysis that contrasts alternative futures of 2030 where renewable support remain at current levels (essentially zero) or is revived and where carbon prices stay at current low levels (€5/t CO_2) or rises to levels needed to accomplish the proposed 40% EU 2030 reduction target. We find that, by 2030, in large parts of Spain, solar PV will be cost-competitive even under low-carbon price and low renewable support regimes, whereas concentrated solar power (CSP) and onshore wind, will require at least either a sustained renewable support regime or a high carbon price to become cost competitive. In Italy, solar PV becomes cost competitive in the low-carbon, low-renewable support scenario except when fossil fuel prices are unusually low. By 2030, there would be large-scale penetration of onshore wind and geothermal in Italy if there is either a high-carbon price or a high renewable support regime or both. In general, if the current levels of carbon price were to exist post-2020, both Italy and Spain would find it rather difficult to increase the penetration of renewables in their electricity mix. A high subsidy world, on the other hand, would be result in the most favorable outcome, particularly for Spain, although it may incur additional costs in comparison to a high carbon price world.

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1. Introduction

Spain and Italy offer interesting contrasts in terms of the resilience of subsidies for low-carbon energy in the face of economic meltdown. Both Spain and Italy have experienced significant economic turmoil in the wake of the 2008 Global Financial Crisis. Italy's economic problems have been somewhat deeper and longer lasting than those of Spain, but Spain has seen a complete collapse of its subsidy support regime as a result of a massive tariff deficit that mushroomed over the 2008-2013 period. We will explore the dynamics of energy subsidies in both countries.

Italy and Spain offer useful comparisons along a number of dimensions. They are large countries, ranking fourth and fifth respectively within the EU in terms of both population and GDP and they are similar in terms of per capita GDP, ranking 11th and 12th out of the EU-28, which is roughly the EU average. Although not quite as severe as Greece, both countries have been two of the hardest hit by the economic crisis. For example, Italy's public debt is currently over 130% of GDP, second only to Greece in the EU-28 and Spanish unemployment is 22% again, second to Greece. Over 2007-2014, Spain experienced an 18% fall in final energy consumption and 4.7% drop in electricity demand between 2007 and 2012. Spanish energy intensity in 2011 was 6.9% lower than 2007 levels. On the other hand, Italy saw a 12.8% reduction in final energy consumption, 3.8% reduction in electricity demand and 1.1% reduction in energy intensity during the same duration as reported in Spain above (Eurostat, 2015; EIA, 2015). In spite of the significant curtailment or outright withdrawal of most future subsidies, over the period 2008-2012, Spain and Italy each spent just over €10 billion in support for energy, behind only Germany (€25.5 billion) and the UK (€13.4 billion).

	2008	2009	2010	2011	2012	2013	2014E	2015F	2016F
Italy	-1.0	-5.5	+1.7	+0.6	-2.3	-1.9	-0.5	+0.6	+1.3
Spain	+1.1	-3.6	0.0	-0.6	-2.1	-1.2	+1.4	+2.3	+2.5

Table 1. Growth in Real GDP (year-on-year); E = Estimated; F = Forecast, source: EC (2015b, 2015c)

In other respects, the two member states are quite different. According to the most recent European Commission assessment (EC 2015a), Italy is expected to easily meet its 2020 renewables target (along with 18 other member states), whereas Spain is expected to fall short (along with other major member states such as the UK, France, and the Netherlands). More generally, environmental taxation in Italy was 3 % of GDP in 2012, considerably higher than the EU average of 2.4 %. Most of these taxes come from energy taxation (2.3% of GDP) as well as transport (0.7 %). By contrast, Spain remains among the member states with the lowest levels of environmental taxation (1.6%), despite recent increases in taxes on electricity, nuclear energy and fluorinated gases introduced in 2012-13 (EC 2015b, 2015c).

Our analysis is structured as follows: section 1 motivates our use of Italy and Spain as comparative cases to study investments in renewables during the financial crisis of 2008-9, surveys existing literature and presents energy sector trends in Italy and Spain. Section 2 discusses the evolution of renewable energy policies and the details of the national support schemes. We present the costs of renewables support and provide an analysis of the impacts of these policies in sections 3 and 4 respectively. In section 5, we discuss the methodology and results of our scenario analysis, and section 6 concludes.

2. Literature Review

There have been many studies that have dealt with energy support mechanisms in the European Union and a number have focused on Spain/or and Italy in particular, although usually in comparison with several other member states. Indeed, before their renewable support schemes were abandoned, many studies offered positive assessments of both the Spanish and Italian systems. Reiche and Bechberger (2004) describe Germany and Spain as the leaders in promoting wind energy because both countries offer 'long-term (planning) security for investors' through their use of fixed feed-in tariffs. Fouquet and Johansson (2008) compare the structure and impacts of Feed-in Tariffs (FiT) and Tradable Green Certificates (TGC) policies in several European countries in light of the EU 2020 climate and energy targets. They conclude that the FiT mechanism, in comparison to TGC, was more successful at lowering investor risks and increasing incentives for innovation and had led to high growth rates in Denmark, Germany and Spain. Similarly, Mulder (2008) used investment data across EU-15 countries between 1985 and 2005 and found that wind turbine investments were successfully induced, particularly in Germany, Denmark and Spain, due to a combination of FiT support and subsidies for investment. Del Rio and Tarancón (2012) employed an econometric approach to capacity additions of onshore wind in the EU and found that some countries, notably Spain (along with Germany and Ireland) had low support but high effectiveness in deployment, although Italy (and UK, Poland and Belgium) had high support levels but low deployment. Campoccia et al. (2014) reviewed the main solar PV support policies in France, Germany, Greece, Italy, Spain and UK and found that Italy had the most attractive FiT structure for supporting solar PV for large systems of the countries surveyed, which they attributed to the high retail price of electricity that made net metering very attractive.

Some studies focused largely or exclusively on Italy or Spain. Ciarreta et al. (2014) conclude that Spanish electricity market prices dropped due to an increase in the share of RES-E (renewable energy sources for electricity). They also find that onshore wind and solar PV resulted in lowest and highest net cost respectively, amongst available renewable technologies in Spain. Labriet et al (2010) use a techno-economic model to identify the strategies and challenges involved in implementing the EU renewables directive in Spain and find that only more ambitious climate targets could achieve an increase in renewables investment.

Gracia et al. (2012) find that most Spanish consumers were not willing to pay an additional premium in order to support a larger share of renewables in their electricity mix and that only 20% of the total population were willing to promote RES-E in the absence of subsidies due to their higher willingness to pay which was higher than the current FiT levels. Similarly, Hanemann et al (2011) tried to reconcile Spanish aversion to energy taxes with strong levels of support for taking action on climate change and also found a high willingness to pay (WTP). Cicia et al (2012) conduct a national survey of 504 Italian households and use a latent class model to find that, in a choice experiment, Italians, in general, prefer wind and solar energy to biomass and nuclear energy technologies to varying degrees, depending on the socio-economic characteristics of the households.

A number of studies have focused on optimal deployment of renewable resources and how to gradually reduce subsidies. De Jonghe et al (2011) examine the optimal technology mix accounting for the constraints imposed by EU renewables targets and need to take into account the increased variability of intermittent renewables such as wind. Roques et al (2010) look at the case of Reuter (2012) find that the current German feed-in tariffs are close to being at the optimal level. Perhaps the most interesting work is that of Lange (2008) who employs “optimal stopping” theory in order to derive the optimal feed-in tariff over time for German photovoltaics.

Other studies have also employed scenario analysis to these countries. Talavera et al (2015) examine three scenarios for the deployment of highly concentrated solar PV (HCPV) in Spain and develop maps of how that translates into levelized cost of electricity (LCOE). Foidart et al (2010) used Life Cycle Assessment to analyze the energy mixes in Belgium and Spain in 2005 and then developed seven scenarios for 2020 and 2030 taking into account the EU targets. Movilla et al (2013) on Spanish PV.

Miniaci et al (2014) present several ways to measure affordability of energy consumption, analyse the energy poverty concerns in Italian market between 1998 and 2011 and also examine the criteria for claiming energy consumption benefits by relevant beneficiaries. One key conclusion is that Italian energy benefits scheme could be made more cost-effective by significant revisions in the eligibility criteria and advocate means-tested cash transfers in order to support households to improve policy effectiveness while maintaining current administrative costs. Gulli and Lo Balbo (2015) find that the wholesale price of electricity increases with increase in integration of solar PV than wind power in Italy and that a critical threshold for RES penetration exists above which this increase in price is affected. Cansino et al. (2010) carry out a comprehensive study of tax incentives used in EU-27 countries that are employed to promote renewable electricity and find that only Spain and Italy use tax incentives for property tax that are effective. Furthermore, they note that Spain offers a taxable profit deduction and Italy offers a lower VAT rate for promoting renewable energy technologies.

More recent studies are able to capture not only the rise but the fall in government support for renewables in Spain and Italy. For example, Avril et al., (2012), which charts the rise and fall in support in Spain, found that strong support through policies for solar PV led to an upsurge in investments despite higher levelized costs in some parts of the EU. They conclude that a well-planned policy in terms of expenditure and funds allocation is necessary to control the extent of new installations and their impact on electricity prices. In response to the withdrawal of subsidies in Italy, Ameli and Kammen (2014) propose a novel financing program in the form of public-private loans to expedite the cost gap between retail energy prices of solar PV and the current costs of electricity generation short-term and as a long-term alternative to financial incentives such as subsidies without overburdening the current debt repayment measures. Mir-Artigues (2013) describe how the previous support policy had prioritized ground-based installations. By contrast, self-generation with the possibility of exporting excess energy had never been prioritized and offered the potential of breaking free of the moratorium on the renewables that had been put in place.

Nevertheless, as Bazilian et al (2013) show, Spain and Italy (alongside Germany, Denmark, Hawaii, and Australia) had already reached socket parity” for PV systems, i.e., the point at which households can obtain > 5% return on investment just by using the energy generated to replace household energy consumption.

Considerable research has been carried out in studying the regulatory, R&D and market structure with a focus on renewable energy. Batlle et al (2012) emphasize the need to understand the implications of the regulatory design of the RES-E support mechanisms taking examples from various RES-E systems around the world by extensively reviewing existing policy support schemes for renewable energy. Guerrero-Lemus et al (2009) outline the R&D activities funded by the Department of Research in the Spanish energy sector between 2004 and 2007. Zhou et al (2011) propose that lesser the intervention requirement to achieve a policy goal, higher would be its efficiency and develop a bi-level optimization model to this end. One key conclusion is that a support policy consisting of a combination of taxes and subsidies is more effective than using either of them alone.

Despite the range of research activities in all these areas, there has been relatively little research to bridge the gap between current trends in energy policy and the trajectories that would enable countries to meet their 2030 EU energy and climate targets. Moreover, the large majority of the studies we review neither directly deals with a zero-subsidy electricity world nor project carbon price impacts on the cost effectiveness of renewable policies. Our paper addresses these gaps by studying the existing renewable energy support policies in Spain and Italy in order to determine which low-carbon technologies would be favored under different subsidy regimes and carbon price scenarios.

3. National Energy and Climate Objectives and Performance

Both Spain and Italy have been driven by their commitments under EU directives and legislation. In October 2001, Directive 2001/77/EC (RES Directive) came into effect and set indicative national targets, which, though not binding, were monitored by the European Commission. The aim was for renewables to comprise a 12% share of total energy consumption by 2010 and a 20% share by 2020 at the EU level. The focus was on renewables in electricity and so the overall goal was to move from the 13.9% share of renewables in electricity in 1997 to 22% by 2010. Italy was meant to increase its share of renewables in electricity from 16% in 1997 to 25% in 2010 and Spain from 19.9% to 29.4%, both of which were higher than the EU average objectives. Spain did meet its 2010 target, reaching a 30% renewable share in electricity, but Italy, like a number of other member states, missed its 25% target, reaching only 20% by 2010. As a non-binding objective, the EU overall only achieved an 8.5% share of renewables in energy compared to its aspiration of 12%.

Negotiations over the 2020 climate and energy package began in January 2007 and took almost two years to conclude. Often referred to as the 20-20-20 targets because it set objectives of an overall 20% reduction in greenhouse gases below 1990 levels, 20% renewable energy as a share of primary energy consumption and a 20% increase in energy efficiency, all by 2020. Other elements included reform of the EU Emissions Trading System (ETS) via the introduction of auctioning of emissions allowances (EUAs), an Effort Sharing Decision for non-ETS emissions, and a 10% target for biofuels in transport. Several directives were enacted to meet these targets, notably to address greenhouse gas emissions from large sources, notably power stations above 20 MW (thermal), and the Renewables Directive (2009/28/EC), which, importantly, imposed binding commitments at the member state level.

3.1 Spain

In 2013, about 15% of the total energy consumed in Spain came from renewable energy sources (RES) (see Fig. 1), compared to its 2020 target of 20%, which translates into a 38% share of RES in electricity (RES-E). The surge in investment in onshore wind and solar PV, which led to a doubling of the share of renewables between 2005 and 2010, came to an abrupt halt with the removal of most new subsidies and there are growing doubts whether the RES target will be reached by 2020.

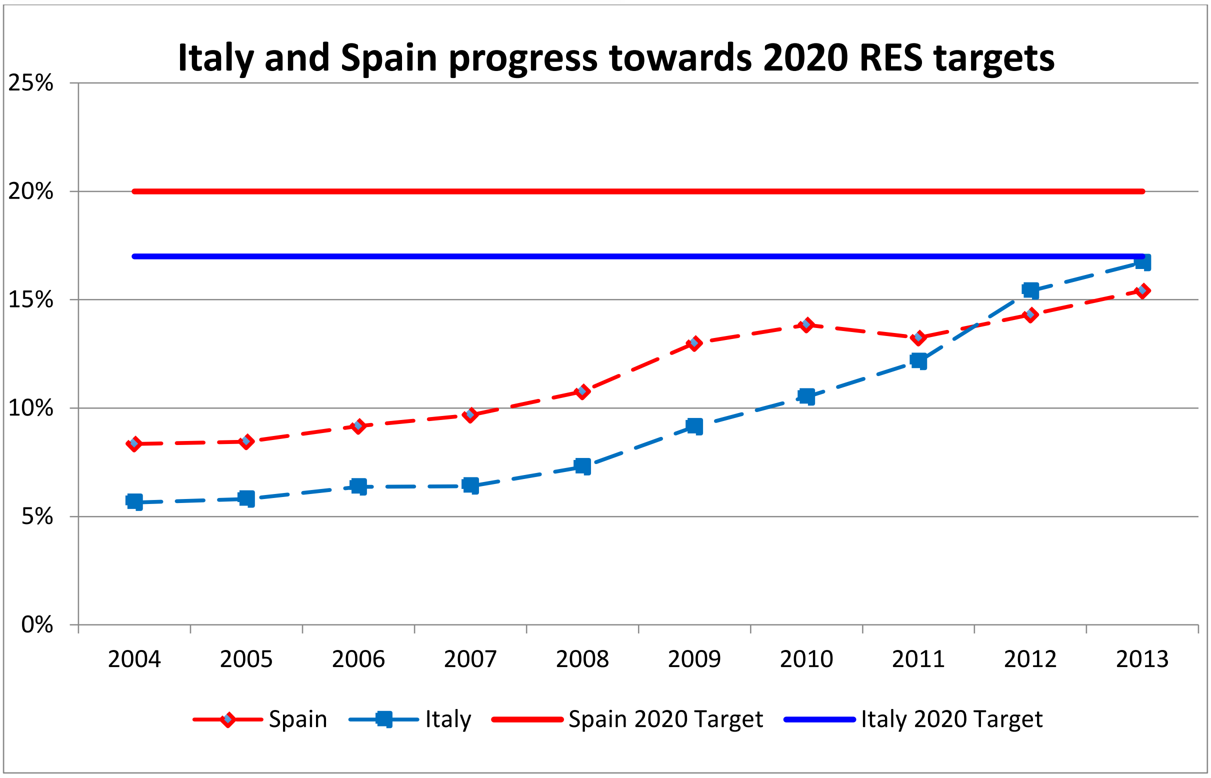

Figure 1. Progress towards 2020 renewables target by Italy and Spain (SHARES-2013, 2015)

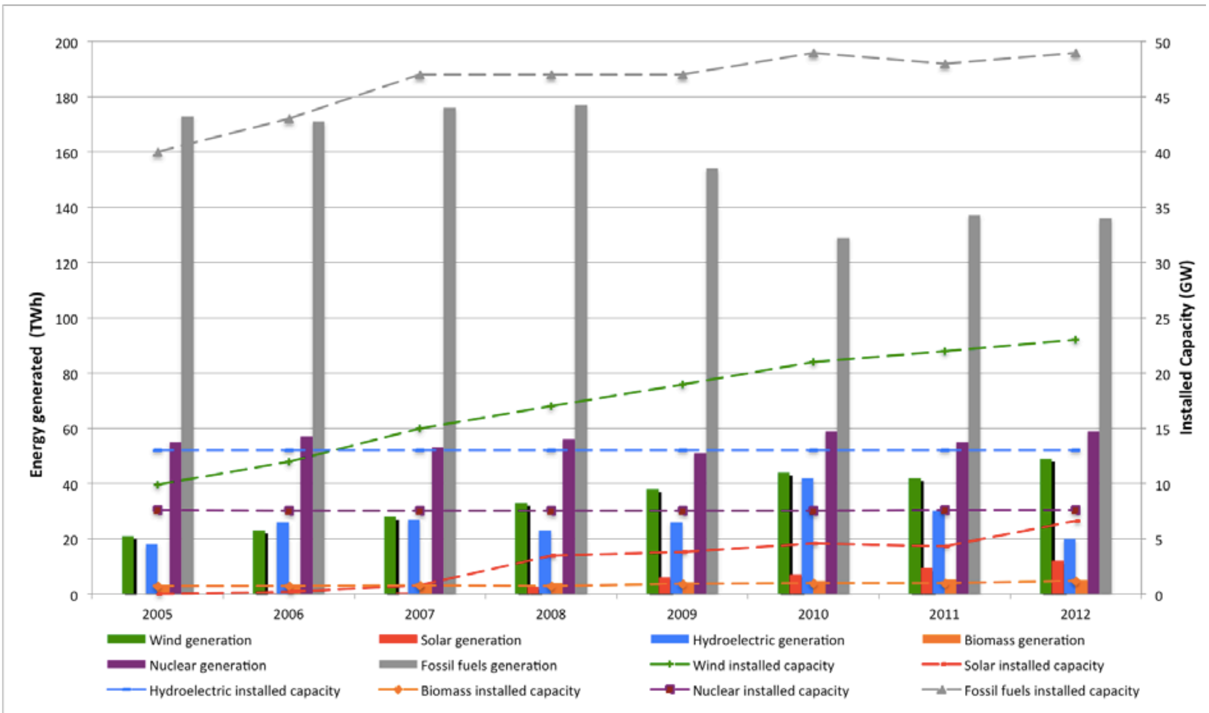

Figure 2. Trends in Spanish electricity generation and installed capacity by technology, 2005-12 (EIA, 2015)

The shares of different renewable energy technologies in the electricity sector have changed over the years. Until the mid-2000's, hydropower was dominant, but hydro generation has remained flat. Wind grew steadily through 2010, but solar PV investment only took off in 2007. Since the early 2000's, wind output has seen consistent growth, while solar PV has risen to prominence since the investment boom of 2007. Both technologies have played a significant role in Spain meeting its interim targets, although at a high cost, which casts doubt on their ability to continue. "All other renewables" includes electricity generation from biofuels, renewable municipal waste, geothermal, and tide, wave & ocean, but are collectively very small. The share of renewables in the electricity mix grew from 19% to 36% between 2004 and 2013, and virtually all of that growth has come from solar and predominantly wind generation at the expense of fossil generation, as illustrated in Figure 2.

Fossil fuels remain the dominant energy sources for electricity generation. Coal, natural gas and other conventional sources of power have been heavily subsidized for several decades. Historically, fossil fuel subsidies took the form of: (i) investment aid for conventional generation facilities with capacities greater than 50 MW (€651 million in 2012); (ii) flat-rate capacity payments for conventional power plants (€191 million in 2012); and several other measures to support the operations of the fossil-fuel industry (CREG, 2012). In addition to these subsidies, fuel tax reductions, exemptions or partial tax refunds for fossil fuels were also available. EU Member States have agreed to phase out coal subsidies by the end of 2018[c]. In total, €5.5 billion were spent on fuel tax reductions and €4 billion were spent on fuel tax exemptions between 2005-2011. During the same period, RES support was calculated to be €20 billion, roughly double the fossil fuel subsidies (EEA, 2014a).

3.2 Italy

As of late 2014, Italy was the only EU member state not on track to meet its Kyoto target because it still needed to acquire an additional 18 Mt CO_2-equivalent via so-called flexibility mechanisms (such as Joint Implementation and the Clean Development Mechanism) to reach its targets of reducing its greenhouse gas emissions 6.5% below 1990 levels by 2008-2012 (EEA, 2014b). Figures need to be reconciled by the end of the true-up period in 2015. As noted above, it also did not meet its indicative 2010 renewables target.

By contrast, Italy is set to meet both its 2020 climate and renewable energy targets. Under the EU 2020 package, Italy committed to a greenhouse gas target of 13% below 2005 levels by 2020 (18% from the covered sector under the EU ETS) and it is well on track to meet this target (facilitated by virtual economic stagnation since 2008 and declining energy consumption). Under its National Energy Strategy (NES), Italy aims to exceed these targets stipulated by the EC to reduce its greenhouse gas (GHG) emissions by 21% by 2020.

Similarly, it has been estimated that Italy's share of RES in its final energy consumption will be approximately 19-20% by 2020 (its target is set at 17%, slightly below the EU average). In the electricity sector, the share of RES would be approximately 38% of total electricity consumption (Ministry of Economic Development, 2013)**.** Italy imported 12.5% of its total electricity consumption, totaling 45 TWh from neighbors including France, Switzerland and Slovenia making it the largest importer in the EU27 after Denmark (Eurostat, 2015). In the wider energy sector, Italy depends heavily on oil and natural gas imports given dwindling local reserves, which also raises concerns over energy security and diversification of primary energy sources. The June 2011 referendum regarding new power in Italy resulted in a majority voting against government's plans for nuclear power generation, which further exacerbated its energy security issues. Renewables therefore serve as an important source of domestic generation.

[c] See 10-December-2010 note on state aid (2010/787/EU)

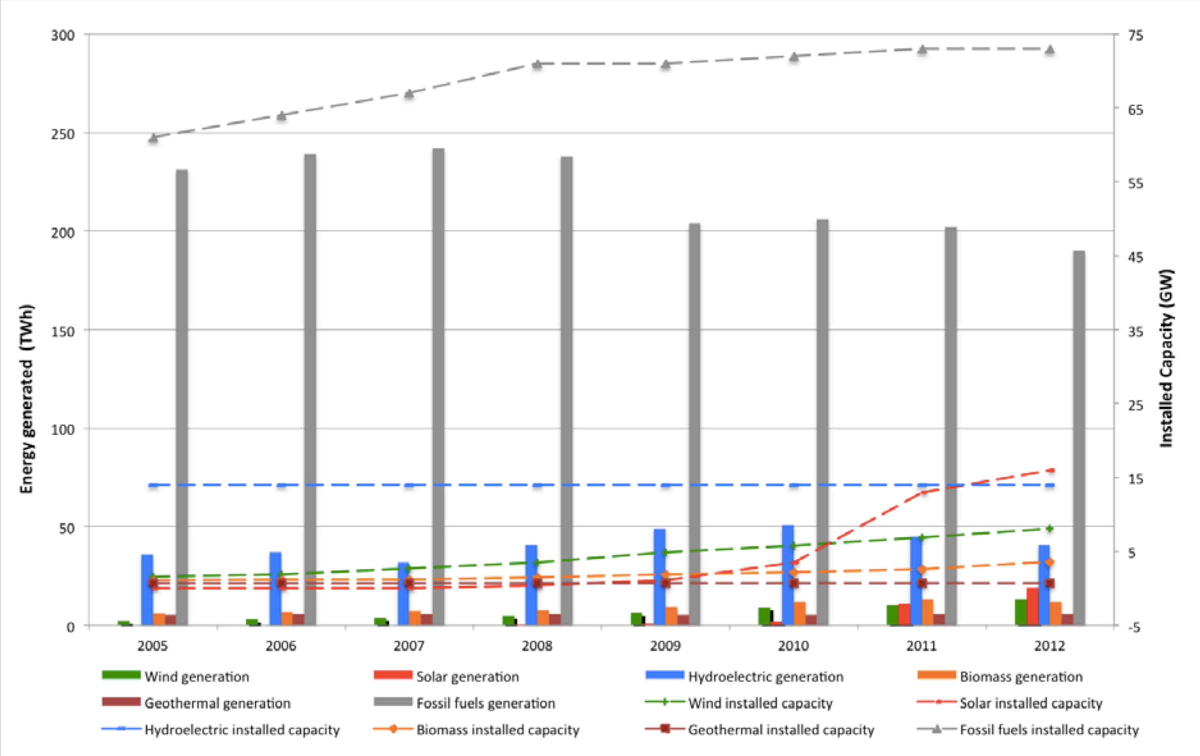

Figure 3. Trends in Italian electricity generation and installed capacity by technology, 2005-12 (EIA, 2015)

In terms of energy costs, the reductions, the estimated savings are approximately €9 billion a year on the national electricity and gas bills combined, which amounts to a total savings of €70 billion in 2012 terms until 2020. According to the Ministry of Economic Development (2013), €62 billion was spent on its net energy imports in 2011, accounting for the above estimated cost savings potential. This calculation is based on the estimate that Italy imports 84% of its total energy needs and with domestic energy production from renewables, gas and crude oil comprising 10%, 4% and 3% of the total, respectively. This is also one of the reasons for electricity prices in Italy to be higher than the European average historically. To increase the share of RES to the end of achieving the targets while reducing the consumers' burden of paying for subsidies, decreasing incentives with decreasing renewable technology cost has been adopted. In order to achieve the 2020 targets, about €11.5-12.5 billion each year has been allocated for supporting renewables over a 20 year period (Ministry of Economic Development, 2013). Deloitte (2015) find that these incentive systems have caused distortions in the allocation of public resources and has increased the cost of avoided CO_2 emissions.

The European Commission noted in its Italy country report[d] that competition in the wholesale market improved, with Enel, the historic incumbent, remaining the main market operator in 2013, holding 25.4% of the total market share followed by ENI (9.5%), Edison (7.2%) and E.on (4.4%). It also reported that despite Italy's degree of interconnection compared to other European countries, electricity prices have been higher than in the rest of Europe. Apart from the retail market, the transmission network is almost entirely owned and operated by a state-owned company, Terna and despite many small operators, Enel operates 86% of the electricity distribution network. In terms of security of supply, there is a substantial surplus in total generation capacity, which was estimated by the European

[d] See https://ec.europa.eu/energy/sites/ener/files/documents/2014_countryreports_italy.pdf

Commission to be more than twice the peak load in 2013. It is also expected that a capacity market would replace the prevailing capacity payment regime. The first capacity auction with reliability contracts took place in 2014.

4. Energy policy evolution and impacts on the renewables sector

4.1. Spain

Under the Kyoto Protocol, Spain successfully met it target, which was set at 15% above 1990 levels by 2008-2012 although it was required to purchase roughly 10% of its base year emissions in order to meet that target (i.e., there was a shortfall of 145 Mt over the five years of the 2008-12 commitment period, which Spain met through flexible mechanisms such as the Clean Development Mechanism or CDM). Under the EU 2020 package, Spain is committed to meeting a target of 10% below 2005 levels by 2020. Before the EU's third climate and energy package (2009/28/EC), Spain's RES target was 12%, but this was increased to 20% in 2007, which prompted a boom in renewable investment. Spain has also set a national target of 38% of renewable share in its electricity mix by 2020.

The key elements in the evolution of Spanish energy policies include:

- **Law 54/1997**, also known as the *Electricity Sector Law* was one of Spain's first attempts to introduce a Feed-in Tariff, FiT. The primary objective of this law was to provide preferential price arrangements for electricity from RES-E generators.
- **Royal Decree (RD) 436/2004** constitutes the first amendment to these provisions where a target of 150 MW of solar PV was set under a stipulated tariff level and a revision to these once the targets were met. It contained no 'degression factor' to account for falling unit capital costs and led to the solar PV boom from 2007 to 2012.
- **RD 661/2007**, was introduced in June 2007 in order to de-link the FiT rate from the Average Electricity Tariff (AET), defined as the level of support as a percentage of the electricity price. This was done in response to a significant increase in the retail price between 2005 and 2006. The choice between a premium FiT and fixed FiT was removed and all generators were obliged to accept the latter. Moreover, a cap-and-floor price system was integrated with the system, wherein RES-E generators would only receive compensation between the lower and upper bounds set by the system.
- **RD 1578/2008** was one of the first cost-cutting measures introduced by the Spanish government, which sought to amend the regulations related to existing installations. Important features included re-classifying the plants into different tariff slabs, reducing tariff levels, setting a cap on eligible output and a maximum period of subsidy, and imposing a moratorium on new projects.
- **RD 1565/2010** introduced further cost cutting measures. New correction factors for existing installations were implemented and the 25-year cap was extended to all existing PV plants at that time. These new measures aimed to reduce electricity system costs by €2.3 billion over three years.
- **RDL 1/2012** imposed a moratorium from January 27, 2012 on all registrations of applications for new projects indefinitely and abolished preferential tariffs for all new RES-E projects.

In 2007-08, the Spanish energy sector witnessed an unprecedented rise in solar PV panel deployment, which in large part could be attributed to flat or even rising subsidies for solar energy in the face of rapidly dropping panel prices, which become evidently unsustainable in the wake of the economic crisis. FiTs were the preferred form of RES-E subsidies, The choice of FiT as the preferred support instrument was based on evidence of its effectiveness elsewhere (such as Germany) and the ease of administering these policy measures with the additional benefit of likely political support due to environmental and claimed employment spill-overs. However, FiTs, as implemented in Spain, attracted criticism, notably from Del Rio & Gual (2004), who worried that they lacked any mechanism to adjust for changing market conditions such as overinvestment in solar PV or falling unit costs. These measures were eventually recognized to be unsustainable and the government intervened to reduce the cost of support, but not before significant liabilities were incurred. Investors criticized what they perceived as abrupt policy changes and argue that the support policy lacked credibility. The FiTs were successful in stimulating investment although at a high cost to taxpayers. What was particularly damaging for investor confidence was that the tariff changes were retrospective; for example, some existing measures were revoked such as reduction in tariff payments or duration of support.

Figure 2 shows that these FiTs had evidently resulted in a sharp spike in the installed capacity for solar PV in 2007 and 2008 in response to the generous FiT policies introduced by the government. Upon the suspension of the support for new project investments, new capacity additions plummeted to zero in 2009. After the boom, further investment in solar PV collapsed and table 2 shows that the value of solar PV subsidies then stabilized. The annual cost of supporting solar was large and by 2009, about €3.45 billion (of which €2.6 billion for solar PV alone; measured in 2012€) accounting for more than half of all the renewable energy subsidies (del Rio & Mir-Artigues, 2014; Ecofys, 2014).

These poorly designed policies were very generous to investors during the ‘golden period’, with IRR ranging from 10-15% as opposed to their original estimates of 5-9%. Several other features added to the poor policy design: the lack of an annual degression to track falling costs of solar PV projects due to learning and other economies and excessively long transition periods between tariff reductions (del Rio & Mir-Artigues, 2014). A common criticism was that the tariff rates were initially set too high without caps for the installed capacity (Voosen, 2009; Mallet, 2010).

After introducing enhanced FiTs, in 2008 the Spanish government announced a plan to completely phase out all support for new solar PV by 2012. In 2008 (phase-1), the support period for PV was limited to 25 years for all new plants and the tariff rates for the small and medium-sized plants were also reduced. In 2010 (phase-2), the total number of hours for eligible operating plants to be remunerated were capped; all existing plants (not only new) were now only due to be compensated for producing solar PV electricity for 25 years, which was accompanied by a further cut in the FiT support rate for existing plants as well. These retroactive changes had severe negative implications for the stakeholders in the solar PV industry of Spain. In 2012 (final phase), a moratorium on all support for new solar PV plants (and also all RES-E as an extension) was announced with a new adjustment in the formula to calculate the future FiT levels which ultimately resulted in further cuts to the total support received by existing solar PV generators for future payments. Such measures were only partly successful since the damage had already been long done owing to poor design and planning of support schemes. For example, in 2009, Bilbao et al. (2011) noted that whereas the maximum peak demand was 44,000 MW, total installed capacity was more than double (93,000 MW).

RDL 1/2012 signaled bleak prospects for solar PV and other RES-E installations in Spain with the removal of future financial support because of the increasing national debt-to-GDP ratio and the magnitude of the tariff deficit. This policy uncertainty, particularly due to the ‘indefinite period of time’ clause, resulting from the previous reforms starting from 2008 reduced the attractiveness of low-carbon projects and took a toll on investor confidence in the electricity sector. See Table 2 for the actual FiT rates under these decrees in Spain.

Royal Decree	Time Period	*Feed-in Tariff by size/location (in nominal €-cents/kWh)*		
		<5 kW	>5 kW	
2818/1998	1998-2004	39.6	21.6	
		<100 kW	>100 kW to < 10 MW	>10 MW to 50 MW
436/2004	2004 → Q1 2007	41.4 → 44.0	21.6 → 23.0	21.6 → 23.0
661/2007	Q2 2007 - Q3 2008	44.0	41.8	23.0
		Roof < 10 kW	Roof 10 kW to 22 MW	Ground < 10 MW
1578/2008	Q3 2008 - Q1 2009	34	34	32
	Q2 2009 - Q4 2009	34	34	32 → 29.1
	Q1 2010 - Q4 2010	34 → 32.2	31.2 → 28.7	28.1 → 25.9
1565/2010	Q1 2010 - Q4 2011	31.4 →27.4	27.9 → 19.3	25.2 → 12.5
		All types and capacities		
RD-L 1/2012	Q1 2012 -	0		

Table 2. Evolution of solar PV FiTs resulting from Spanish policy changes (adapted from del Río & Mir-Artigues, 2012)

2012 was particularly eventful for Spanish policy, since it began with a renewables moratorium (through RD-L 1/2012) and ended with the enforcement of the "Law of Fiscal Measures for Energy Sustainability". This law applied a tax of 11% on wind generators, much higher than for other renewables technologies such as solar PV, and was seen as the death knell for the wind sector. New and prospective investors were left with no promise of future support payments, thereby undermining the credibility of the new government's energy and industrial policy. The nature of the supply chain in the wind industry, with its 2-year lead-time only exacerbated the uncertainty and industry responded quickly.

AEE (2013) reported that there were almost no orders for wind turbines in 2012 in light of the new policy changes. Orders collapsed from more than 1,500 MW (in past years) to 100 MW in 2011. The Spanish wind energy association estimated that the sector would stand to lose €600 million as a result of these measures, however, the top priority of the government was to limit its tariff deficit, which was still growing. In addition to these, possible investment losses of some €27 billion were reported by Deloitte[e] in 2011.

Figure 2 shows fairly consistent additions in wind capacity over the entire period, dropping somewhat from over 2 GW per year to 1GW in the last few years. This made Spain the fourth largest country in terms of wind market, after China (75,564 MW), USA (60,007 MW) and Germany (31,332 MW). In 2012, wind production in Spain exceeded 50 TWh although actual generation varied from one year to the next because of variation in the wind capacity factor (for example, generation in 2010 exceeded 2011 in spite of the greater installed capacity).

Until the end of 2012, wind generators could opt for either the regulated FiT or selling their power in the wholesale market. It was estimated that about 25% of the installed wind capacity chose the former in 2012. The different choices may reflect differing assessments of expected market returns between the two systems. The regulated FiT was a mandated tariff structure for wind generation along the period that was selected by the wind farm owners,

[e] Study of the Macroeconomic Impact of the Wind Power Sector in Spain in 2011, Deloitte (as cited in Pg. 14 of AEE (2013))

whereas the market mechanism allows the wind generators to extract a production incentive in the form of a premium over the hourly marginal price.

Part of the reason for different actors choosing the regulated FiT or selling into the market can be explained by the volatility of the wholesale prices. There were quite large variations in the daily market price on a year-to-year basis, with 2008 being the highest with €64.43/MWh. In 2007, it was beneficial to choose the FiT option since the lower bound of remuneration was €79.102/MWh (projected in 2012 under RD 661/2007) as shown in table 2, since this lower bound was still higher than what the generators would receive if they chose to sell their electricity directly into the market.

However, the new policy changes that resulted in a significant reduction in the tariff structure made the FiT less lucrative to wind generation units in 2012 and therefore may have resulted in their choosing to sell their power in the wholesale market instead.

Some €2.03 billion worth of incentives were paid by the Spanish government to the wind sector in 2012, of which €1.77 billion was for production and €260.27 million was in the form of payments for ancillary services. The total remuneration for the entire sector, including the wholesale market sales, was computed to be €4.06 billion and the average remuneration during the year for wind power was calculated to be €87.77/MWh (all measured in nominal terms).

Belatedly, the Spanish Government passed one reform after another in rapid succession: RD-L 2/2013 imposed a mandatory regulated FIT, which would no longer rise with the consumer price index. A few months later in July, RD-L 9/2013 moved from paying the established tariff for 20 years, to a system where compensation was based on the "reasonable profitability" for each project, which varied with a project's age, cost, and amount of subsidies already received (IEA Wind, 2015). The system runs retroactively and excludes wind farms commissioned before 2004, for which support was cancelled altogether.

As a result of the loss in investor confidence and the unattractiveness of the new regimes, investment dropped dramatically – from 1112 MW in 2012 to 175 MW in 2013 and 28 MW in 2014. The only projects going ahead are those without any subsidy such as the 14-MW wind farm in Galicia being built by the Spanish utility Gas Natural Fenosa.

4.2. Italy

The share of renewable energy production capacity, excluding hydropower, rose dramatically between 2008 and 2012 (see Figure 3). The growth can be attributed primarily due to an upsurge of investments in solar and wind capacity. Wind and biomass capacities doubled over this period and that of solar PV has grown many-fold. In 2011 alone, solar PV capacity more than tripled, from under 4 GW to over 12 GW due to the generous schemes under *Conto energia* and *Salva Alcoa law* and falling unit costs. However, on July 6, 2013 some of the incentives to solar farms on agricultural land were revoked leading to a slowdown in solar PV investments. This was done after the assigned annual incentive budget of €6.7 billion was reached. Deloitte (2015) anticipates that solar PV would continue to grow strong until 2020. The report also predicts a weak growth for geothermal power and stable hydropower capacity until 2020. Looking forward, it is anticipated that more than 29% of the final energy production would be produced from renewable energy by 2030, however, a target energy mix for 2030 has not been finalized.

Over 2011-2014, prices on the power exchange have not shown high degree of convergence in Italy, similar to that of the UK (Deloitte, 2015). Also, given the high dependence on natural gas electricity trades at a premium. The nominal electricity prices for both industrial and domestic users increased sharply between 2010 and 2012 and stabilized later on. The taxes and grid costs rose by 58% and 8% between 2008 and 2012 (in current amounts) for industrial consumers, which resulted in the noted increase in their electricity prices.

The earliest efforts in climate policy through national measures by the Inter-Ministerial Committee on Economic Planning (CIPE) to reduce GHG emissions find roots in Italy's ratification of the Kyoto Protocol in 1998. Provisions through resolutions such as 137/98, 126/99 and 123/02 directly relate to the earlier national energy policies aimed at GHG reductions. Particularly, the last of the 3 CIPE resolutions mentioned above elaborated the establishment of an Inter-Ministerial Technical Committee for GHG emissions (CTE), whose main task was to monitor emissions and evaluate policies outlined in the national strategy. As per the *Finance Law 2001*, a total of 3% from the carbon tax receipt financed the CO_2 emissions reductions and the energy efficiency improvement measures until 2002, when the carbon tax law ended. This fund financed up to 80% of the total cost of programs that supported installation of solar PV systems. In 2002, the Environment Ministry declared that Italy would rely on the three flexible mechanism of the Kyoto Protocol to meet more than 20% of its emissions reductions. It was estimated that approximately 93 million tons of CO_2 reductions would be achieved by proposed measures (yet to be implemented then) and the other 30 million tons were to be cut through other measures that had not been established at that time. The government by enforcement of Law no. 239 reorganized the Energy sector by devolving it to Italian regions (Grantham Institute, 2015).

In 2006, Italy adopted the EU ETS scheme along with 12 other EU Member States. It was decided that 50% of ETS revenues would be disbursed to climate and energy efficiency programs. The *Finance Law 2007,* introduced the 'Revolving Fund for Kyoto', which provided €200 million for the period of 2010-2012 to promote GHG reductions by means of soft loans for distributed generation, small-scale technologies and other energy efficiency measures. The *Climate Change Action Plan* aka CIPE 135/2007 revised the national GHG reduction plans and set out extensive action plans to meet the Kyoto targets. In 2013, CIPE recently updated its national strategy, known as the *National Energy Strategy (NES)*, to adopt pathways to achieve both the Kyoto requirements and the European 2020 targets. The main drivers for this legislation were energy security concerns and improving competitiveness in the energy system.

As of 2013, Italy's 2020 targets for renewables had almost been met, with about 97 TWh produced from renewables compared to its target of 100 TWh by 2020. Of this figure, about 40 TWh comes from solar PV and wind energy. The primary reason for this rapid growth can largely be attributed to Italy's renewable support system, which did not taken into account the rapid fall in technology costs while designing its incentives. Technology costs for solar PV fell by 70% from its 2008 levels by 2012. This design resulted in significant costs to the system with about €9 billion/year being borne by consumers through their energy bills, accounting for approximately 20% of the average Italian electricity bill in 2012. Moreover, as a result of long term contracts for generators, Italy's total commitment has been estimated at €170 billion over the 15-20 year horizon. To get a sense of Italy's 'generosity', in January 2012, Italian PV incentives were double or triple the levels in Germany or France, and wind incentives roughly 50% higher. (Ministry of Economic Development, 2013)

Renewables in Italy have historically been supported by means of Green Certificates and Feed-in Tariffs (FiT). Below is a brief overview of the legislation that shaped these support schemes in Italy.

4.2.1. Green Certificates (Certificati Verdi)

The legislative decree **79/99** and the *Electricity Liberalization Act of 1999* paved the way for the introduction of a cap-and-trade mechanism in Italy and also was key in commencing the green certificates scheme. Since 2002, renewable energy generators qualify for green certificates, which are traded between the generators on a dedicated market. At the end of the year, a fixed amount of certificates are surrendered to the Energy Service Operator, Gestore dei Servizi Energetici (GSE). This measure was mainly introduced to increase the share of renewables in the energy mix. Initially in 2002, a 2% quota obligation was set, which was subsequently increased by +0.35% annually from 2004 through 2006 and by +0.75% per year from 2007 through 2012. The RES-E quota reached 7.55% by 2012 and the duration was 8 years through 2004, was briefly 6 years for 2005, before rising to 12 years in 2006 and 15 years thereafter following the *Finance Law 2008* (Ragwitz et al, 2012). The generators could meet these requirements by either purchasing green certificates from eligible new renewable plants, building new renewable capacity or importing renewable electricity from outside the country. In 2004, the Italian government reduced the size of these certificates from its initial value of 100 MWh to 50 MWh.

CRS (2013) indicated that 16.3% of Italy's electricity was due to RES compared to its obligation of only 2.7% and therefore it was estimated that Italy had more than 100% compliance by 2015. Thus, GSE purchases the oversupplied green certificates in order to maintain a price floor in order to ensure the economic viability of the new renewable projects. This has also led to the planned phase-out of these certificates as outlined below.

The *2008 Budget Law* added flexibility to the support schemes by allowing small new renewable generation units (commissioned after 1st January 2008) to choose between these certificates and FiTs, for a period of 15 years. The green certificates scheme would be replaced by a dedicated FiT, which would be calculated based on the average price of electricity during the given year, from 2016 onwards. In the interim period, the *Destinazione Italia Decree*, introduced in early 2014, amended the terms of support to include lower guaranteed minimum prices and higher taxes for industrial renewable producers in order to ensure the long-term benefits while reducing the total costs of support. According to this legislation, a new optional scheme was introduced wherein the renewable energy generators could opt to do one of the following: (i) continue with their current scheme for their remaining duration while forsaking any incentive 10 years beyond its expiry for any new initiatives which the site would be eligible for; or (ii) allow for a restructuring to their existing support scheme which is characterized by a fixed percentage reduction (depending on the plant type) while the period of support is extended by seven years.

4.2.2. Feed-in Tariffs (or all-inclusive tariffs)

The Italian Ministry of Economic Development issued decrees in 2005 and 2006, which offered solar PV specific Feed-in Tariffs (FiT) from February 2007, where support depends directly on the amount of electricity fed into the grid based on the methodology outlined in the *Conto Energia* legislation. Most recently, with effect from 2013, a degression factor has been introduced to automatically account for falling unit costs. All plants covered under this scheme are ineligible for support through the green certificates. The current version, *Conto Energia V*, which entered into force in August 2012 guarantees FiT and premium support for a period of 20 years. This legislation introduced cuts in the incentive 43% and 39% for ground-mounted and rooftop PV installations respectively, relative to pre-2012 levels. An annual expenditure cap of €6.7 billion was also introduced as a part of the revised measures.

In July 2012, another ministerial decree extended FiTs to other renewable sources of electricity generation. This was intended as a preliminary measure that would supplement the government's intention of phasing out the green certificates scheme. According to this scheme, plants of certain sizes are eligible for FiTs while others would be covered through market premiums. The levels of support would depend on the size of the project. A caveat is that an annual budget of €5.8 billion exists for this scheme and once this limit is reached no non-solar PV projects would be supported in that calendar year. As of 2013, onshore projects that are larger than 5 MW are eligible for support through a reverse auction process, administered by the GSE, wherein the amount of new wind capacity that is eligible for support is capped at 500 MW each year for the years running through 2013 and 2015. In an effort to prevent under and over-bidding, a floor and ceiling for this premium has been introduced.

Law no. 116, which was introduced in August 2014, lays down new rules for FiTs for solar PV and other renewables. Starting from 2015, generators could choose one of three options: (i) reduction in FiT levels based on the remaining plant lifetime, ranging from 25% for 12 years remaining to 17% for 19 years or more, which would be distributed over a 24 year support duration from the date of grid connection; (ii) fixed reduction of FiT over the 20-year period, where the reduction varies depends on the nominal capacity of the plant; and (iii) variable structure of FiT which allows for a fixed percentage reduction of support initially which would be increased by the same amount at a later date, which is done in order to ensure the budget constraint between the 2015-2019 duration. Additionally, the owners can sell up to 80% of their expected FiT to a third-party investor who would be selected through a competitive tender process.

In addition to these two measures, tax deductions and net-metering benefits are also available for certain type of renewable generation units. For rooftop PV systems less than 20 kW in size, a deduction ranging from 36%-50% of the total system capital expenditure from the owner's income tax over a 10-year duration is available. The net-metering scheme applies to solar projects with size less than 200 kW only and the owners are eligible to receive compensation for electricity that exceeds the self-consumption.

As in Spain, after 2012, additional investment in renewables dropped dramatically. New wind capacity installations dropped from 1266 MW in 2012 to just 105 MW in 2014 bringing total installed capacity to 8663 MW (IEA Wind, 2015).

5. Cost of renewables support

5.1. Spain

To meet its climate and renewables objectives, Spain heavily subsidized renewable energy production although the bulk of that support was concentrated in a short period. The trends in expenditure on policy support for all technologies since 2008 are shown in Figure 4. Production subsidies did not just increase for solar and onshore wind but also for coal. The data for this graph is presented in Table 3. Since 2009, solar has taken well over half the subsidy going to RES with wind taking one-third, although capacity installed from 2012 no longer receives support and installations from before 2004 are also no longer supported. The effects and regulatory changes that accompanied these payments are discussed in greater detail in the following sections.

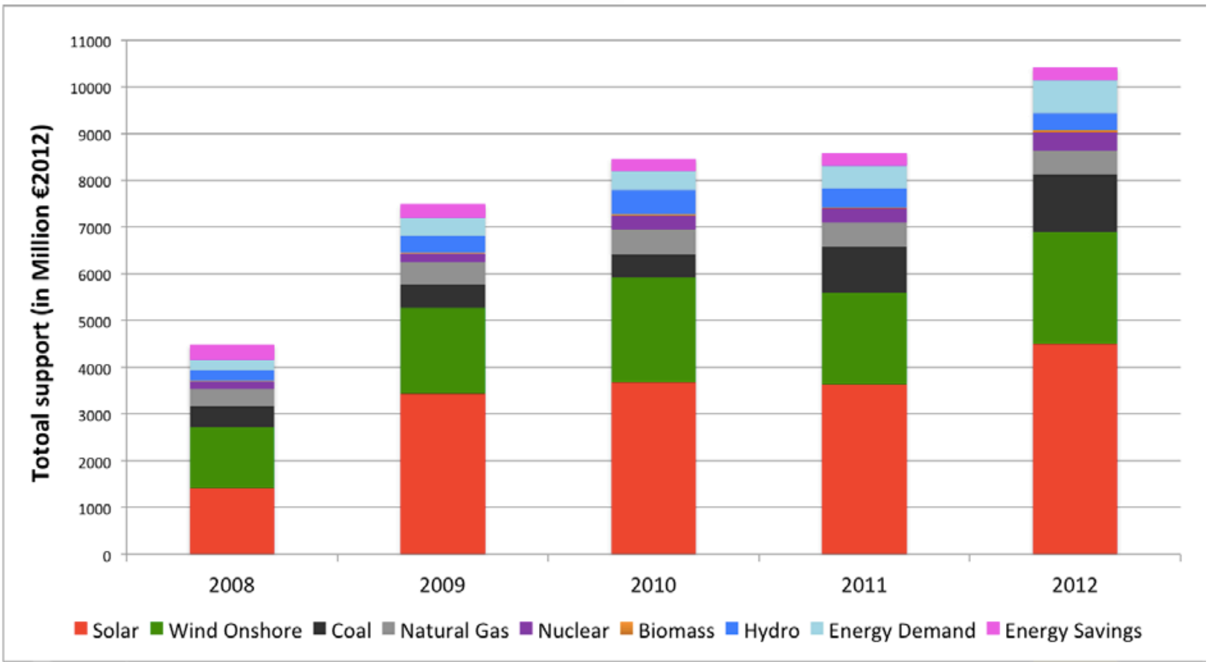

Figure 4. Total support by technology in Spain measured in €2012 (Ecofys, 2014)

Technology	Actual Production Cost (€/MWh)	Subsidy element (€/MWh)	Energy receiving support (TWh)	Total RES incentive costs (million €)
Total biogas	57.04	13.67	0.893	50.94
Hydropower	43.07	-0.3	7.033	302.91
Solar - CSP	251.39	208.02	4.428	1113.2
Solar - PV	377.54	334.17	6.79	2563.8
Solid biomass	76.48	33.11	4.627	353.9
Wind - onshore	43.98	0.61	54.536	2398.3

Table 3. Support granted by renewable technology in Spain in 2013 under different FIT schemes (based on wholesale price of €43.37/MWh) (CEER, 2015)

Recent statistics show that in 2012, roughly 22.9% of the 297 TWh of gross electricity produced received support from the government. Table 3 shows a time slice of the subsidies granted to renewable energy producers in 2013. Solar subsidies are between 480% and 770% of the reference wholesale price. In addition to these payments, the Spanish R&D budgets for RES increased from €28 million to €49 million in nominal terms between 2005 and 2010. Strikingly, in 2011, according to the IEA statistical database, this budget more than doubled to €132 million. Taken together with support for deployment, in 2011, €1.94 billion was spent supporting fossil fuels as compared to €4.9 billion for renewable energy technology.

Overall, Spanish R&D remains low by OECD standards – in 2012, only 1.3% of GDP went in to R&D, compared to the OECD average of 2.4%, although R&D investment did continue to grow between 2007-10 in the depths of the economic crisis (OECD, 2015). Pre-crisis, overall gross energy R&D spending outstripped other categories of R&D spending increasing by 66% between 2004 and 2010 so that by 2010 energy and environment R&D together accounted for 10% of its government R&D budget, which was relatively high as a share compared with other OECD countries. Since then, energy and environment has declined to 6.2% of total R&D spending. In fact, energy spending peaked in 2008 and since then has declined by 54% between 2008 and 2012 (OECD, 2015). Pre-2009, renewable R&D was very small (<€40 million) and focused largely on solar energy and since 2009, renewable R&D funding has roughly doubled and has focused on biofuels, wind and solar technologies in roughly equal measure,

Italian energy R&D funding has been rather volatile in spite of an overall upward trend over the 2005-11 period. Through 2006, Italian R&D into renewables was almost completely aimed at solar power. Beginning in 2007, some 20-30% of R&D spending was devoted to renewables, with small and growing funding allocated to geothermal energy and small but diminishing R&D funds spent on wind energy. Annual budgets have varied from €40-€80 million and have typically been in the range of €60 million. Nevertheless, Italian R&D spending overall remains low and relative to other large countries (OECD, 2015).

A distinguishing feature of the Spanish case is that the Spanish Electricity Authority held down electricity prices to protect consumers and in so doing accumulated large tariff deficits. This has added to the massive public debt, which in 2012 was calculated to be roughly 85% of the GDP (CIA, 2015). Figure 5 shows the accumulation of the tariff deficit, which by 2013 reached €29 billion or 3% of Spain's GDP. As table 3 shows, in 2013 solar PV generators alone absorbed more than half of the total support provided to RES-E, despite only contributing to 10% of the total renewable energy at that time, as commented on in more detail by del Río & Mir-Artigues (2012). Nevertheless, the 2013 electricity sector reforms have helped contain the tariff deficit and the 2014 deficit is expected to decline still further.

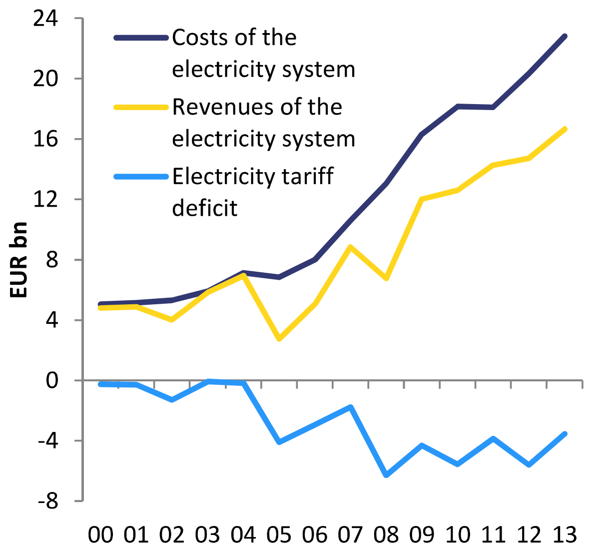

Figure 5. Evolution of Spanish Debt over the period, 2000-2013 (CNE, 2013)

5.2. Italy

The total cost of support per technology type under each support scheme in 2013 for renewables in Italy is shown in Table 4 and the total costs incurred for all technologies (incl. fossil fuels) is reported in Figure 6.

Technology	Type of support scheme	Energy receiving support (GWh)	RES incentive costs (million €)	Cost (€/MWh)
Solar - PV	FIP	20,421.1	6513.73	318.97
Solar - PV	FIT	945.4	44.22	46.77
Solar - PV	Green Certificates	4.4	0.35	80
Wind - onshore	FIP	112.2	4.07	36.27
Wind - onshore	FIT	111.8	17.51	156.59
Wind - onshore	FIT - Cip 6/92	198.4	8.9	44.86
Wind - onshore	Green Certificates	12,328.1	986.25	80
Total		53,281	9585	

Table 4. Levels of energy support per technology in 2013 in Italy (CEER, 2015)
(based on wholesale price of €61.55/MWh)

In addition, there are three categories of biodegradable waste, four categories of 'other solid biomass', but total support amounted to less than €700M for just over 5 GWh.

Tables 3 and 4 reveal that Spain and Italy had two of the highest levels of subsidy in the European Union (along with Germany). Total support amounted to almost exactly 0.6% of GDP in each of the three countries. By contrast, in 2012, both the UK and France only spent 0.1% of their GDP on renewables support. Moreover, these high levels of support did not translate into greater efficiency. The average subsidy across the EU was 13.68 €/MWh of electricity generated, but in Spain the subsidy was just over 20 €/MWh, compared to 25 €/MWh Germany, and over 32 €/MWh in Italy, by far the least efficient subsidy in the EU. By contrast, the average subsidy in Denmark was €18.5/MWh, was between 5 and 10 €/MWh in the UK, Poland the Netherlands and less than 5/MWh in France, Sweden and Ireland (CEER, 2015).

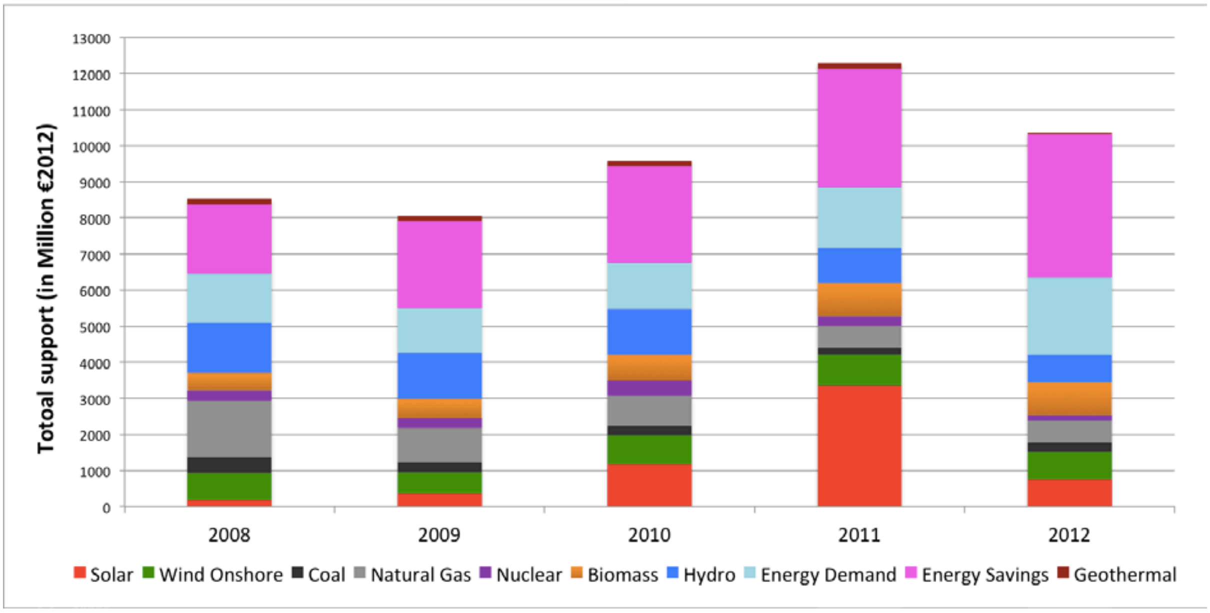

Figure 6. Total support by technology in Italy measured in €2012 (Ecofys, 2014)

The project support costs for the lead up to 2020 as estimated in the NES 2013 report by the Italian Ministry for Economic Development projects that the costs of support for PV will stay roughly constant at €7 billion, with non-PV renewables rising from €3 billion to ~€5 billion by 2015 and staying at that level thereafter (Ministry of Economic Development, 2013).

6. Repercussions of policy reversals and the rise in investor claims

In Spain, there was almost no solar PV installations before 2007 and the Feed-in Tariff (FiT) levels supporting them were below the cost of the PV system, but in 2007 there was a surge in commissioning of PV plants which stabilized soon thereafter. Annual support costs for solar PV also spiked in 2008 and 2009 (to €3440 million in 2012€) and remained close to that amount until 2011. The sudden upsurge of installed capacity was attributed to the change in policy that resulted in generous FiT support to new installations that were contracted in 2007 (See Fig. 2). The sudden policy changes in Spain in light of increasing concerns over the tariff deficit resulted in reductions in FiT levels from 2008 (in irregular steps). This effort to reduce the subsidy burden culminated in the FiT and other forms of remuneration to new projects being suspended as of January 2012, however, the legacy effects of support to existing plants still continue to affect Spain's tariff deficit.

Onshore wind in Spain has seen tremendous increase in installed capacity over the past decade, while the capacity factor has been mostly stable. Therefore, the support costs for wind has closely followed the annual energy generation profile for wind without exception. There has been no noticeable increasing trend for biomass, unlike Italy. Notably, the nominal residential 'energy and supply' costs have increased after 2012 and this has also resulted in an increase in the retail prices of electricity in Spain, despite network cost reductions. Furthermore, nominal electricity retail prices for both households and industrial consumers have been rising since 2008, with the former more prominent and the latter stabilizing after 2012. The levels of inflation since the financial crisis has remained low, therefore these increases in nominal amounts are chiefly due to other factors.

Whereas in Italy, solar PV installed capacity saw rising trends between 2008 and 2012, which had the intended effect of the policies that were introduced to promote it. However, this resulted in a concomitant increase in support costs during this period. More recently, from 2010-12, support costs for solar PV rose from 1170 to 3360 million 2012€ in 2011. With regards to the levels of PV FiT, Italy did not reduce its tariffs until 2011 despite significant technological cost reductions during that time all over the world, which was attributed to economies of scale and module efficiency improvements. Other major renewable technologies in Italy, in terms of installed capacities, are onshore wind and biomass. Onshore wind installed capacity has risen steadily over the years starting from 2005. The costs of supporting them have also been roughly the same each year, with the little variance could have due to changes in wind speed and thus the wind generated annually. The installed capacity of biomass has a slight upward trajectory and consequently its support costs have increased correspondingly, particularly between 2010 and 2012. Geothermal power in Italy appears to show some long-term promise (Sigfusson and Uihlein, 2015)

De La Tour & Glachant (2013) show how after Spain raised the tariff for most of 2007 and 2008, its tariff was some 50% higher than that of Germany despite far more favorable solar insolation. Even after Spain made a large one-off cut in its tariff in late 2008, the timing coincided with a rapid and sustained decline in PV unit costs, which made even the greatly reduced Spanish solar tariff attractive to investors, particularly since it was maintained at this level until early 2010 in the face of falling prices. By contrast, Germany retained tight control over its tariff, which tracked falling unit costs well over the entire period of 2005-12. Unlike Spain, Italy maintained a relatively fixed tariff between 2005 and the end of 2010. Therefore, there was no early surge in solar deployment in Italy and it was only with the fall in PV panel prices from late 2008 that investors flocked to solar to take advantage of constant PV FiTs, which did not acknowledge the falling PV system prices.

Many countries responded with alarm at the slowly dawning recognition of the impact of high feed-in tariffs. For example, the UK dropped its solar PV subsidy from 43p/kWh to 21p/kWh at the end of 2011 in the midst of an ongoing consultation (Cherrington et al, 2013) but few other countries moved as decisively to claw back previous commitments as Italy and especially Spain. Future subsidies were not simply halted or dramatically slashed, many of the previous commitments were reversed and this not only shook investor confidence but led directly to investors seeking legal recourse including bringing both Spain and Italy to arbitration through the Energy Charter Treaty (Jones, 2015). For example, Spanish Law 15/2012 of 27 December 27, 2012 imposed a 7% levy on revenue received from all power generation, including revenues generated at solar plants and discontinued the premium for solar power generation versus natural gas. On 1 February, 2013, another new law limited remuneration for renewable energy producers further by eliminating premium pricing, reducing adjustments based on the consumer price index and excluding from the FiT any power produced at solar thermal installations using gas.

As a result of these and similar changes in Italy, from November 2011 through to November 2015, total investor-state arbitration cases brought under Article 26 of the Energy Charter Treaty (ECT) tripled, from 30 total cases between 2001 and 2011 to almost 90 by late 2015, driven almost entirely by solar claims. Of these cases, 27 were brought against Spain, 4 against Italy (as well as 6 suits involving the Czech Republic, etc) and the cases show no signs of abating (Energy Charter Conference, 2015). The large number of cases actually understates the total number of actors involved since suits often involve multiple parties, for example, there are 16 parties in *PV Investors v. Spain.*

In 2014, Italy withdrew from Energy Charter Treaty, nominally to save €450,000 in costs, but in any case, all investments made prior to the end of 2015 will receive full protection under the ECT and its provisions will continue to apply to investments made before January 2016 for a period of further 20 years (under the so-called ‘sunset clause’).

Thus, the Italian withdrawal has few implications for any policy decisions or reversals already made.

In general, details of the compensation requested are not released although in one case (that of Abengoa's solar thermal farms) the request is for €60 million in compensation for each year until the dispute is resolved (Pozzi, 2013). Separately, firms have also brought private-law actions against government in the civil court where they have sought to force governments to abide by their earlier commitments or asked for damages equivalent to the difference between the profit achieved under the original and the reformed regime although, to date, few such cases have been allowed to proceed.

7. Scenario analysis and discussion

Looking forward, the European Union has recently committed to reducing greenhouse gas emissions by 40% below 1990 levels by 2030 (EC, 2014). This commitment will eventually be translated into binding national targets and will be challenging because achieving the Kyoto and 2020 targets has been greatly facilitated by both the Global Economic Crisis and major one-off reductions resulting from German reunification and North Sea gas production, which led to the 'dash for gas' in the UK – the majority of EU reductions was met by German and British 'actions' (EEA, 2014b). At the same time, the EU adopted an overall renewables target of 27% for 2030, but, unlike the 2020 framework, this will not be translated into member state level commitment.

In addition to the new 2030 targets, the Commission also passed new State Aid Energy & Environment guidelines for 2014-2020

- Emphasis on improving the efficiency of public support measures and reduce market distortions
- Continues to allow aid to a wide range of RES in form of operating or investment aid
- FiTs to be replaced by a premium (in addition to the market price) or tradable green certificates by 1 Jan, 2016
- In principle, all aid should be granted in a competitive bidding process (from 2017) although cases can be made if not possible or desirable
- Although guidelines only hold through 2020, EC argues subsidies and exemptions from balancing responsibilities should be phased out in a degressive way between 2020 and 2030. Although this outlook has no legal effect, it makes clear the Commission's aim to abolish all subsidies for established renewables in the longer term

In the context of different post-2020 worlds, we analyze four different scenarios: **abundant support** (historical subsidies and high carbon price), **minimal support** (zero subsidy and low carbon price), **carbon price only** (zero subsidy and high carbon price) and **subsidy only** (high subsidy and low carbon price), post-2020. For the sake of our analysis, we define a *high carbon price world* to be higher than €50/ton-CO_2(eq) and a *low carbon price world* to be less than €5/ton-CO_2(eq). Similarly, a *zero-subsidy world* is one where there are no support schemes in place for both renewables and fossil fuel power generation technologies, and a *historical-subsidies world* is characterized by subsidies that were in place during 2012 in each country (see Table 5*).*

TECHNOLOGY	FiT levels (€/MWh)	
	Italy	Spain
Solar PV - rooftop (small scale)	38.5	235.1
Solar PV - ground (utility)	38.5	130.3
Wind onshore	48.4	91.7
Nuclear	0.0	0.0
CHP Biomass - electricity	91.3	169.4
Hydropower - Dam	151.8	82.5
Hard coal	0.0	0.0
Natural gas	0.0	0.0
Geothermal	50.6	0.0
Concentrated Solar Power	0.0	185.2

Table 5. FiT levels in Italy and Spain as of 2012[f] (reported in nominal amounts)

We define the *base case* as being where the 'general assumptions' (described below) about the financial parameters are met in 2020. In a *high (or low) fuel cost state* we assume 30-percentage points (p.p.) increase (or decrease) in the fuel costs from the base case assumptions ceteris paribus. Similarly, in a *lower (or higher) WACC (weighted average cost of capital) state* is one wherein the investment costs of renewable technologies and nuclear are 20 percentage points lower (or higher) than the base case assumptions ceteris paribus. All prices are reported in 2012€ for the ease of comparison across technologies and time. The data for the capital costs; financial and technical parameters are based on the estimates reported in Ecofys (2014).

The general assumptions for the base case are: (i) a 50 p.p. reduction in investment costs for solar PV, 30 p.p. for CSP, 10 p.p. for onshore wind and biomass technologies; and a modest 5 p.p. for geothermal in 2020 measured from its 2012 levels (IRENA, 2015), (ii) fossil fuel costs for 2020 are adjusted based on a chosen scaling-up factor, 1.17 for coal and 1.1 for natural gas, which are derived from the IEA World Energy Model 2013 price projections, and (iii) The O&M costs, electrical and thermal efficiencies, capacity factors of all technologies (except geothermal, where it rises to 65% due to expected new thermal storage methods), WACC and the full load hours of operation of all plants are held constant between 2012 and 2020. Hereon, we define renewable technologies to be 'cost-competitive' only if their Levelized Cost of Electricity (LCOE)[g] estimate, measured in 2012€-cents/kWh, is lower than that of both natural gas and coal for electricity generation.

We impose several other constraints for the purposes of this study. Nuclear is assumed to be confined only to Spain given the overwhelming Italian 2011 referendum results opposing nuclear power. CSP is assumed restricted to Spain given the proliferation of plants there and the poor prospects in Italy (other than perhaps in Sicily). Finally, geothermal is only available Italy. In reality, we appreciate that the case may be different in 2020. Moreover, the potential for cost reductions will change over time; for example, Pietzcker et al (2014) find that although PV will be deployed first, by mid-century CSP catches up and overtakes PV due to its lower system integration costs.

The results of the scenario analysis are summarized in Table 6. Unless explicitly stated, the other technologies being considered (in Table 6) are cost-competitive in all states under a given scenario for any country.

[f] The tariff levels in Spain are based on RD 1565/2010, RD 1614/2010 and RDL 14/2010 and the data reported in http://www.autorita.energia.it/allegati/comunicati/140130tab.pdf for Italy

[g] Calculate based on the method adopted in Ecofys (2014) and calibrated against the mean LCOE figures reported in Appendix 4-5 of the main report for the 2012 reference case.

Minimal support scenario:

Onshore wind is only cost competitive in Italy and Spain only at high fuel cost and techno-optimistic states. Investments in rooftop (household) solar PV is not likely at the techno-pessimistic states in both the countries. In Spain, nuclear energy is not viable at all in most states, although it may be the closest to being viable at the techno-optimistic state. A carbon price greater than €3.34/ton-CO_2(eq) would make it cost-competitive. Also, CSP becomes economically competitive in the techno-optimistic and high fuel costs states in Spain. Interestingly, this is similar to the situation of geothermal in Italy.

Carbon price only scenario:

In Italy, all technologies are cost-competitive under this scenario. In Spain, however, nuclear, onshore wind and CSP are not cost-competitive in the low fuel cost and techno-pessimistic states with the former being more favorable for onshore wind and CSP. A carbon price greater than €67.57/ton-CO_2(eq) would allow for both these technologies to be favored whereas a price of €56.77/ton-CO_2(eq) would only allow CSP to be cost-competitive. In the base case, nuclear would be favorable at a carbon price of €53.33/ton-CO_2(eq) in Spain.

Subsidy-only scenario:

In Italy, all technologies are cost-competitive under this scenario as well. All technologies with the exception of nuclear are cost-competitive under this scenario. Nuclear is viable only under the techno-optimistic state. It may also be favorable at the high fuel costs state only if some additional form of support for its operation or investment at least to the equivalent of €4.28/MWh is made available in Spain. The generous tariffs for other technologies make them cost-competitive under this scenario despite the low carbon price.

Abundant support scenario:

In Italy, all technologies are cost-competitive under this scenario as well. The outcome for Spain is similar to the carbon-price-only scenario with respect to nuclear since there is no additional support except for the carbon price. Here, due to the high support levels, CSP and onshore wind becomes cost-competitive at all states. Continuing to provide forms of support for the other technologies that are nevertheless viable would lead to unwarranted costs for both the countries.

SCENARIO	ITALY					SPAIN				
	Base Case	**High Fuel Cost**	**Low Fuel Cost**	**Lower WACC**	**Higher WACC**	**Base Case**	**High Fuel Cost**	**Low Fuel Cost**	**Lower WACC**	**Higher WACC**
Minimal support	*Wind*		*Wind*		*Wind*	*Wind*		*Wind*		*Wind*
			Geo-thermal		*Geo-thermal*	*Nuclear*	*Nuclear*	*Nuclear*	*Nuclear*	*Nuclear*
					Solar PV			*CSP*		*CSP*
										Solar PV
Carbon price only								*Wind*		*Wind*
						Nuclear		*Nuclear*		*Nuclear*
								CSP		*CSP*
Subsidy only						*Nuclear*	*Nuclear*	*Nuclear*		*Nuclear*

Abundant support						*Nuclear*		*Nuclear*		*Nuclear*

Table 6. Summary of results from LCOE and scenario analysis

Note: Technologies in red indicate they are not cost-competitive and ones in blue denote that under certain conditions (carbon price or support levels) they may become competitive, as outlined above.

8. Conclusions

Both Spain and Italy assumed ambitious climate and renewables targets just as the Global Financial Crisis hit them with full force. Both countries were driven by European objectives, in the form of the 2020 Climate and Energy Package and in particular, the 2009 Renewables Directive, which unlike the previous incarnation, imposed binding constraints at the member state level. Unfortunately, neither Spain nor Italy had explicitly linked their Feed-in Tariffs to the underlying costs of renewables, which had a particularly large impact on solar PV support, since dramatically falling PV panel costs over the period 2007-2010 and unchanging tariffs made this very attractive as an investment and ended up imposing significant long-term liabilities on both Spain and Italy. Bazilian et al (2013) note that many decision-makers around the world were not able to fully appreciate the rapid decline in PV costs, which led some jurisdictions to neglect the potential importance of solar PV and other jurisdictions (such as Spain and Italy) to ignore the implications of these reductions for their support regimes and the potential liabilities that they were building up. Frustrated by the slow uptake of solar PV for the first half of the 2000's, Spain raised its FiT for PV in 2007 to levels that were considerably higher than that of Germany or other major European countries in spite of much higher solar insolation (and thus lower payback periods for Spanish investors). After a surge in solar investment in Spain in 2007, investment dropped back down before reviving when panel prices collapsed. In Italy, the surge in investment only came after panel prices fell dramatically from 2007-10, but also set levels significantly above those in Germany and many other member states. By contrast, Germany, which deployed some 30 GW of solar PV over roughly the same period in considerably less sunny climes and which weathered the economic downturn much more successfully, carefully tracked the costs of the technology. Onshore wind investment by contrast saw slow and steady growth across the entire period although by 2012 in Italy and Spain. The combination of Spain's larger fiscal problems and the tariff deficit led to all renewables support being cut off, whereas in Italy the subsidies were slashed dramatically.

In our scenario analysis, under most scenarios, except where there is a low carbon price in a zero subsidy world (*minimal support scenario*), renewables in Italy would be cost-competitive (against fossil fuels). Italy would find it difficult to increase the share of renewables in onshore wind, geothermal and solar PV (with varying degrees that are state-contingent) in case of a low carbon price under zero subsidy conditions while looking forward towards 2030. Spain, on the other hand, would struggle to improve the market penetration of renewables and nuclear power in most scenarios. In states where the fuel costs are high or when there is a large reduction in renewable investment costs, all low-carbon would be cost-competitive with the exception of nuclear power (in *minimal support* and *subsidy only* scenarios). Spain in particular would benefit from a high carbon price if onshore wind and CSP were to become favorable. Unsurprisingly, the *minimal support* scenario would lead to the least favorable outcome and the high subsidy scenarios (*abundant support* and *subsidy only*) are the most favorable in terms of renewables penetration for both countries. However, the *abundant support* scenario would incur unsustainable costs once these low-carbon options become cost-competitive.

Our scenario analysis offers the potential for higher levels of carbon price and/or renewable support. The current low carbon price as reflected in the EU emissions trading scheme (ETS) and the halting of renewable support in both Spain and Italy do not appear to bode well for our scenarios of high carbon price and/or renewable support. Yet, there is nothing in principle to say that it is not possible to design a programme of energy subsidies that maintains public support. As Clements et al (2014) note: “well-designed energy subsidy reform strategies can win public support”, the key is “a far-reaching communications strategy, appropriately phased energy price increases and targeted mitigating measures to protect the poor”. Some countries such as Germany have been able to design a renewables policy that has recognized the need to be able to link tariffs to the underlying technology costs and in so doing has helped restrain costs. By contrast, Italy, and especially Spain are naturally endowed with abundant solar radiation and so should have been able to design effective regulatory support mechanisms that were considerably less generous than Germany but that would still have incentivized investors with generous returns. Unfortunately, not only did both the Spanish and Italian governments ignore the potential for technology cost reductions to undermine their subsidy regimes, but the cost overruns took place largely after the onset of the devastating global financial crisis and it then took several years to correct, by which time both countries had accumulated significant deficits that have led not simply to reduction and correction but to a complete halt of most renewable subsidies.

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