UNIVERSIDAD PONTIFICIA COMILLAS

ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA (ICAI)

OFFICIAL MASTER'S DEGREE IN THE ELECTRIC POWER INDUSTRY

Master's Thesis

RES support in Spain: Distributional effects on residential consumers and comparison with a carbon tax and a tax based on the heat content

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Madrid, July 2014

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ABSTRACT

Using survey expenditure data of Spanish households, the present study analyses the distributional incidence of the costs of RES support that are included in the grid tariff. The grid tariff, which is paid by all electricity consumers within their electricity bill, is found to be highly regressive, i.e. the share of a household's electricity expenditure with respect its total expenditure decreases as disposable income increases. Thus, because electricity is a first necessity good, the current financing system of RES is questionable from the standpoint of fairness. The present study proposes a tax based on the heat and carbon content of several home and motor fuels as an alternative means to recover the cost of RES support. The existing studies suggest that energy is a less necessary good than electricity, mainly because motor fuel consumption more closely follows income than electricity consumption does. The findings of the present paper confirm this, specially for the use of diesel fuel under the carbon emissions scenario. In contrast to the grid tariff, the analysed proposals distribute less regressively RES surcharges among household income segments. Because of the nature of a carbon tax or a tax on the heat content, which levy a wider diversity of energy products, its costs would be more evenly distributed.

Keywords

Distributional effects, RES support, Carbon tax, Heat content tax.

RESUMEN

A partir de encuestas sobre el gasto de los hogares españoles, el presente estudio analiza el efecto distributivo de los costes de apoyo a las energías renovables incluidos en la tarifa de acceso a la red. La tarifa de acceso, que es pagada por todos los consumidores de electricidad a través de la factura eléctrica, ha resultado ser muy regresiva; esto es, la proporción del gasto en electricidad de un hogar con respecto a su gasto total disminuye a medida que aumenta la renta disponible de los hogares. Por lo tanto, y dado que la electricidad es un bien necesario, el actual sistema de financiación de las energías renovables es cuestionable desde un punto de vista equitativo. El presente estudio propone un impuesto basado en el contenido calorífico y el contenido en carbono de varios combustibles fósiles como un medio alternativo para recuperar el coste de apoyo a las renovables. Los estudios existentes sugieren que los combustibles son bienes menos necesarios que la electricidad, ya que el consumo de carburantes está más correlacionado con el nivel de ingresos del hogar que el consumo de electricidad. Los resultados del presente estudio confirman esta hipótesis, especialmente para el consumo de diesel en el escenario de emisiones de carbono. Por lo tanto, al contrario que la tarifa de acceso, las propuestas analizadas distribuyen menos regresivamente los costes de las renovables entre los distintos segmentos de renta de los hogares. Debido a la propia naturaleza de un impuesto sobre el carbono o de un impuesto sobre el contenido calorífico, los cuales implican a una mayor diversidad de productos energéticos, sus costes se distribuyen de manera más equitativa.

Palabras Clave

Efectos distributivos de la renta, Financiación de las energías renovables, Impuesto sobre el carbono, Impuesto sobre el contenido calorífico.

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I. INTRODUCTION

The growing concern about the consequences of climate change and the scarcity of natural resources has led governments and international organizations to set targets for reducing greenhouse gas emissions (GHG) and to support the development of alternative energies to reduce the strong dependence on conventional fossil fuels. In the European Union, the Climate and Energy Package sets a target of 20% reduction of GHG emissions compared to 1990 levels, and further determines that 20% of the energy consumed must be produced from renewable sources. At the European level, the EU Emissions Trading System (EU-ETS), which covers around 45% of total GHG emissions from the 28 Member States (MSs), is the key tool to reducing industrial GHG emissions. In addition to the European mechanisms to accomplish with the established objectives, each MS has adopted its own instruments to enhance the development of renewable energy projects. The support given to renewable energy sources (RES) is in the majority of MSs transferred to electricity consumers[1].

Looking at the particular case of Spain, consumers pay the incentives given to RES through the grid tariff. Because electricity is an important necessity good, this surcharge on the bill paid by consumers has a relevant impact on their disposable income. Surcharges are paid regardless of the income level of households, what make them more significant in low income segments than in high income ones, thus being *regressive* across households.

The objective of the present paper is to analyze the regressiveness of the grid tariff across Spanish households, and to compare this effect to the application of a carbon tax and a tax based on the heat content that would eventually levy all fossil fuels as an alternative means for recovering the cost of RES support. Because motor fuel consumption more closely follows income than electricity consumption does, we expect to demonstrate that both a carbon tax and a heat content tax would be less regressive than the grid tariff.

The paper is organized as follows. Section II describes the recent development of RES in the EU as well as the support schemes implemented in Spain and five other MSs and the regulatory applications and implications of environmental and energy taxes. Section III describes the data and methodology used to estimate the incidence of the grid tariff across income distribution as well as the incidence of an equivalent carbon tax and a taxed based on the heat content. Section IV illustrates the results obtained and finally, Section V summarizes the outstanding conclusions that can be derived from the analysis.

[1] Malta is the only MS where charges for the support of RES are financed through national taxes in the national budget (see ACER/CEER, '*Annual Report on the Results of Monitoring the Internal Electricity and Natural Gas Markets in 2012*').

II. STATE OF THE ART

1. LITERATURE REVIEW

In many countries where RES are becoming an important source of energy production, tariff design has at the same time become crucial on energy regulation. In a context were financial support to clean energy is exponentially increasing, cost-allocation of RES has awaken the interests of many investigators in the recent years, seeking to propose alternative methods that achieve the regulatory principles of competitiveness and cost-causality.

Given rising electricity prices in Spain, Batlle (2011) proposed a method to allocate RES subsidies to all final energy consumers in proportion to their final energy consumption, regardless of the origin of renewable energy (such as biofuels or wind or solar energy). The author demonstrated that, as the European objectives is for all RES energy, it would be both cost-effective (regarding the achievement of the targets), and equitable (across consumption of different fuels) to charge all forms of non-renewable energy. The methodology proposed by the author, he states, is consistent with the main objectives that should govern tariff design, which are to maximize efficiency and equity.

Furthermore, empirical studies support the presumption that motor fuel consumption increases with rising income more than home fuel consumption does. Among the examples, Callan *et al.* (2009) founded that a carbon tax in Ireland is more regressive for home heating consumption than for motor fuels. Strong differences between poor and rich income segments were found regarding motor fuel consumption: the top decile used 132% more than the bottom one, in contrast to home heating, which use was rather flat across the income distribution (the richest decile consumes only 8% more home fuels than the poorest one). Therefore, for Irish households (and specially for rural ones, which houses are bigger, distances are longer and more transport is by car than for urban households) a carbon tax is regressive, and this effect is more pronounced for home heating than for motor fuels. Additionally, using the SWITCH model (Callan *et al.*, 2008) of direct taxes and welfare payments to study the distributional implications of revenue recycling, the authors propose a modest increase in welfare payments to offset the negative impacts of a carbon tax in the lower half of the income distribution. Additional studies supporting the presumption that motor fuel consumption increases with rising income more than home fuel consumption does are those developed by Ekins *et al.* (2011) or Barker and Köhler (1998) for several European countries and Tiezzi (2005) for Italy.

In contrast to the regressivity of carbon taxation shown for Irish households, Labandeira *et al.* (1999), employing an input-output demand model to simulate price changes after the introduction of a carbon tax based on Spanish households' micro-data, determined that a carbon tax would not be regressively distributed across households in Spain. The authors explain that the proposed Spanish carbon tax would raise considerable tax revenue in terms of size and stability, due to the generalised dependence of developed countries upon CO_2 emissions and the difficulties in modifying behaviours in the short run. Also, that the carbon tax has limited environmental effectiveness. Finally, the study proposes that tax design should be jurisdictionally allocated to the Spanish central government because carbon taxes are a response to a global environmental problem that should be arranged from the wider possible authority. The model used by the authors in their analysis uses the quadratic extension of the Almost Ideal Demand Model of Deaton and Muellbauer

(1980) for simulation, thus providing an accurate representation of the behavioural responses to the carbon tax.

Other studies have also been done with the aim of comparing the distributional implications of carbon taxes versus the electricity surcharges paid by final-energy consumers to support RES. In their report of 2013 on 'Environmental energy taxes in Spain', Economics for Energy carries out several scenario simulations for the case of Spain: a) a scenario that implements a carbon tax on non EU-ETS sectors, b) a scenario that transfers the cost of RES subsidies by means of a tax to all energy products and c) a scenario that transfers the cost of RES subsidies to all the sectors of the economy. The tool used by the authors for the analysis is a *General Equilibrium Model with Electricity Detail* (GEMED) with a substantial microeconomic detail regarding production and consumption of electricity decisions with respect to location, temporality and technologies used. For the micro analysis of the effects of the different simulated policies, in order to reflect the effect on consumption levels when taxes are applied on energy products, the authors apply estimated price elasticity indexes for four energy products: electricity, natural gas, gasoline 95 and gasoil A. In the three scenarios analyzed on the report, distributional effects are determined by the change on electricity prices, which are the highest compared to the price changes on the other fuels analyzed. In this situation, the effects are very progressive, as the lower income households would have a bigger increase on their disposable income than the higher income ones.

Additional comparative studies between carbon taxes and RES financing have been developed outside Spain. This is the case for Italy, where Stefano F. Verde and Maria Grazia Pazienza (2013) investigated the incidence, across income distribution, of the electricity surcharge used to recover the cost of RES support in Italy (the 'Componente tariffaria A3'). In the study, the surcharge, which is funded on electricity consumption, has resulted to have an important regressive impact. As an alternative to the A3, the authors consider a carbon tax applied to all CO_2 emissions, as such a tax would be less regressive for Italian households given their demand elasticities and consumption patterns. The authors also highlight the differences on the impacts caused by the A3 much more than the carbon tax on the south, central and northern regions of the country, given the different climatic and wealth conditions among them.

2. RES SUPPORT MECHANISMS IN SPAIN AND EUROPE

The comparatively higher cost of RES technologies has made them impossible to grow without regulatory intervention. The fast and large penetration of RES in many European power systems has turned the focus on how best to design subsidy regimes to ensure a proper development of RES. The regulatory incentives that have motivated the quick (and in some cases unexpected) development of clean technologies, have increased public and private concern about the impact of RES on costlier energy bills, their potential to displace from the market older and more polluting technologies and the effect of intermittent primary energy on the system's reliability of supply.

In Europe, direct support methods are the most widely implemented schemes to incentivize RES. Price-based mechanisms, such as Feed-in-Tariffs (FiT) and Premia (FiP) are a popular form of support in Spain and Germany, two European countries with the largest renewable energy generation of the UE. On the other hand, quantity-based mechanisms, such as Renewable Obligations (RO) are the key tool for incentivizing RES in the UK and the U.S. The main purpose of the present section is to give an overview of the main support schemes implemented in Spain and other four Member States, namely Germany, France, Italy and UK and to determine the weight of the costs of such mechanisms in end-consumers, to which costs are always passed-through.

2.2 THE EVOLUTION OF RES IN THE EUROPEAN UNION

The great evolution of RES in some MSs of the EU has been driven by national regulatory programs along with European mandatory national targets that have strongly incentivized investment and technology development in clean energies. Moreover, with the EU's 2030 and 2050 framework for climate and energy policies[2] it is reasonable to think that the trajectory for additional renewable capacity will continue to grow with more or less intensity in all MSs.

2.1.1 The European Climate and Energy Targets for 2020

In 2009, under the 2020 Climate and Energy Package, the European Union set the following three climate and energy objectives known as the '20-20-20' targets to be achieved by 2020:

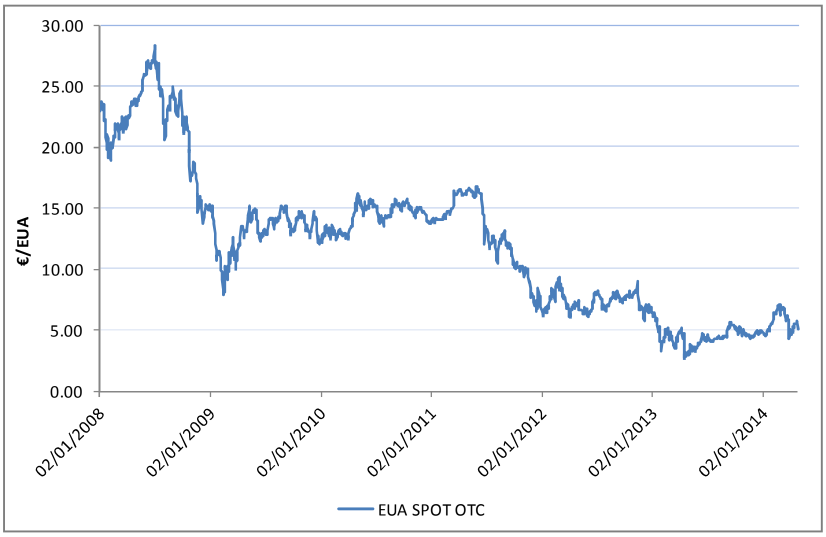
- A 20% reduction in EU greenhouse gas emissions from 1990 levels.
- Raising the share of EU energy consumption from renewable resources to 20% and specifically for transport in 10%.
- A 20% improvement in the EU's energy efficiency.

Regarding the GHG reduction objective, the European Union Emissions Trading System (EU ETS) is the key tool for cutting industrial greenhouse gas emissions, covering around 45% of the EU's total emissions. However, and although the EU ETS is the largest GHG market for emissions reductions allowances in the world[3], its price has sharply decreased since the beginning of the second phase of the market, from 23€/EUA in 2008 to 5€/EUA in 2014 mainly due to the surplus of allowances caused by the economic and financial crisis.

[2] The EU's targets for 2030 are to reduce GHG emissions by 40% below the 1990 level (80-95% for 2050) and to increase the share of RES to at least 27%.

[3] According to the European Commission's factsheet about the EU ETS, 7.9 billion allowances were traded in 2012.

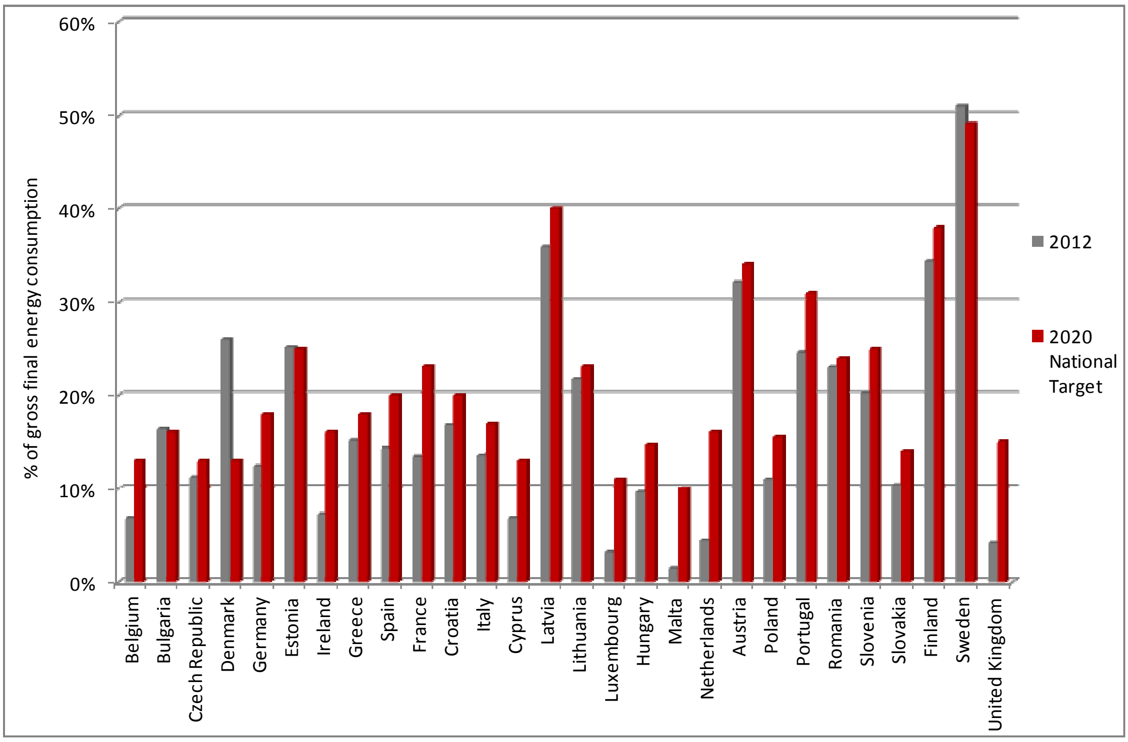
Figure 1: Price evolution of the EUA certificate (Spot OTC - €/tCO2eq)



Source: Own compilation from Sendeco2's webpage.

With regard to the RES objective, the Renewable Energy Directive 2009/28/EC establishes binding national targets for all MS that range from 10% for Malta to 49% for Sweden, depending on each Member's standpoint position and potential increase in RES production. *Figure 2* below shows how in 2012 some countries had already achieved in 2012 their national target (Sweden, Denmark, Estonia and Bulgaria).

Figure 2: Share of RES in gross final energy consumption as of December 2012 (%)



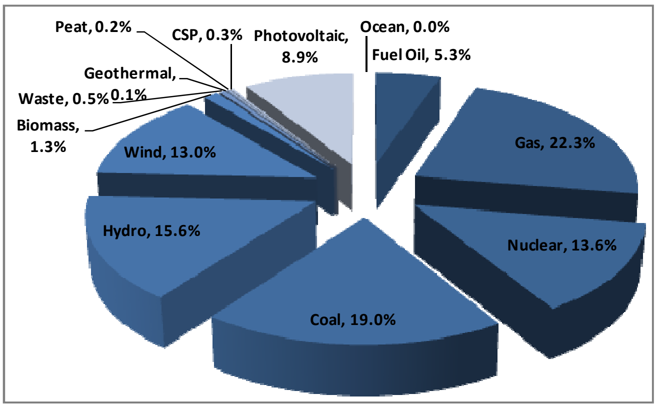
Source: Own compilation from Eurostat and Directive 2009/28/EC for targets.

2.1.2 RES installed capacity in the European Union

According to the European Statistics Report 2013 published by EWEA, renewable capacity increased approximately 60% for the period 2000-2013, from 25% of total power capacity in 2000 to 39.6% in 2013 (including large hydro). The greatest growth corresponds to wind technology, which accounts for 13% of total RES installed capacity in the EU.

By MS, Germany (71 GW), Spain (31 GW) and Italy (29 GW) are the countries with higher RES capacity in the EU (excluding hydro)[4].

Figure 3: Distribution of installed power capacity in the EU as of December 2013 (%)

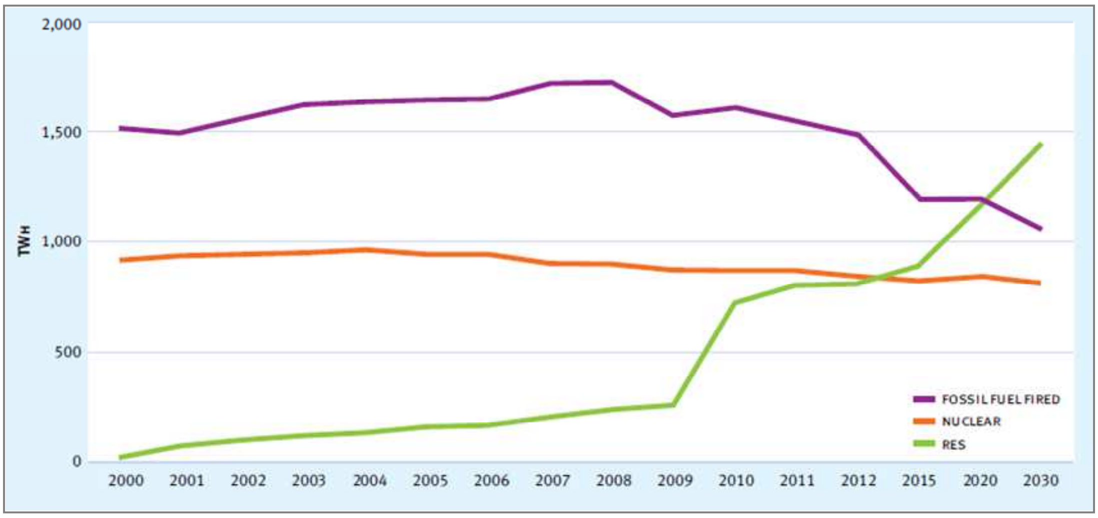


Source: EWEA, Wind in Power: 2013 European Statistics'.

2.1.3 RES generation in the European Union

The share of RES generation in the EU accounted for 22.38% in 2012. While generation from fossil fuels (48.38%) and nuclear (27.01%) has decreased over the last four years (except coal-fired generation which has increased 13% in 2012 with respect to 2011 mainly due to the significant drop in the use of gas for electricity), RES generation has experienced a year-on-year increase of 7%[5]. The trend is that RES generation will continue to grow through the coming years and studies suggest that it will become the second electricity source by the end of the decade[6].

Figure 4: Forecasted evolution of electricity by primary energy in the European Union

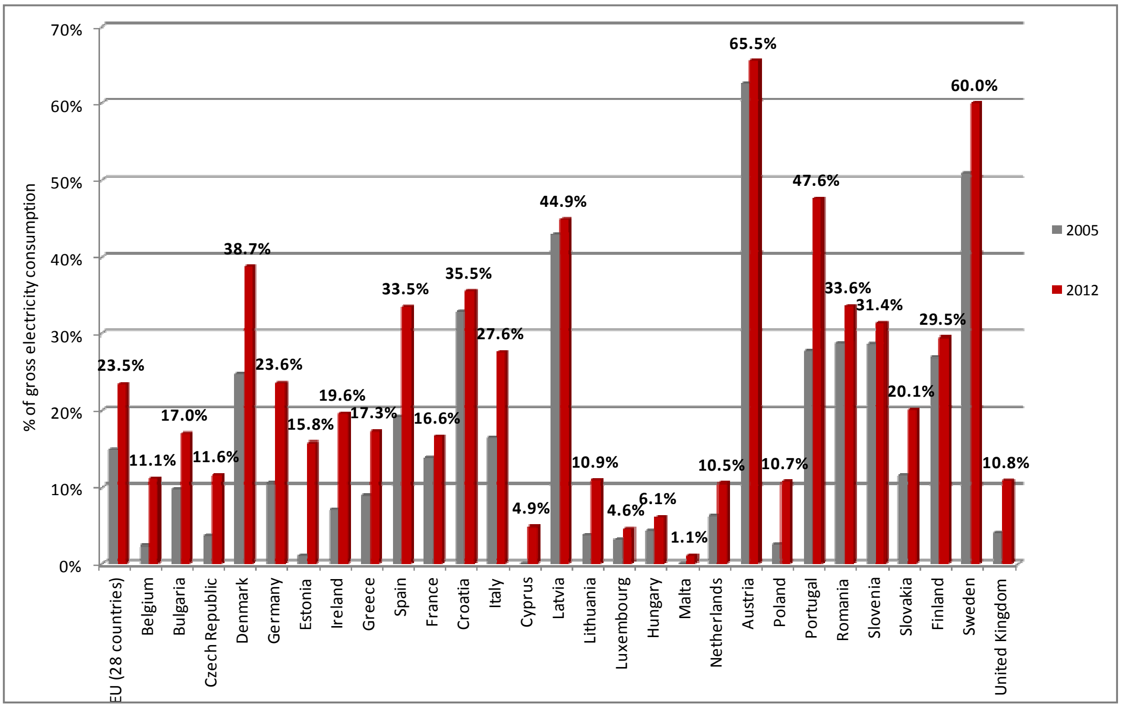


Source: Euroelectric, 'Power Statistics & Trends 2013'.

By MS, the share of electricity generated from RES from total gross electricity consumption is shown on *Figure 5*.

[4] 2012 data from REN21, '*Renewables 2013: Global status report*'.
[5] Euroelectric, '*Power statistics and trends 2013*'.
[6] Euroelectric ('*Power statistics and trends 2013*'), European Commission ('*EU Energy, Transport and GHG emissions: Trends to 2050*').

Figure 5: Share of electricity generated from RES from gross electricity consumption in 2005 and 2012 (%)



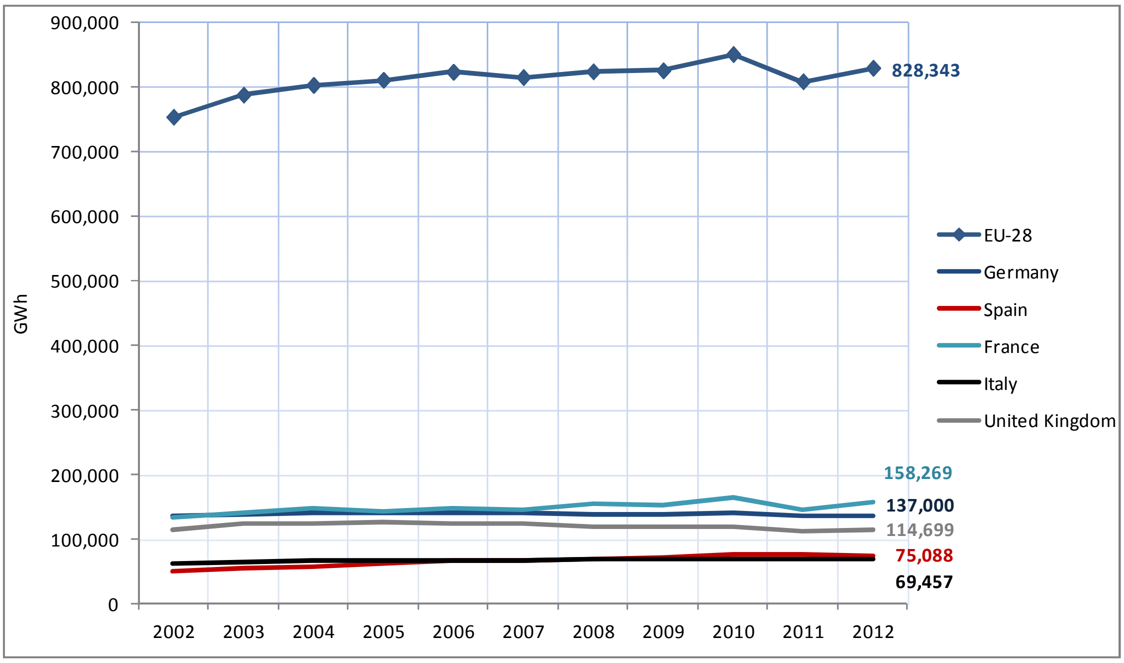
Source: Own compilation from Eurostat.

2.1.4 Retail electricity market in the European Union

2.1.4.1 <u>Households' electricity consumption</u>

According to last Eurostat's data available at the time of writing, households' electricity consumption in the EU in 2012 increased 2.6% with respect to 2011. By MS, the highest increase in residential consumption took place in France (9%), in contrast to Portuguese households which consumption was reduced 6.2%.

Figure 6: Electricity consumption of households (GWh)

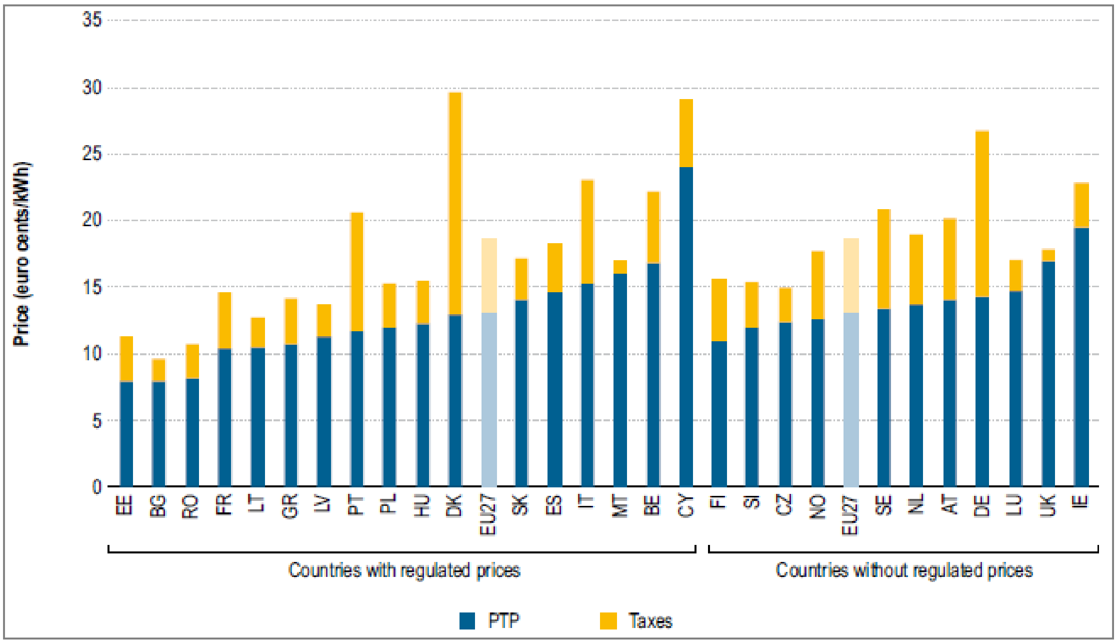


Source: Own compilation from Eurostat.

2.1.4.2 Electricity prices for final-energy consumers

According to the annual report on electricity and natural gas markets published by the Agency for the Cooperation of Energy Regulators (ACER) and the Council of European Energy Regulators (CEER), electricity prices rose significantly in 2012 for both households and industrial consumers in the majority of EU-27 MSs. On average, post-tax electricity prices increased by 4.6% for households and by 5.2% for industrial consumers between 2011 and 2012. Large disparities in pre-tax electricity exist across the EU. In most MSs, household energy prices are greatly influenced by taxation and network charges, which usually make up more than half the total energy bill. In a few years, these charges have significantly increased in many MSs, particularly as a result of costs related to support schemes for renewable energy sources. *Figure 7* shows the evolution and the differences among MSs on gross (POTP)[7] and net (PTP)[8] prices, which range between 9.55 to 29.72€cents/kWh in Europe.

Figure 7: Electricity net and gross prices for households in 2012 (€cents/kWh)



Source: ACER & CEER, 'Annual Report on the results of monitoring the internal electricity and natural gas markets in 2012'.

Gross and net price differences for industrial consumers were smaller, ranging from 9.15 to 27.32€cents/kWh[9], compared to household consumers. These differences reflect the more developed role of retail liberalisation in the industrial segment. In addition, in some countries, such as Germany (as we will see in section 2.3.1), some energy-intensive industrial segments, depending on the level of consumption, are exempted from certain tax and levy components added to the total price.

Moreover, in 26 out of 28 countries, gross electricity prices for households exceeded prices charged to industry. The differences between total prices for household and

[7]The POTP is defined as the sum of the electricity price, regulated transmission and distribution charges, and retail components (billing, metering, customer services and a fair margin on such services) plus VAT, levies (local, national, environmental) and any surcharges.

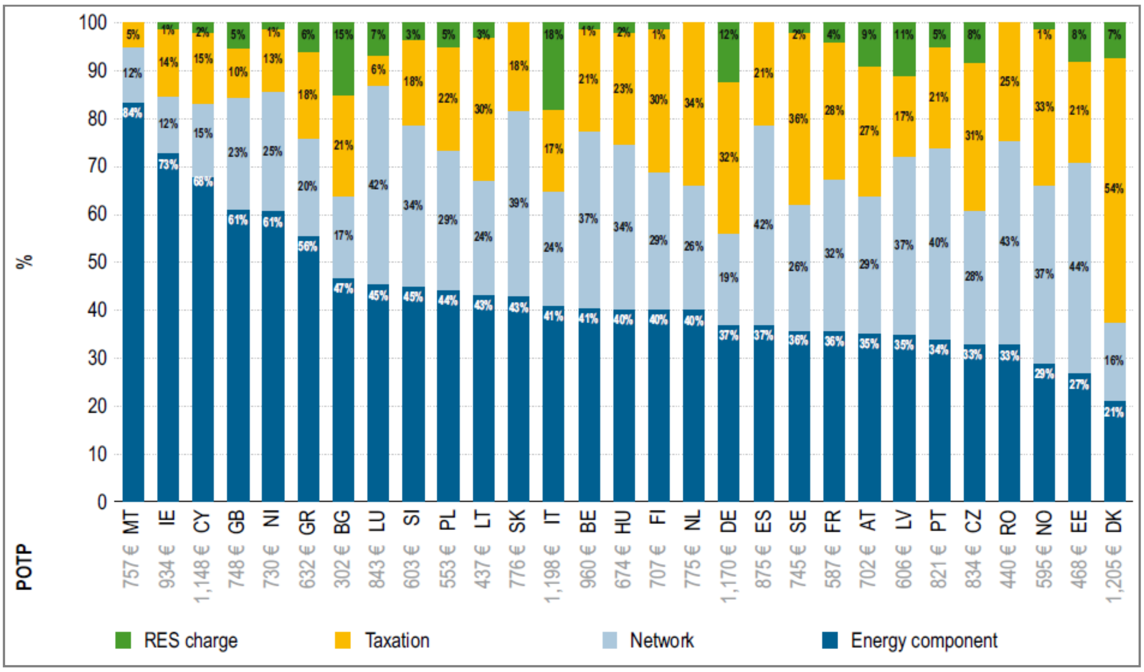
[8]The PTP is de POTP without adding the VAT, levies and surcharges.

[9] ACER/CEER, '*Annual Report on the results of monitoring the internal electricity and natural gas markets in 2012*'.

industrial consumers in net terms were the highest in Sweden (11.1€cents), followed by Belgium (7.2€cents) and Ireland (5.9€cents).

In order to understand the price differences among MSs, *Figure 8* shows the electricity price structure of each country as of December 2012. The energy component (which includes a margin, costs for marketing, billing and other related costs to run the supplier's business) represents less than half of the total energy bill for the majority of MSs. With regard to RES financing, the RES surcharge from the total energy bill can range from 18% (in Italy) to 1% (in Ireland). For the Spanish and the Romanian cases, no RES charge is differentiated from the energy bill as RES support is included within the grid tariff set by the government (Spain) or included in the energy component (Romania).

Figure 8: POTP break-down of households living in capital cities as of December 2012 (%)



Source: ACER & CEER, 'Annual Report on the results of monitoring the internal electricity and natural gas markets in 2012'.

2.3 MECHANISMS USED TO SUPPORT RES IN THE EUROPEAN UNION

In this section we will analyze the RES support mechanisms implemented in five MSs: Germany, France, Italy, the United Kingdom and Spain.

2.3.1 Mechanisms used to support RES in Germany

In Germany, the Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz – EEG), which came into force on January 2012, provides two price-based mechanisms to support RES. On the one hand, a feed-in tariff (FiT) in which the operator of the installation receives a fixed payment for every kilowatt hour produced exported to the grid. The transmission grid operators are entitled to sell this electricity on the spot market on the electricity exchange.

On the other hand, renewable energy generators who directly feed their electricity into the grid may claim a premium on top of the electricity market price. Under the FiP scheme, RES producers have to market their electricity themselves and receive from the Transmission System Operator (TSO) the difference between the FiT a plant would be entitled to receive and the average market price of the electricity sold. Additionally, under this mechanism installations receive a management premium designed to cover additional costs incurred for participating in the market[10]. The support given to RES generators is known as the EEG reallocation charge or EEG Umlage.

Furthermore, RES generators are given priority to grid connection, and grid operators are obliged to give them priority when purchasing and transmitting electricity. Finally, grid operators are statutorily entitled to immediately expand the grid upon the request of any RES generator in feeding electricity into the grid.

2.3.1.1 Total costs derived from RES support in Germany

For the year 2012, the total compensation given to RES installations under the EEG accounted for 19,118 million Euros. *Table 1* shows the technologies that have benefited from the supports as well as the electricity production and payments made under the EEG.

Table 1: Electricity production and payments under the Renewable Energy Sources Act (EEG)

		2000	2002	2004	2006	2008	2010	2011	2012
Hydropower gases		4,114	6,579	4,616	4,924	4,982	5,665	4,843	5,417
Gases		-	-	2,589	2,789	2,208	1,963	1,815	1,769
Biomass		586	2,442	5,241	10,902	18,947	25,155	27,977	34,321
Geothermal energy		-	-	0	0	18	28	19	25
Wind energy on lnad	GWh	5,662	15,786	25,509	30,710	40,574	37,619	48,315	49,948
Wind energy at sea (offshore)		-	-	-	-	-	174	568	722
Solar irradiation energy		29	162	557	2,220	4,420	11,729	19,599	26,128
Total EEG electricity		**10,391**	**24,969**	**38,512**	**51,545**	**71,149**	**82,333**	**103,136**	**118,330**
of which directly marketed electricity		-	-	-	-	-	1,587	11,650	51,163
Total compensation	M€	**883**	**2,225**	**3,611**	**5,810**	**9,016**	**13,182**	**16,763**	**19,118**
Average EEG compensation rate	cent/KWh	8.50	8.91	9.29	10.87	12.25	15.53	15.87	15.62
Total final consumption		344,663	465,346	487,627	495,203	493,506	485,465	462,205	489,006
of which privileged final consumption	GWh	-	-	36,865	70,161	77,991	80,665	85,118	86,127
Total RES-E		36,042	45,110	56,632	71,638	93,247	104,810	123,775	142,418
of which not entitled to EEG compensation		25,651	20,140	18,121	20,093	22,099	22,478	20,639	24,088

Source: Federal Ministry of the Environment, Nature Conservation and Nuclear Safety, 'Renewable Energy Sources in Figures'.

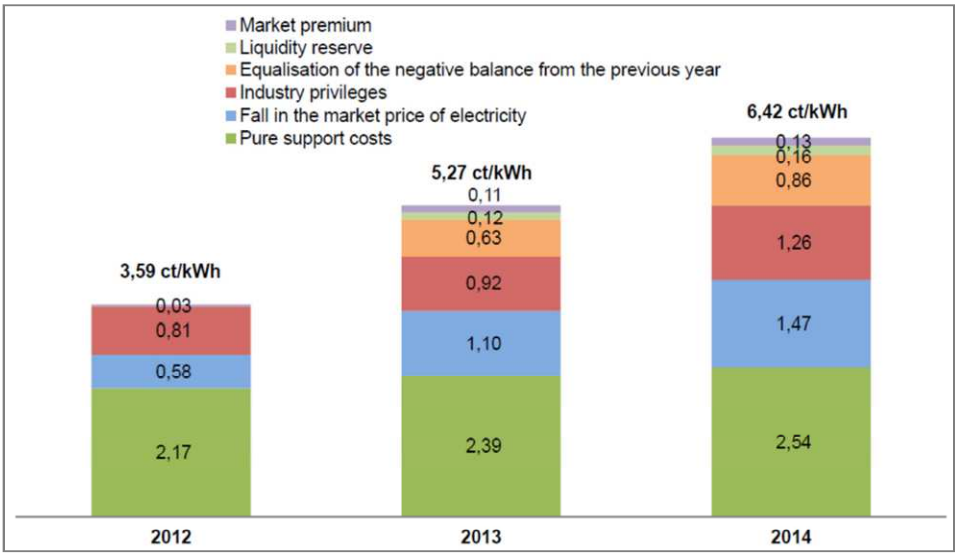
2.3.1.2 Financing of RES support mechanisms in Germany

The EEG Umlage is allocated among *non-privileged* final consumers. The Equalisation Scheme Ordinance (AusglMechV) exempts electricity-intensive enterprises and rail operators (known as privileged consumers) with a minimum electricity consumption of 1GWh per year and with electricity costs accounting for 14% of the company's gross value from paying the EEG surcharge. In 2013, nearly 18% of the total power consumption was subject to the EEG exemption.

According to calculations by the German TSOs, the EEG surcharge for 2014 will be of 6.42€cents/KWh, compared to the 5.277€cents/KWh in 2013. *Figure 9* shows the evolution of the composition of the EEG surcharge since 2012.

[10] As explained on Annex 4 of the EEG 2012, the additional costs are those of the stock exchange admission, the trading connection, the transactions for recording the current values and billing, for the IT infrastructure, for staff and services, for preparing forecasts and for variations of the actual feed-in compared to the forecast.

Figure 9: Annual evolution of the EEG Umlage (€cents/kWh)

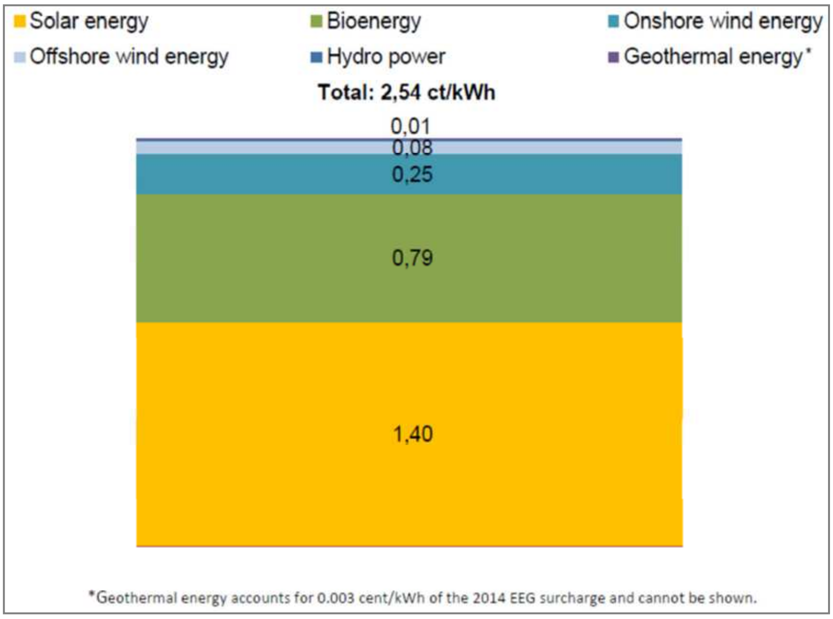


Source: Bundesverband Erneuerbare Energie e.V. (BEE), 'The EEG surcharge for 2014'.

According to the German Renewable Energy Federation (BEE), the main factors that determine the increase of the EEG surcharge in 2014 with respect to 2013 are the price decrease on the electricity market (36%) and the expansion of energy privileges (specially for the energy-intensive manufacturing industry – 33%).

The pure costs of financing renewable energy account for 2.54€cents/kWh of the EEG surcharge in 2014, from which more than the half are destined to solar energy. In 2014, this RES surcharge represents 6.3% more with respect to 2013.

Figure 10: EEG surcharge 2014 without extraneous costs (€cents/kWh)

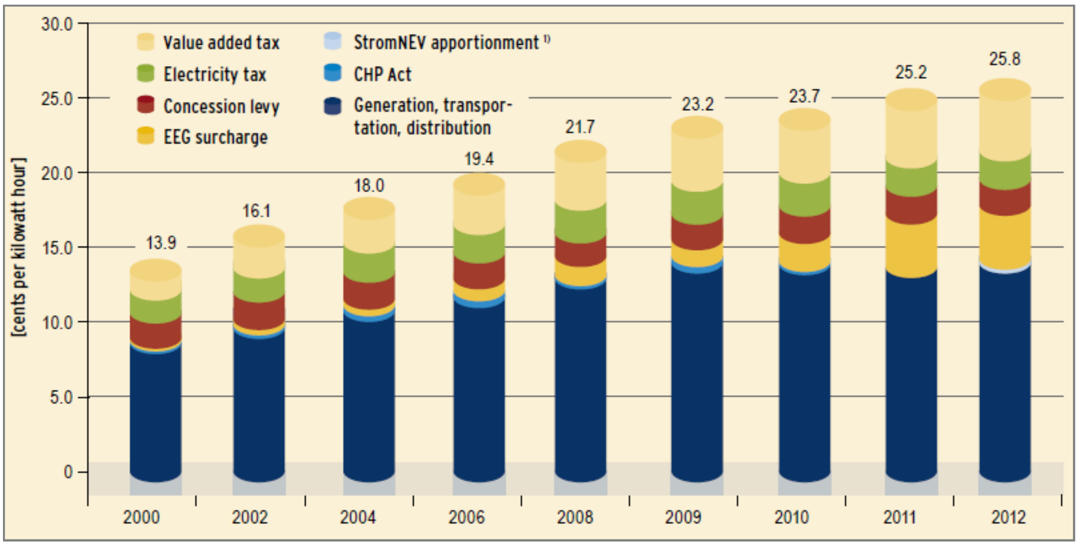


Source: Bundesverband Erneuerbare Energie e.V. (BEE), 'The EEG surcharge for 2014'.

2.3.1.3 <u>RES financing impact on German households</u>

As shown on *Figure 11*, household consumers paid in their 2012 electricity bill 25.8€cents/kWh, where RES accounted for 13.91%.

Figure 11: Cost components for household consumers (€cents/KWh)



Source: Federal Ministry of the Environment, Nature Conservation and Nuclear Safety, 'Renewable Energy Sources in Figures'.

2.3.2 Mechanisms used to support RES in France

The French Energy Code, which comprises the 'Grenelle Laws' ('Grenelle I' on August 3rd 2009 and Grenelle II on July 12th 2010) aims to enhance the development of RES by the establishment of two major price-based support mechanisms. First, a power purchase obligation is set to all electricity distributors to buy energy produced from renewable sources at a fixed price. Installations can benefit from the purchase obligation at a FiT provided their installed capacity does not exceed 12MW along with those facilities that implement energy efficiency techniques such as cogeneration. Exemptions are set for land-based installations using mechanical wind energy in an interconnected area to the continental metropolitan network.

The other major mechanism to support RES are calls for tender in which installations with a greater installed capacity of 12MW can participate. This mechanism is used to determine *ex ante* the quantity of renewable energies benefiting from public support.

2.3.2.1 Total costs derived from RES support in France

In 2012, total costs of RES and cogeneration accounted for €3.4 billion and the 'Commission de Régulation de l'énergie' (CRE) estimate them to be of €4.1 billion in 2014. Solar PV has received the greatest share of the support and tends to increase until 2014, in contrast to cogeneration, which estimated costs tend to reduce in the last three years. *Table 2* shows the costs of the support given to each technology type.

Table 2: Confirmed and estimated costs of RES support by technology (million €)

	Confirmed costs for 2012 [M€]	Estimated costs for 2013 [M€]	Estimated costs for 2014 [M€]
Wind (MA)	550.0	564.9	854.6
Wind (NIA)	5.4	6.6	5.8
Solar PV (MA)	1,683.2	1,898.7	2,146.6
Solar PV (NIA)	197.4	208.1	246.8
Other RES-E (MA)	228.4	330.1	459.2
Other RES-E (NIA)	9.0	10.4	9.5
Total RES-E	**2,673.4**	**3,018.8**	**3,722.5**
Cogeneration (MA)	**743.8**	**527.5**	**412.1**
TOTAL	**3,417**	**3,546**	**4,135**

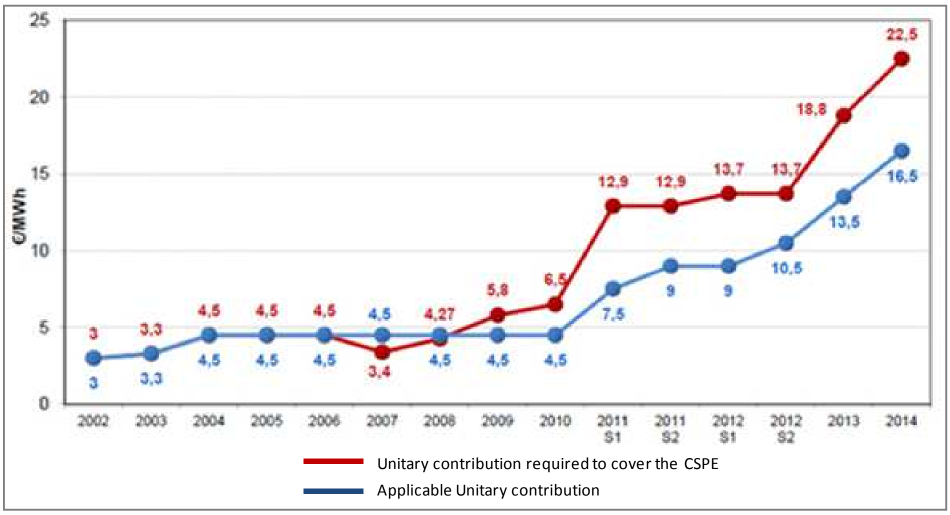
MA: Metropolitan Area
NIA: Non Interconnected Area

Source: Commission de Régulation de l'Énergie (CRE), 'Déliberation de la Commission de Régulation de l'énergie du 9 octobre 2013 portant proposition relative aux charges de service public de l'électricité et à la contribution unitaire pour 2014'.

2.3.2.2 Financing of RES support mechanisms in France

The costs resulting from the mechanisms to support cogeneration and renewable energy production are covered by the 'Contribution au Service Public de l'électricité' (CSPE) in the consumers' electricity bill. The CRE estimates de costs of the CSPE for the year 2014 at €6.2 billion, 28% more than for the year 2012 and 21% with respect to 2013. In reality, the overall CSPE projected for 2014 is estimated at €8.4 billion, where €6.2 billion correspond to projected expenses for 2014 and approximately €2.2 billion to cost regularisations for the year 2012. Thus, the overall required unitary contribution to cover the CSPE in 2014 is estimated by the CRE to be 22.5€/MWh, including both 2014 expenses and 2012 regularisations. However, Article L.121-13 of the Energy Code limits the rise on the unitary contribution to 3€/MWh with respect the year before, therefore setting the surcharge for 2014 at 16.5€/MWh. *Figure 12* shows the evolution and the difference between the applicable unitary contribution and the unitary contribution that would cover all CSPE costs.

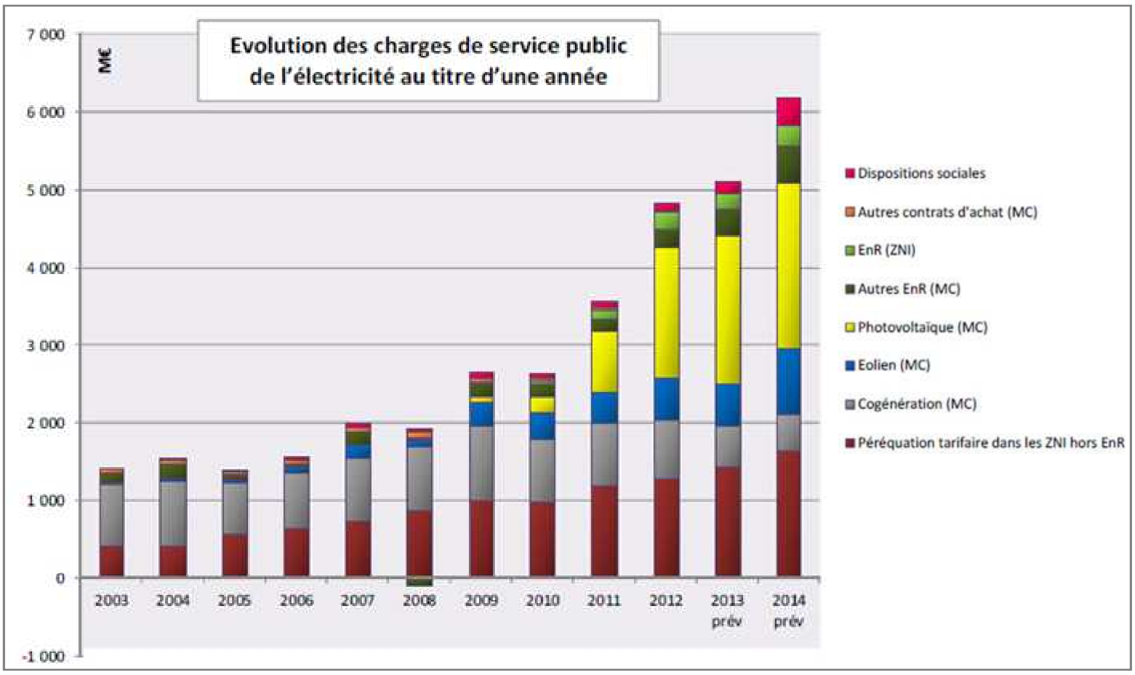
Figure 12: Annual evolution of the unitary contribution (€/MWh)



Source: Commission de Régulation de l'Énergie (CRE).

The strong evolution of the CSPE through the last twelve years is shown on *Figure 13* below. The increase in costs between 2010 and 2014 is explained by the development of the photovoltaic and wind industries, both representing 60% of the total surcharge in 2014. Along with cogeneration, the portion increases up to 67.4%.

Figure 13: Annual evolution of the CSPE (million €)



Source: Commission de Régulation de l'Énergie (CRE).

The contribution is payable by all end electricity consumers in proportion to the kWh consumed (including self-producers). However, some exemptions are applied to big electricity producers and consumers:

- Electricity producers may benefit from an exemption from contribution on the produced and self-consumed electricity up to 240GWh per production site.
- The total contribution per production plant is limited to €597,889 in 2014.
- The contribution for industrial companies consuming more than 7GWh is limited to 0.5% of their added value.

Table 3 shows the estimated supported CSPE surcharge by sector in 2014:

Table 3: Estimated supported costs by sector in 2014 (million €)

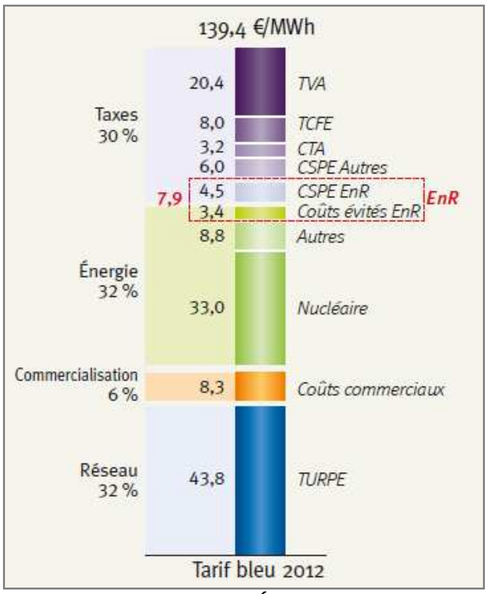
Sectors	M€	Share [%]
Residential	2,112	34%
Small & Medium Enterprises	3,393	54%
Small Professionals	759	12%

Source: Commission de Régulation de l'Énergie (CRE).

2.3.2.3 RES financing impact on French households

The cost of RES is transferred to the consumers' bill via two different ways. On the one hand, customers pay the rate corresponding to the electricity produced by renewable energy and purchased by the distribution companies, valued at wholesale market prices. On the other hand, customers face the CSPE, a fraction of which finances the additional costs of RES supported. As shown on *Figure 14*, the total cost of RES supported by a residential customer represents 5.7% (7.9 €/MWh) of the overall tariff paid.

Figure 14: Components of a 'Tarif Blue' bill in 2012 (€/MWh)



Source: Commission de Régulation de l'Énergie (CRE), 'Rapport d'activité 2012'.

2.3.3 Mechanisms used to support RES in Italy

In Italy, a variety of price-based and quantity-based support mechanisms have been in place since 1992. The four major mechanisms in force in Italy are described below:

- 'CIP 6/92' is a FiT that guarantees a fixed price for RES generators for up to 15 years. Apart from RES generators, other generation including cogeneration, energy-from-waste as well as generation using fossil fuels from minor isolated deposits are eligible to benefit from the CIP.
- A tradable green certificates scheme, namely 'Certificati Verdi', in which green certificates are surrendered by conventional generators in proportion to the electricity produced from renewable energy plants put in operation after April 1st, 1999. In the last years, there has been an excess of supply on the market of green certificates. Unsold certificates are purchased by the system operator ('Gestore dei Servizi Energetici' – GSE). However, as of 2013, no more certificates are being issued and the ones still on the market will expire in 2015.
- A FiT mechanism which guarantees a fixed price exclusively for photovoltaic plants for up to 20 years, called 'Conto Energia'. As a result of the last adjustment made to the mechanism, in 2012 the annual cumulative cost of the scheme was limited to €6.2 billion. This frontier was reached on June 2013, as from when no more installations are eligible to receive the FiT.
- 'Tariffa Onnicomprensiva', a FiT scheme for which only small non-photovoltaic installations are eligible (up to 1MW except for wind plants where the limit is set at less than 200 KW). Eligible generators have to choose between being subject to the 'Tariffa Onnicomprensiva' or the 'Certificati Verdi' scheme.

2.3.3.1 Total costs derived from RES support in Italy

Table 4 shows the different RES technologies supported in 2012 by the different schemes already mentioned. 'Conto Energia', which exclusively supports solar PV technology, accounts for more than the half of the overall supported costs.

Table 4: Costs of RES Support Mechanisms in 2012 (million €)

	Certificati Verdi	Tariffa Onnicomprensiva	CIP6	Conto Energia	Total by Source	Share by Source
Hydro	426	187	-	-	**613**	**7%**
Wind	701	4	38	-	**743**	**8%**
Solar PV	-	-	-	6,036	**6,036**	**66%**
Geothermal	11	-	-	-	**11**	**0%**
Bioenergies	221	865	710	-	**1,796**	**20%**
Total by Mechanism [M€]	**1,359**	**1,056**	**748**	**6,036**	**9,199**	**100%**
Share by Mechanism [%]	**15%**	**11%**	**8%**	**66%**	**100%**	

Source: Gestore Servizi Energetici (GSE).

2.3.3.2 Financing of RES support mechanisms in Italy

The costs of RES support in Italy are recovered through a specific surcharge called 'Componente tariffaria A3' (A3). The A3 rate is different depending on the consumer type (residential or industrial) and the consumption level, and it is revised by the market regulator ('Autoritá per l'Energia Elettrica e il Gas' – AEEG) every three months. On *Table 5* are shown the rates applied for residential consumers on the last quarter of 2013[11]:

Table 5: Componente Tariffaria A3 per residential user type (2013 Q4) - €cents/kWh

	Annual consumption [KWh]		
Consumer Type	**< 1800**	**1800 - 2640**	**> 2640**
D2	€ 4.305	€ 5.879	€ 4.334
D3	€ 4.863	€ 4.863	€ 4.863

Source: Autorità per l'Energia Elettrica, il Gas e il sistema idrico (AEEG).

2.3.3.3 RES financing impact on Italian households

The A3 is included within the retail prices paid by residential consumers. *Table 6* shows the evolution of the retail prices for the last 4 years. The relative weight of system services' costs (which represent 90% of the A3 surcharge) account for nearly 20% of the overall surcharge in the 4th quarter of 2013, a figure that has doubled since the 1st quarter of 2008.

Table 6: Annual evolution of retail electricity prices for a representative residential consumer

	2008 Q4		2009 Q4		2010 Q4		2011 Q4		2012 Q4		2013 Q4	
Component	**Euros [c/KWh]**	**Share [%]**	**Euros [c/KWh]**	**Share [%]**	**Euros [c/KWh]**	**Share [%]**	**Euros [c/KWh]**	**Share [%]**	**Euros [c/KWh]**	**Share [%]**	**Euros [c/KWh]**	**Share [%]**
Network costs	2.4	13.2%	2.5	15.1%	2.5	16.2%	2.5	15.1%	2.6	13.2%	2.8	14.6%
System services	**1.3**	**7.3%**	**1.4**	**8.2%**	**1.6**	**10.0%**	**2.2**	**13.6%**	**3.3**	**16.8%**	**3.7**	**19.5%**
Taxes	2.5	13.7%	2.3	14.1%	2.2	14.4%	2.3	14.1%	2.6	13.3%	2.5	13.3%
Energy costs (procurement and sale)	11.9	65.8%	10.4	62.7%	9.3	59.5%	9.4	57.2%	11.0	56.7%	10.0	52.7%
Total	**18.1**	**100.0%**	**16.6**	**100%**	**15.6**	**100%**	**16.5**	**100%**	**19.4**	**100%**	**19.0**	**100%**

Source: Autorità per l'Energia Elettrica, il Gas e il sistema idrico (AEEG).

[11] The classification of residential users is done, a) whether the dwelling is the place of residence and the committed capacity is not greater than 3kW (D2); b) whether the dwelling is not the place of residence, regardless of the committed power capacity level (D3).

2.3.4 Mechanisms used to support RES in the United Kingdom

In the United Kingdom, RES are supported through three regulatory instruments: a FiT, a tradable quota system and a tax on fossil fuels. The Energy Act, which received Royal Assent in the UK on December 2013, has introduced changes to the existing support mechanisms for RES under the Electricity Market Reform (EMR). The functioning of the implemented mechanisms is as follows:

- The FiT scheme was introduced on April 2010 regarding small scale RES projects. Photovoltaic, wind, hydro and anaerobic digestion projects with less than 5MW of installed capacity (and less than 10 MW for community photovoltaic projects) receive a regulated fixed tariff (the FiT) established by the regulator (Ofgem). Additionally, micro-combined heat and power installations with a total installed capacity of less than 2kW are also eligible to receive the FiT.
- The Renewables Obligation (RO) scheme, introduced in England, Wales, Scotland (in 2002) and in Northern Ireland (in 2005), is the main support for RES. The market regulator issues Renewables Obligation Certificates (ROCs) to accredited electricity generators of more than 5MW capacity relating to the amount of eligible renewable electricity they generate. Generators sell the ROCs to suppliers or traders what allows them to receive a premium in addition to the wholesale market price. The price of the ROC is defined by negotiation between both parties. On their side, electricity suppliers and traders have the obligation to source a proportion of their electricity from renewable generation to consumers. The Department of Energy & Climate Change (DECC) establishes each year the level of the obligation as well as the buy-out price, i.e. the payment to be made by the supplier for the ROCs not presented for compliance to the regulator plus 10%. The proceeds of the buy-out fund are paid back to suppliers in proportion to how many ROCs they have presented. *Table 7* shows the buy-out prices and obligation levels set for compliance since the start of the scheme.

Table 7: Obligation level and buy-out price for each year of the RO

Obligation period (1st April - 31st March)	Buy-out price	Obligation for England & Wales and Scotland (ROCs per MWh of electricity supplied)	Obligation for Northern Ireland (ROCs per MWh of electricity supplied)
2002-2003	£30.00	0.030	
2003-2004	£30.51	0.043	
2004-2005	£31.39	0.049	
2005-2006	£32.33	0.055	0.025
2006-2007	£33.24	0.067	0.026
2007-2008	£34.30	0.079	0.028
2008-2009	£35.76	0.091	0.030
2009-2010	£37.19	0.097	0.035
2010-2011	£36.99	0.111	0.0427
2011-2012	£38.69	0.124	0.055
2012-2013	£40.71	0.158	0.081
2013-2014	£42.02	0.206	0.097

Source: Ofgem

The RO scheme will close to all generators in 2037. With the objective of reducing price volatility on the RO market, from 2027 the DECC will fix the price of the ROC for the remaining 10 years of the RO at its long-term value and will buy the ROCs directly from the generators.

On 31st March 2017, the RO will close to new generators and the scheme will transit to a Contract for Difference (CfD) mechanism. The CfD is defined as a contract between the generator and a new government-owned counterparty which aim is to reduce the risks faced by low-carbon generators by paying a variable top-up between the market price and a fixed price level, known as the 'strike price'. The CfD mechanism is intended to protect consumers by ensuring that generators pay back when the price of electricity goes above the strike price.

- Moreover, commercial and industrial users of conventional energy sources are subject to pay a tax on fossil fuel consumption (the Climate Change Levy – CCL) and a tax for the use of fossil fuel for electricity generation (the Carbon Price Floor – CPF). Neither of the previously mentioned taxes are applied to renewable energy generators.

RES electricity in the UK is connected to the grid under the non-discriminatory principle, therefore no priority is given to renewable energy generators when connecting, using or developing the grid.

2.3.4.1 Total costs derived from RES support in the UK

During the third year of the FiT scheme, the costs accounted for £506.3 million, covering 1,675 GWh of renewable generation and a total of 379,122 installations as of 31st March 2013. Of this total more than 98% of installations were solar PV, with the remaining percentage corresponding to wind, micro-CHP, hydro and anaerobic digestion. As of the end of the third year of the scheme, total costs account for £671.6 million, as shown on *Table 8* below:

Table 8: Costs of the FiT scheme (million £)

	April 2010 - March 2011	April 2011 - March 2012	April 2012 - March 2013
FiT [M£]	14.4	150.8	506.3

Source: Own compilation from Ofgem's 'Feed-in Tariff Annual reports'.

Regarding the RO scheme, the majority of ROCs were issued to fuelled[12] (25%), offshore (22%) and onshore (40%) wind stations. All of the suppliers with an obligation under the RO can comply by presenting ROCs, making a buy-out payment, or through a combination of both. The buy-out price is intended to act as a cap on the costs to be charged to consumers. Based on the value of a ROC of £44.38, the total value of the 44.8 million ROCs presented for compliance in 2012-13 was £1.99 billion. *Table 9* shows the total value of the ROCs presented for compliance in the last 5 periods of the scheme.

[12] Fuelled technology refers to stations generating from eligible biomass, bioliquid, energy crops or waste.

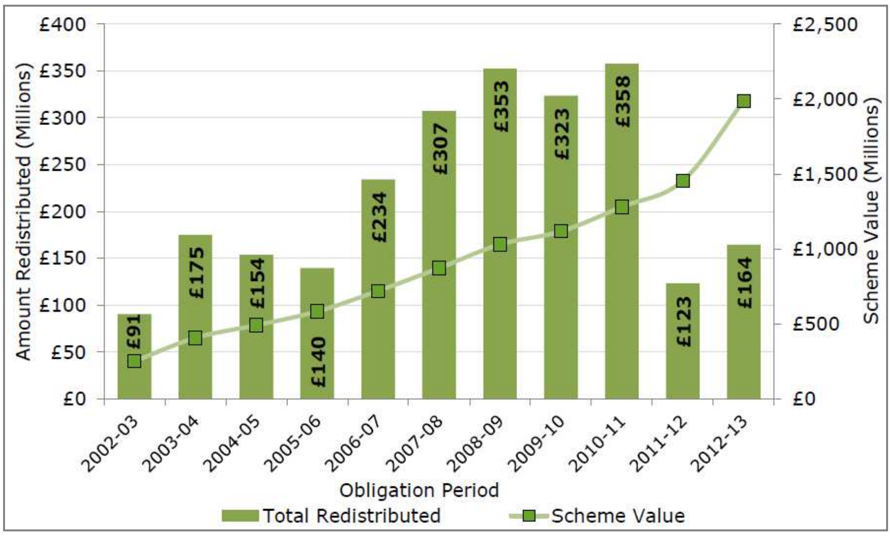
Table 9: Total value of ROCs presented for compliance

	April 2008 - March 2009	April 2009 - March 2010	April 2010 - March 2011	April 2011 - March 2012	April 2012 - March 2013
Total of buy-out and late payments redistributed	£352,651,576	£323,668,318	£358,308,373	£123,116,772	£164,420,029
Total ROCs presented	18,948,878	21,337,205	24,969,364	34,404,733	44,773,499
Recycle value per ROC presented	£18.61	£15.17	£14.35	£3.58	£3.67
Worth of a ROC to a supplier	£54.37	£52.36	£51.34	£42.27	£44.38
Average ROCs issued/MWh	1.00	1.04	1.07	1.12	1.27
Support per MWh supplied	£54.37	£54.45	£54.93	£47.34	£56.36
TOTAL VALUE OF THE PRESENTED ROCs	**£1,030,250,497**	**£1,117,216,054**	**£1,281,927,148**	**£1,454,288,064**	**£1,987,047,886**

Source: Ofgem, 'Renewables Obligation Annual report 2012-13'.

The notable accelerated growth in value of the scheme since its introduction in 2002 is shown in *Figure 15*.

Figure 15: Scheme value since 2002 (million £)



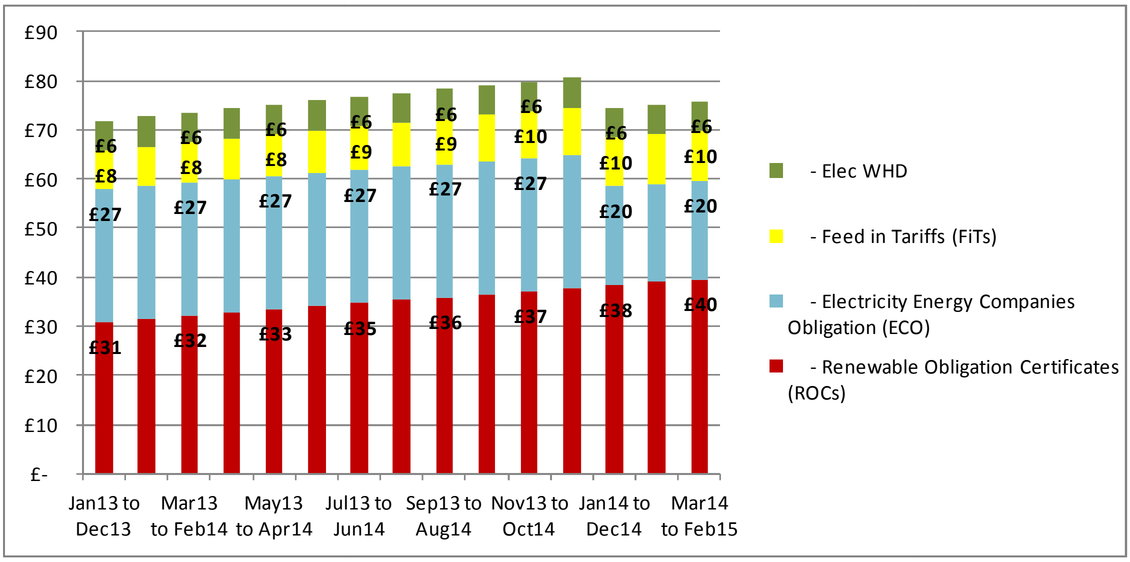
Source: Ofgem, 'Renewables Obligation Annual report 2012-13'.

2.3.4.2 Financing of RES support mechanisms in the UK

The costs of the RO and FiT schemes are paid by final electricity consumers through their energy bill within the 'Environmental charge'. In 2013, the annual surcharge paid by an average household[13] for the FiT scheme was £8 and for the RO scheme £31, both expected to grow until 2015. *Figure 16* shows 2013 data of the overall environmental charge and the projected estimates by Ofgem from January 2013.

[13] Average households are does considered by Ofgem with an average annual consumption of 3,300kWh.

Figure 16: Annual Environmental charge (£)



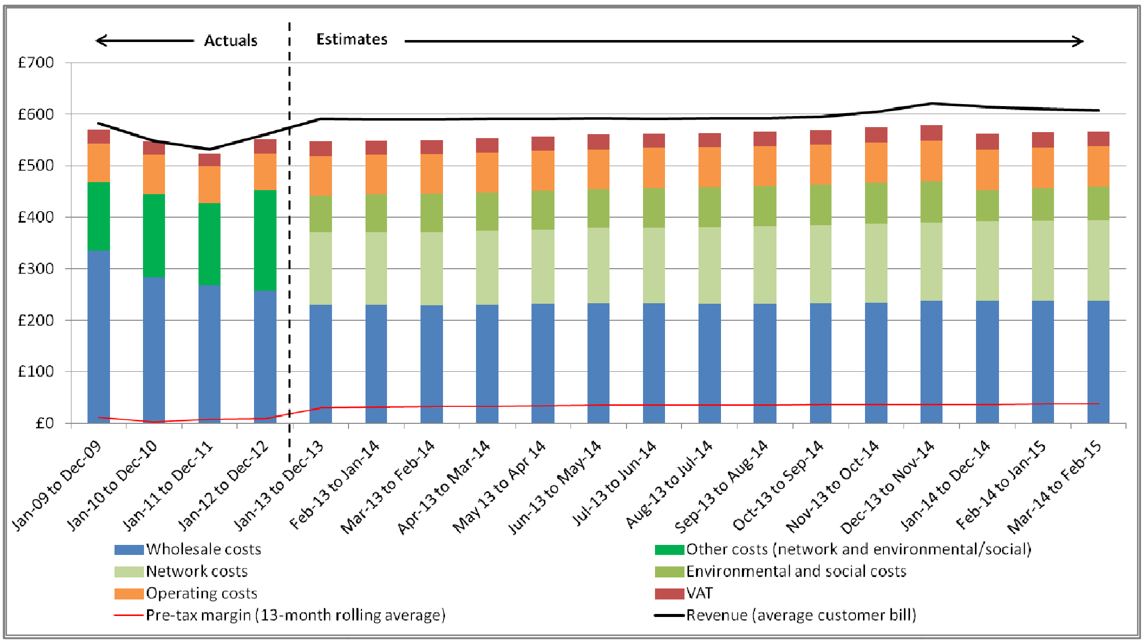
Source: Ofgem

Apart from the FiT and RO surcharges, households are entitled to pay within the environmental charge the electricity 'Warm Home Discount' rebate (which is paid by all consumers and given to vulnerable and low income households) and the Electricity Energy Companies Obligation (a domestic energy efficiency programme that creates a legal obligation on certain energy suppliers to improve the energy efficiency of domestic households).

2.3.4.3 RES financing impact on UK's households

The portion of the FiT and RO costs paid by households on their electricity bill was of 7% in the year 2013 and it is expected to increase up to 9% in February 2015. These figures are shown on *Figure 17* below:

Figure 17: Breakdown of costs of the average customer bill (£)



Source: Ofgem

2.3.5 Mechanisms used to support RES in Spain

The regulatory context of Spain regarding RES support is characterised by a series of regulatory changes that, in a period of less than 10 years, has evolved from the strong push on the promotion of new RES plants, to limitations on the energy produced receiving financial support, to a temporal suspension of financial support to new RES installations to, finally, a new support mechanism that is the first of its kind and that has replaced the previous mechanisms that were in place until June 2014.

RES were first classified as 'Special Regime' under Royal Decree 2366/1994 which regulated hydro, cogeneration and other units using renewable energy sources with installed capacity equal to or less than 100 MVA. The RD introduced a remuneration based on Feed in Premia (FiP) and gave renewable units priority of access to the grid. Later on, RD 2818/1998 of the Electricity Sector Act 54/1997, broaden the FiP to units with an installed capacity lower than or equal to 50MW, establishing the basic regulatory framework of RES under the Special Regime. In 2004, RD 436/2004 gave RES installations the option to choose between receiving a FiT when the energy was sold directly to the retailer or to sell the electricity in the wholesale market and receiving, on top of the wholesale price, a premium and an incentive for participating in the market, in terms of €/kWh. In addition, independently of the remuneration scheme chosen, all installations classified under the Special Regime received a supplement for reactive power.

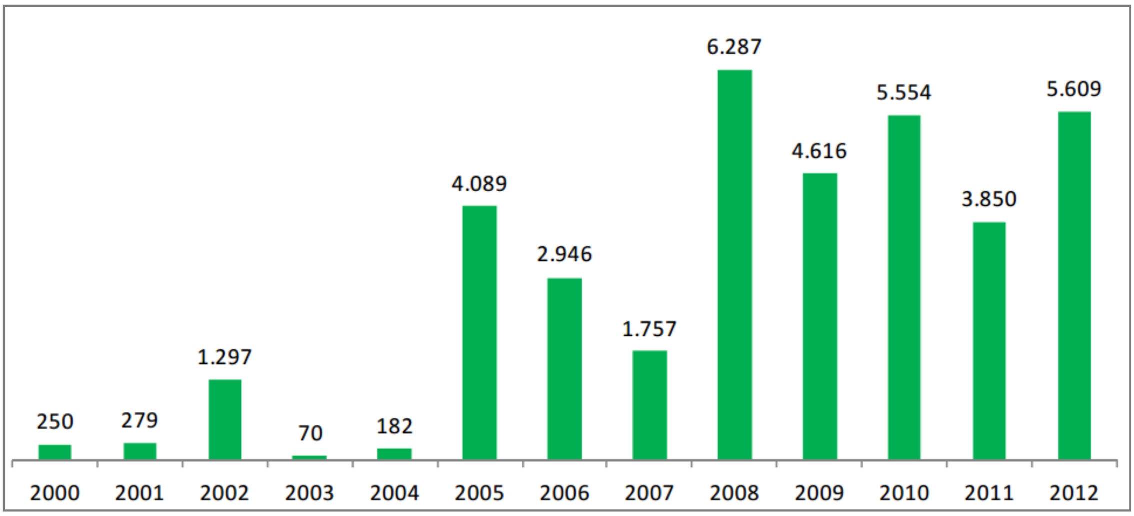
In 2007, RD 661/2007 replaced RD 436/2004. Under the later, FiTs and FiPs were set with reference to the average electricity tariff, while the new regulation established tariffs and premia based on the technology group, subgroup, age of the installation and power range. Additionally, to prevent excessive or insufficient remuneration, upper and lower limits were established on the total FiP received (i.e. limitations on the sum of the market price plus the reference premium, which was annually updated by an IPC-X factor).

In 2009, concern grew regarding the increasing evolution of the tariff deficit (see *Figure 18*), what resulted in a series of retroactive Royal Decrees that limited the equivalent operating hours benefiting from a regulated tariff. The new regulatory framework covered wind and thermoelectric plants within RD 1614/2010 and solar PV plants under RD Law 14/2010.

Early in 2012, RD Law 1/2012 suspended all economic incentives for new RES facilities, and in 2013, all facilities in the Special Regime where entitled to sell their electricity under the FiT mechanism (RD Law 2/2013). In addition, along with other energy fiscal measures promoted by Law 15/2012, a 7% tax was levied on electricity production, including both conventional and RES and CHP generation.

Recently in June 2014, the Ministry approved the new remuneration of RES, cogeneration and waste under RD 413/2014. RES, which are no longer treated differently from conventional technologies and classified under the category of Special Regime, will be remunerated according to, as stated on the RD, a remuneration for investment and a remuneration to the operation. On the one hand, the remuneration for investment is paid on top of the energy sold in the market only when such sell of energy is not sufficient to cover the investment costs, and will depend on the plant's installed capacity. On the other hand, the remuneration to the operation will be paid to cover the operating costs that are not covered with the sale of electricity in the market. The calculation of both remunerations will be based on the definition of several standard 'efficient and wellmanaged' installations, considering a standard income from the sale of energy valued at market price, the standard operating costs necessary to develop the activity and the standard value of the initial investment. According to the CNMC, the new regulatory framework would reduce RES support in 1.2 billion Euros[14].

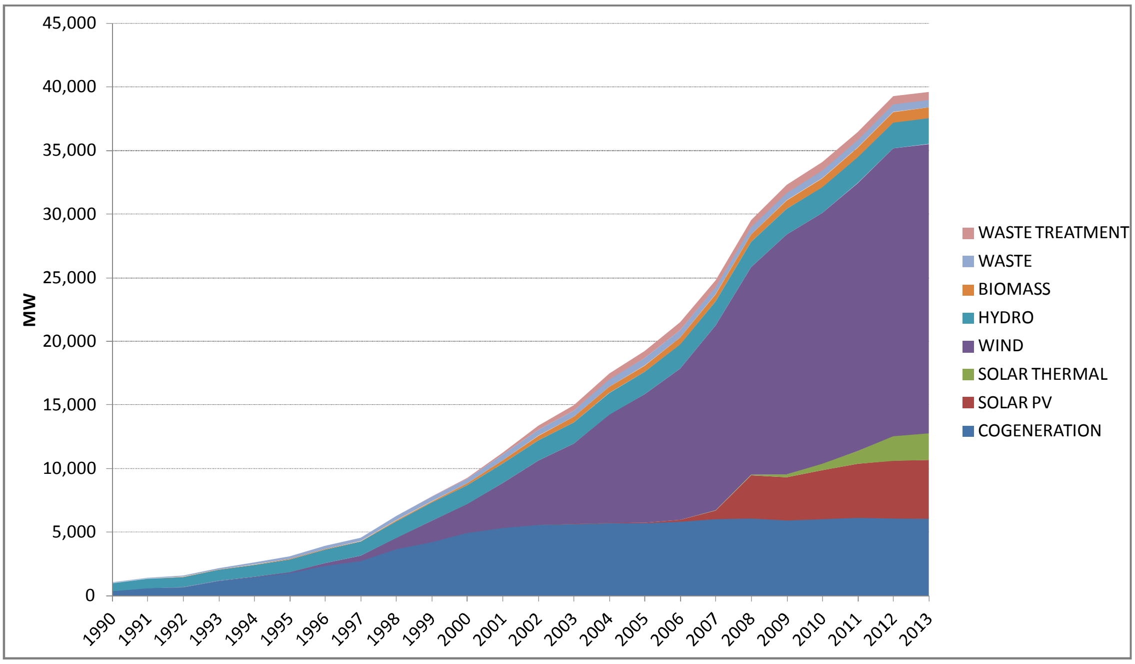
Figure 18: Evolution of the deficit of the system (million €)



Source: CNE, 'Nota resumen del saldo de la deuda del sistema eléctrico a 10/05/2013'.

Figure 19 below shows the strong increase in RES installed capacity as a response to the regulatory measures implemented in Spain in the last twenty years. Barely 1GW of RES was installed in 1990, increasing up to more than 39GW in 2013. Wind is the technology that presents the highest evolution, with 2MW installed at the beginning of the period to nearly 23GW in 2013.

Figure 19: Evolution of renewable installed capacity in Spain (MW)



Source: CNE, 'Información Estadística sobre las Ventas de Energía del Régimen Especial'.

[14] CNMC, '*Informe sobre la propuesta de Real Decreto por el que se regula la actividad de producción de energía eléctrica a partir de fuentes de energía renovables, cogeneración y residuos*'.

2.3.5.1 Total costs derived from RES support in Spain

Photovoltaic and wind installations have received the greatest share of the support in 2013, as shown on *Table 10* below. By mechanism, the FiT accounts for 98% of the total RES costs.

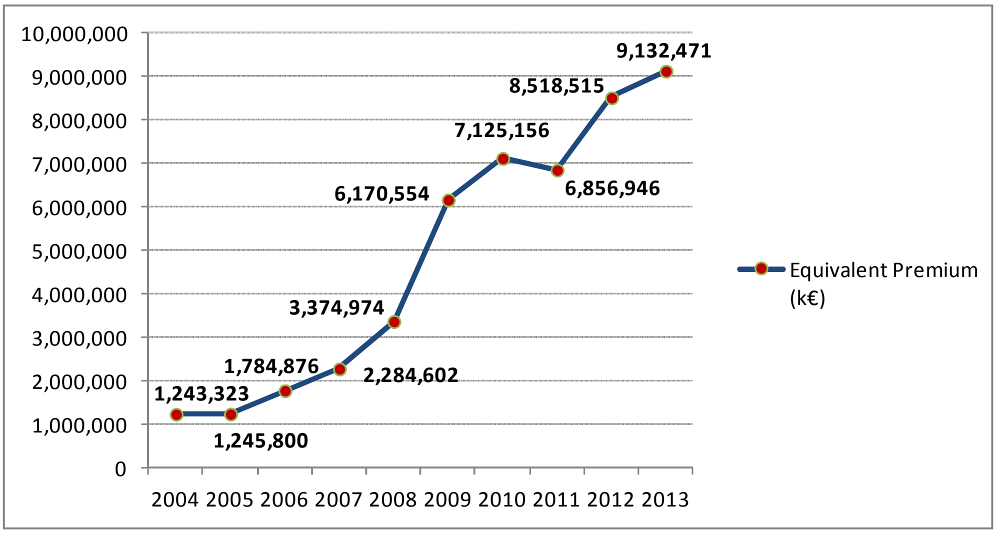
Table 10: Costs of RES support mechanisms in 2013 (k€)

	Feed-in Tariff [k€]	Feed-in Premium [k€]	Total by Source [k€]	Share by Source [%]
Cogeneration	1,690,554	130,739	**1,821,293**	**20%**
Photovoltaic	2,561,335		**2,561,335**	**28%**
Thermosolar	1,111,713		**1,111,713**	**12%**
Wind	2,393,927		**2,393,927**	**26%**
Hydro	297,676	4,205	**301,881**	**3%**
Biomass	375,469		**375,469**	**4%**
Waste	72,254	11,358	**83,612**	**1%**
Waste treatement	483,232		**483,232**	**5%**
Other RES	9		**9**	**0**
Total by Mechanism	**8,986,169**	**146,302**	**9,132,471**	**100%**
Share by Mechanism	**98%**	**2%**	**100%**	

Source: CNMC, 'Liquidación provisional de las primas equivalentes, primas, incentivos y complementos a las instalaciones de producción de energía eléctrica en Régimen Especial. Mes de producción 12/2013'.

Figure 20 aims to illustrate the increase in the evolution of the costs of financing RES from 2004 to 2013. With respect to 2004 levels, costs in 2013 have increased by more than 600%.

Figure 20: Evolution of the financial support received by RES generators (k€)

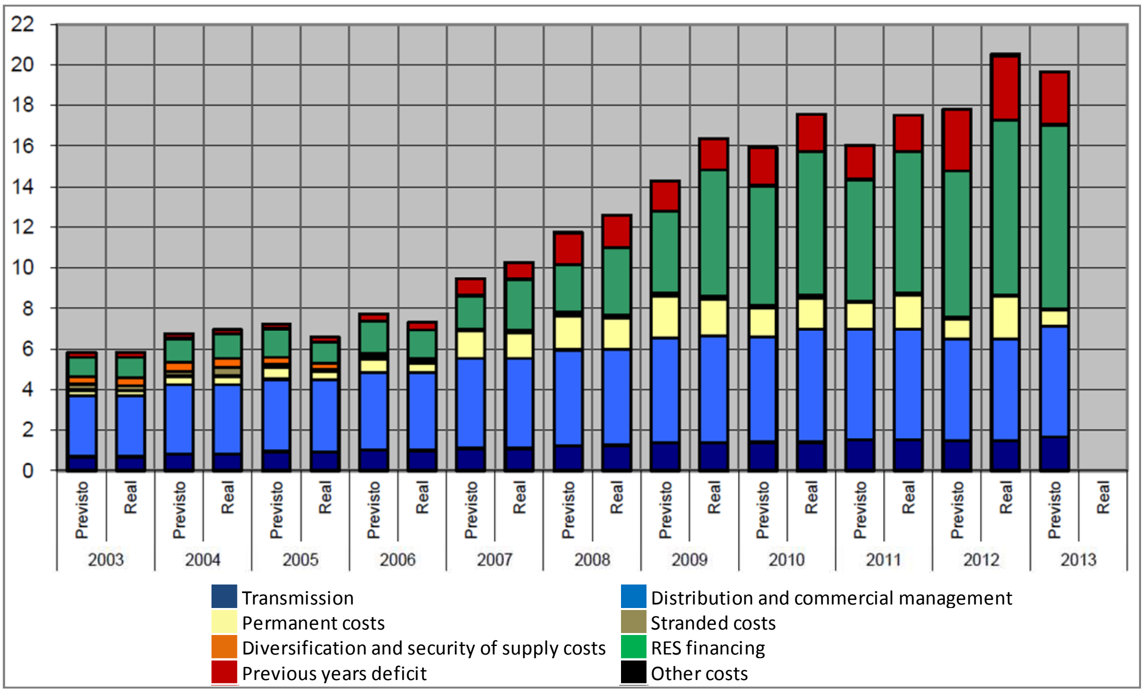


Source: Own compilation from CNMC.

2.3.5.2 Financing of RES support mechanisms in Spain

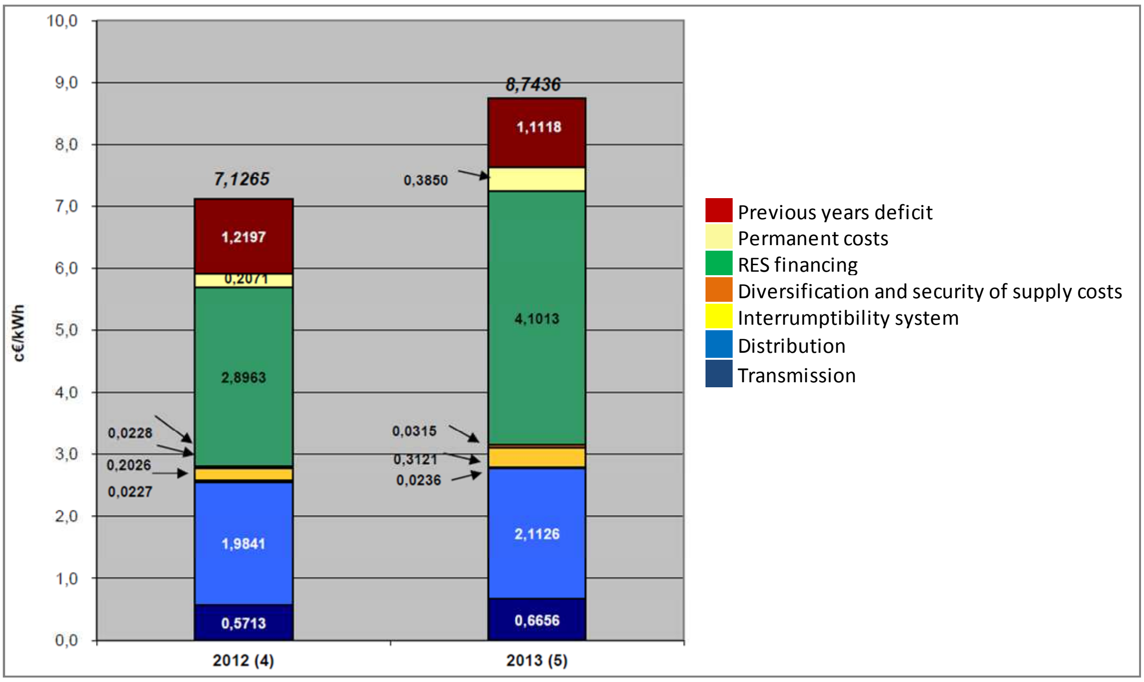
In Spain, RES support is financed through the access to the grid tariff, which is a surcharge included on residential and industrial electricity bills and comprises several costs of different nature. The grid tariff has been incremented in approximately 242% in the period 2003-2012 as shown on *Figure 21*. The main part of the surcharge is destined to finance RES support, accounting for 47% of the total tariff in 2013 (see *Figure 22* for a disclosure of the components of the tariff in 2012 and 2013).

Figure 21: Evolution of the regulated costs included in the grid tariff (billion €)



Source: CNMC, 'Boletín mensual de indicadores eléctricos de abril 2014'.

Figure 22: Components of the grid tariff (€cents/kWh)

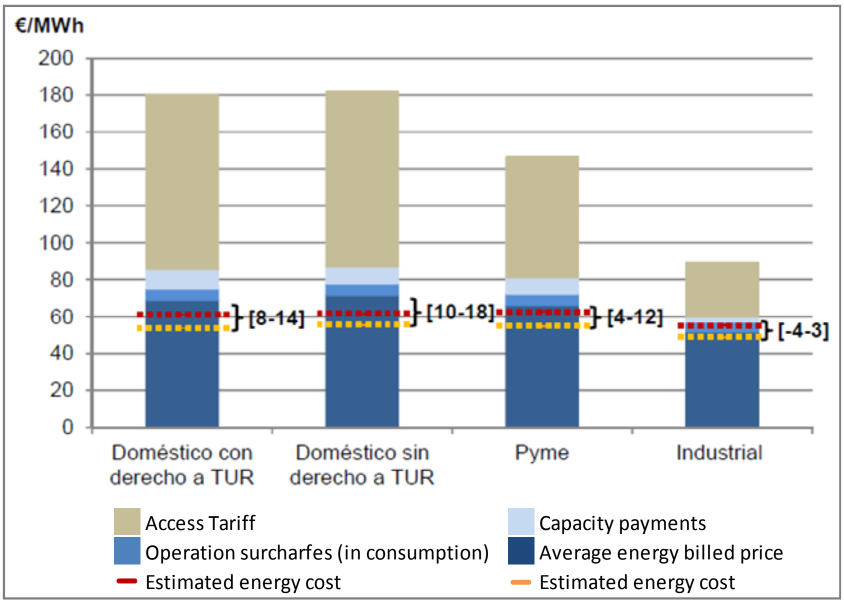


Source: CNMC, 'Boletín mensual de indicadores eléctricos de abril febrero 2014'.

2.3.5.3 <u>RES financing impact on Spanish households</u>

From 1st July 2003, all Spanish consumers (including domestic consumers) have the right to choose their supplier and therefore to decide whether to buy their electricity in the open market or to stay in the regulated market. The CNMC, on their Monitoring report of the retail electricity market as of December 2013, estimates the costs included in the electricity price for the following sectors: eligible and non-eligible households to the regulated tariff (TUR), small and medium companies (PYME) and industrial consumers. As shown on *Figure 23*, the grid tariff paid by households (which accounts for approximately 53% of the total bill) more than doubles the one paid by industrial consumers and it is also significantly higher than that paid by PYMES.

Figure 23: Estimated components of the average billing price (July 2012 - June 2013)



* Retail margins are not included in the figure.

Source: CNMC, 'Informe de supervisión del mercado minorista de electricidad, Diciembre 2013'.

3. ENERGY TAXES: APPLICATIONS AND IMPLICATIONS

This section aims to give an overview of the current status of energy and environmental taxation in the EU, focusing, as the study requires, in the case of Spain. Before introducing the fiscal context of Spain and based on the report elaborated by Economics for Energy '*Impuestos energético-ambientales en España, 2013*', this section primarily reviews the academic basis of optimal tax design and the reasons that support the use of energy and environmental taxes. Then, we mention the taxes currently applied in Spain, both from the central and autonomous levels. Finally, the section ends with a conclusion that intends to summarize the most relevant aspects of the fiscal Spanish energy and environmental policy.

3.1 THE REASONS BEHIND ENERGY TAXATION

Energy and environmental taxation is justified by three main theoretical foundations: fundraising, correction of environmental impacts and rent-seeking.

Regarding the first reason for the taxation of energy products, it is justified by the natural characteristics of energy that make them a high and stable source of income. Due to the strong dependency of contemporary societies on energy, energy products present a low price elasticity for consumers (see *Table 11* below), what makes them difficult to be substituted by other products or to reduce their consumption. Moreover, fiscal literature states that higher taxes should be applied to those products with lower price elasticity, what additionally justifies its taxation.

Table 11: Price elasticity indexes for different energy products

Authors	Country	Energy Product	Price Elasticity
Baker *et al.* (1989)	UK	Natural Gas	-0.31
Baker and Blundell (1991)	UK	Natural Gas	[-0.62, -0.41]
Bentzen and Engsted (1993)	Denmark	Energy	[-0.47, -0.14]
Rothman *et al.* (1994)	53 countries	Energy	[-0.78, 0.69]
Maddala *et al.* (1997)	USA	Natural Gas	-0.01
Koopmans and te Velde (2001)	Netherlands	Energy	-0.29
Batltagi *et al.* (2003)	France	Gasoline	-0.09
Hunt *et al.* (2003)	UK	Energy	-0.18
Holtedahl and Joutz (2004)	Taiwan	Electricity	-0.16
Kamerschen and Porter (2004)	USA	Electricity	-0.93
Narayan and Smyth (2005)	Australia	Electricity	-0.26
De Vira *et al.* (2006)	Namibia	Energy	-0.34
Pock (2010)	14 European countries	Gasoline	-0.09
Filippini and Hunt (2011)	29 OECD countries	Energy	[-0.4, -0.2]
Vásquez *et al.* (2011)	USA	Natural Gas	[-0.41, -0.11]
Labandeira *et al.* (2012)	Spain	Electricity	-0.25
González-Marrero *et al.* (2012)	Spain	Gasoline	-0.29
Lin and Zeng (2013)	China	Gasoline	[-0.497, -0.196]

Source: Economics for energy,' Impuestos energético-ambientales en España, 2013'.

The environmental reasons that justify energy taxes are related to the negative impacts caused on the environment by energy-related activities. These social costs are not supported by agents that produce them, thus appearing a market failure or externality whose correction requires public intervention, as the allocation of property rights is not possible due to the non-excludability and non-rivalry characteristics of the environment. The application of a tax can internalize externalities and can also allow to decentralize decisions on polluting agents, introducing flexibility in environmental policies, thus allowing improvements to achieve minimum cost (known as static efficiency). Also, the tax continuously encourages polluters to seek technological improvements that reduce their emissions to reduce future tax payments (known as dynamic efficiency).

Finally, rent-seeking motives are primarily related to the distribution of economic rents associated to non-renewable resources (specially oil) between producer and consumer countries of these products. Thus, if energy producers use a cartel to maximize economic rents associated with a resource, consuming countries can use energy taxation to capture part of such rents.

3.2 TAX DESIGN AND EVALUATION CRITERIA

A proper tax design is determined by a series of issues that should be taken in mind before any tax is implemented. On the one hand, one should determine if the tax will be applied to the consumption of energy, to the goods that consume energy or to both. In addition, the tax can be applied to the quantity consumed, to the heat content of the energy good or to the emissions caused by its consumption. Furthermore, the tax can be applied uniformly to all polluters or can depend on each polluter's location or emissions level. Finally, one should also examine if the tax will be applied upstream or downstream in the chain.

Once the tax is designed, four evaluation criteria must be considered:

- Its environmental effectiveness is one of the most important criteria. It determines the capacity of the tax to solve an environmental externality and to create positive environmental effects in the medium and long term.
- Its economic efficiency, which determines the tax's ability to provide an optimal or, in a second-best option, sub-optimal solution to a market failure, in terms of cost efficiency.
- Its practical viability, determining the possibility of such a tax to be implemented in the real world, taking into account its administrative viability and social acceptance.
- Finally, the distributional effects that the cost-allocation of the tax may cause to the different agents.

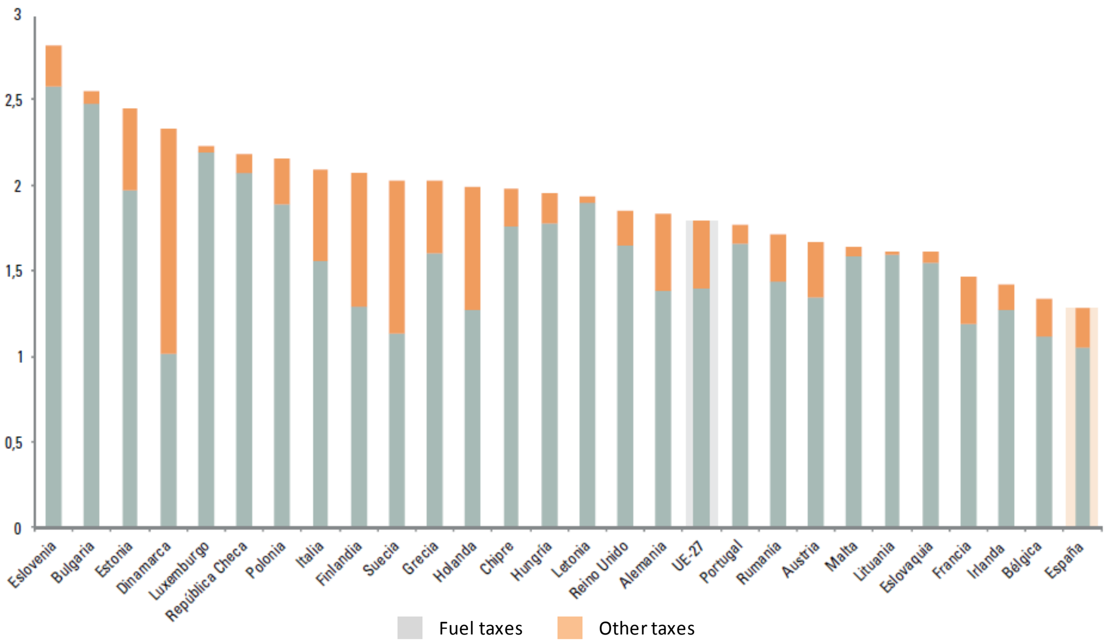
Other additional criteria, such as the interference of the tax with other fiscal policies or its jurisdictional allocation (the environmental tax should be allocated to those jurisdictions where the costs and benefits derived from the environmental externality are exhausted), are also important to take into consideration when evaluating the effects of a tax.

3.3 IMPLEMENTATION OF ENVIRONMENTAL AND ENERGY TAXES IN THE EUROPEAN UNION

As explained on section 3.1, energy taxes represent an important source of income in developed countries. In 2011, environmental and energy taxes represented 4.6% of the overall tax collection in the EU and 1.8% of the EU's GDP[15] (see *Figure 24* and *Figure 25* below).

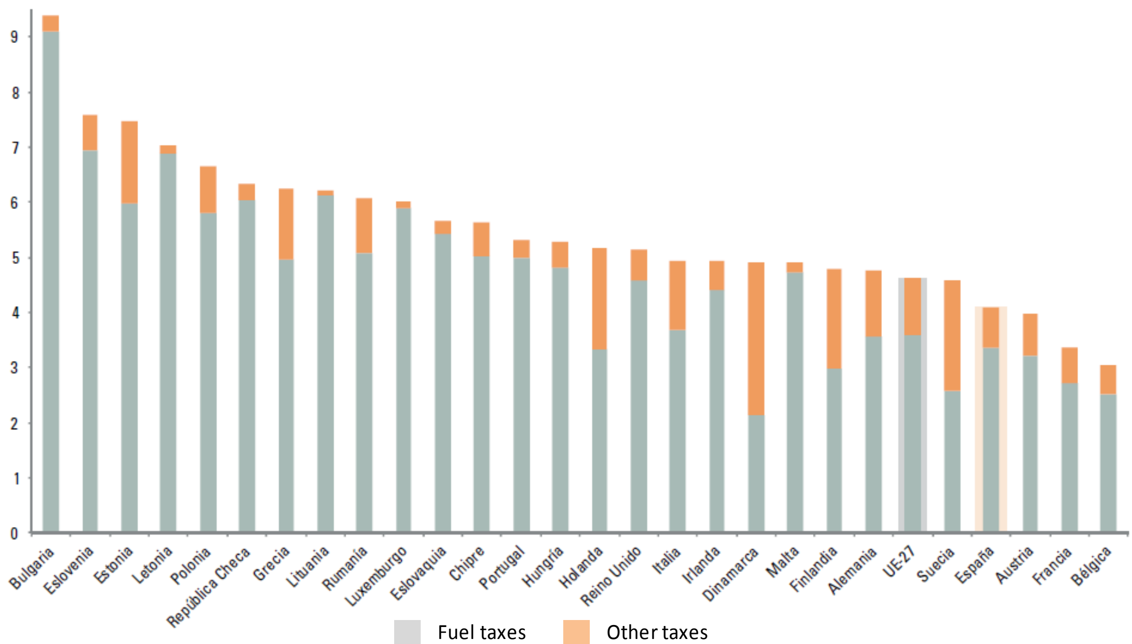
[15] European Commission, '*Taxation trends in the European Union. 2013 Edition'.*

Figure 24: Share of environmental and energy taxes from GDP in the EU (%)



Source: Economics for energy,' Impuestos energético-ambientales en España, 2013'.

Figure 25: Share of environmental and energy taxes from total tax collection in the EU (%)



Source: Economics for energy,' Impuestos energético-ambientales en España, 2013'.

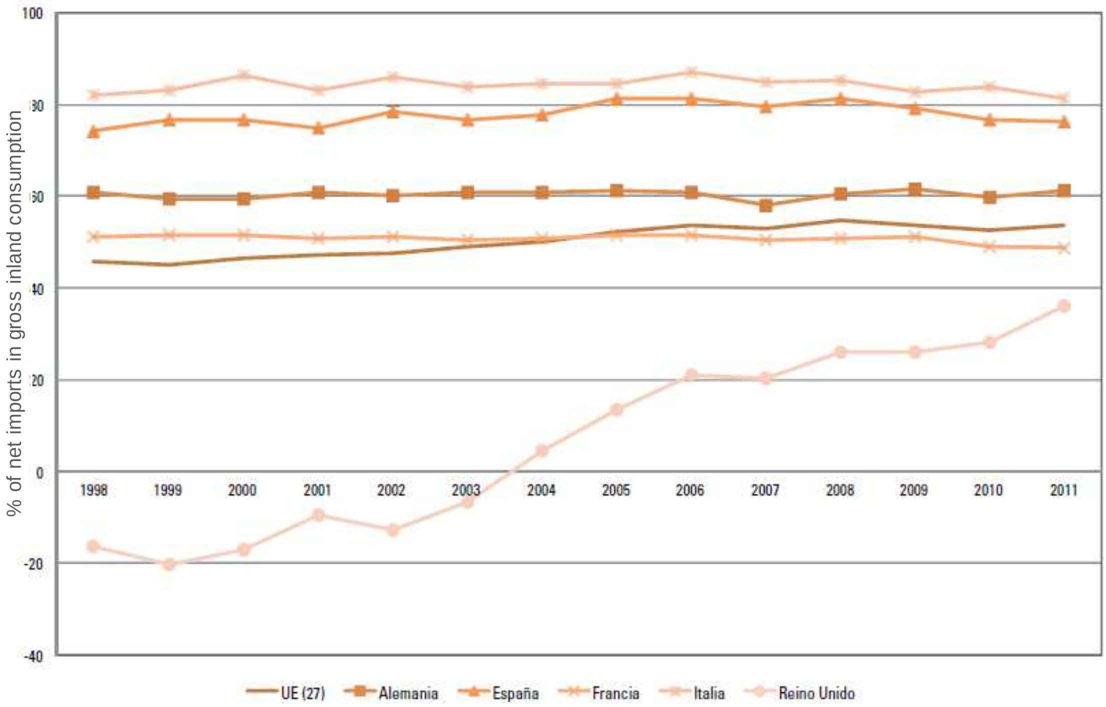
In general, energy taxes are levied on energy products and some major durable goods associated with the consumption of energy, specially vehicles. In the EU, within the so-called harmonized indirect taxation, taxes on energy are defined from minimum unitary tax rates, which may be raised by MSs, on which subsequently the general VAT is applied. In 2011, the Commission presented a new proposal defining a minimum level and structuring energy taxation in two sections, one based on the energy content (to cover tax collection and energy security issues) and another one based on the CO_2 content and linked to the EU ETS prices. Additionally, the Commission proposed a gradual implementation and compensation mechanisms to protect the competitiveness of the

Industry[16]. However, the proposal has stagnated since then, due to the lack of agreement between MSs.

3.3.1 Environmental and energy taxes in Spain

Before analyzing the fiscal situation of Spain, it is relevant to describe the country's environmental and energy context. On the one hand, GHG emissions have exceeded the targets set by the Kyoto Protocol between 1997 and 2012 and have only reduced as a consequence of the economic crisis and the emergence of RES in the electricity sector (see *Figure 26* below). The Spanish energy dependence, on the other hand, is one of the highest in the EU as shown on *Figure 27*. Finally, it is important to remember, as shown on section 2.3.5, the considerable support given to RES and energy efficiency.

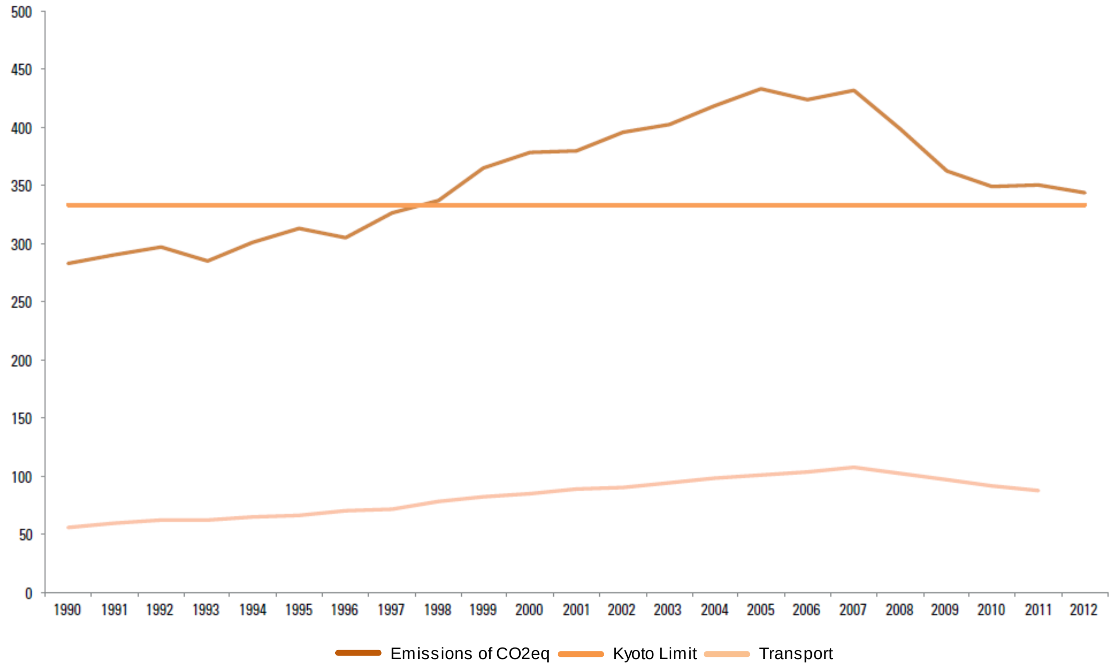
Figure 26: Energy dependence of Spain



Source: Economics for energy,' Impuestos energético-ambientales en España, 2013'.

[16] European Commission, 2011. '*Proposal for a Council Directive amending Directive 2003/96/CE restructuring the Community framework for the taxation of energy products and electricity*'.

Figure 27: Evolution of CO_2 emissions in Spain (tCO_2eq)



Source: Economics for energy,' Impuestos energético-ambientales en España, 2013'.

As shown on *Table 12* below, the weight of energy taxation in Spain is below the main countries of the EU, where 100 is taken as the average rate of the EU-21. For the case of electricity, it is important to remember, however, that as discussed on section 2.3.5, although tax revenue is below the European average (it represents 80%), other several non-energy related components are included in the electricity bill of Spanish households.

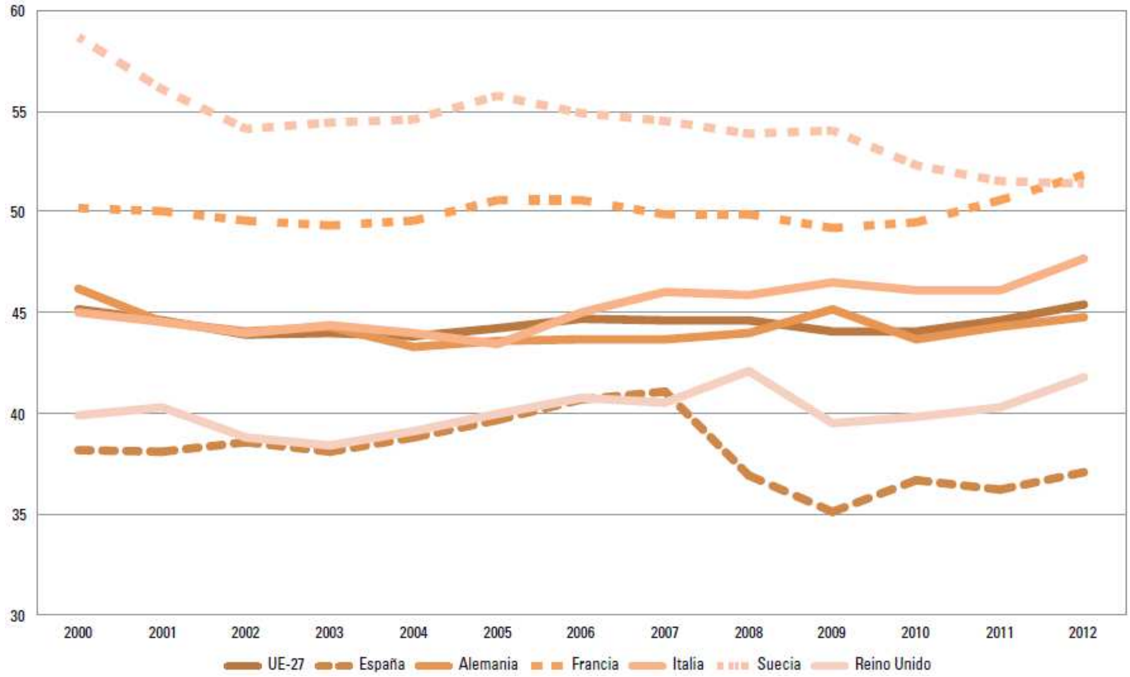
Table 12: Percentage of taxes in energy prices (2012)

	Electricity (households)	Natural Gas (households)	Light fuel-oil (households)	Gasoline 95	Non-commercial Gas-oil
Germany	45.5 (172)	23.8 (111)	22.9 (83)	55.6 (99)	47.5 (98)
Spain	**19.4 (73)**	**16 (74)**	**25 (90)**	**48 (85)**	**42.4 (87)**
France	30.2 (114)	16.6 (77)	22.2 (80)	54.9 (97)	47.2 (97)
Italy	30.5 (116)	37.6 (175)	45 (162)	57.5 (102)	52.9 (109)
UK	4.8 (18)	4.8 (22)	20.5 (74)	59.5 (105)	57.5 (119)
EU-21	26.4 (100)	21.5 (100)	27.7 (100)	56.4 (100)	48.5 (100)

Source: Economics for energy,' Impuestos energético-ambientales en España, 2013'.

In relative terms, the crisis has led to a significant drop in revenue collection from energy taxation as a percentage of the Spanish GDP. This situation is illustrated on *Figure 28*.

Figure 28: Evolution of tax collection in several European countries (% GDP)



Source: Economics for energy,' Impuestos energético-ambientales en España, 2013'.

The energy-related taxes implemented at a national level are listed below. In addition, *Table 13* shows the revenue collection of each tax in 2012 and 2013, and the forecasted collection for 2014.

a) Special tax on certain transportation facilities
b) Special tax on motor fuels
c) Special tax on electricity
d) Special tax on coal
e) Tax on the value of electricity production
f) Tax on the production of spent nuclear fuel and radioactive waste resulting from nuclear power generation
g) Tax on the storage of spent nuclear fuel and radioactive waste in centralized facilities
h) Charges on the utilisation of inland waters for the production of electricity
i) Tax on fluorinated GHG emissions

Table 13: Year of entry into force and revenue collection of energy related taxes in Spain

	Entry into force	Revenue Collection (M€)
a.	1993	339
b.	1993	8,595
c.	1998	1,507
d.	2005	147
e.	2013	1,259
f.	2013	266
g.	2013	17
h.	2013	298
i.	2014	113

a, b and c taxes: revenue collection in 2012
d, e, f, g and h taxes: revenue collection in 2013
i tax: revenue collection forecasted for 2014

Source: Economics for energy,' Impuestos energético-ambientales en España, 2013'.

In general, the figures show a high heterogeneity between the different taxes and a very disparate revenue collection capacity. In this regard, the taxation of motor fuels, which is close to 9,000 million Euros (and below the European average), is far from the revenue collection of the levies on production (1,250 M€) and electricity consumption (1,500 M€). The revenue collection capacity of the rest of the above listed taxes is very low, in some cases representing only tens of millions of Euros per year.

The different autonomous regions of Spain have taken advantage of the lack of interest at the central level in the use of energy and environmental taxation[17]. Because the majority of subjects were already levied when the autonomous regions decided to implement energy-related taxes, they introduced taxes of an extra-fiscal nature, i.e. taxes whose main objective is not to obtain financial resources but also to serve as a regulatory tool in the economy to achieve different objectives (economic, social, environmental, etc.). These taxes are normally associated with a low revenue collection capacity. However, despite their intended environmental objectives, these taxes are in practice purely tax collection figures with few environmental effects. Regional governments generally have been more concerned about capturing certain stable income taxes to enable them to achieve a certain collection level than to achieve a change on the agents' environmental behaviour (see Labandeira *et al.*, 2009). Below are listed the energy-related taxes implemented by autonomous regions:

a) Taxes on atmospheric emissions: Andalucía, Aragón, Castilla La Mancha, Cataluña, Galicia, Murcia and Valencia
b) Taxes on facilities and activities that affect the environment: Asturias, Canarias, Castilla y León, Castilla La Mancha, Cataluña, Extremadura and Valencia.
c) Taxes on energy waste: Andalucía and Castilla La Mancha.
d) Wind fees: Castilla y León, Castilla La Mancha y Galicia.
e) Taxes on dammed waters: Castilla y León, Castilla La Mancha y Galicia.
f) Excise duty on petroleum fuels: Canarias[18]

The estimated collected revenues by each tax are shown on *Table 14*. It should be noticed that many of the above listed taxes have been introduced in the recent years. Also, the relatively low revenue collection of the taxes: only a few achieve a revenue collection above 20 million Euros.

[17] See Labandeira *et al. (2009)*, '*La fiscalidad energético-ambiental como espacio fiscal para las Comunidades Autónomas*'.
[18] In Canarias, the special tax on motor fuels is not applied.

Table 14: Entry into force and revenue collection of autonomous energy and environmental taxes (M€)

	a.	b.	c.	d.	e.	f.
Andalucía	**2004** (5.88)		**2004** (5.89)			
Aragón	**2006** (5.80)					
Asturias		**2011** (1.25)				
Canarias		**2013** (0.75)				**1986** (298.46)
Castilla y León		**2012** (17.04)		**2012** (17.04)	**2012** (17.04)	
Castilla La Mancha	**2001** (8.03)	**2001** (8.03)	**2001** (8.03)	**2012** (12.42)		
Cataluña	**2014** (5.9*)	**2014** (43.20*)			**2003** (NA)	
Extremadura		**1997** (93.2)				
Galicia	**1995** (3.49)			**2010** (14.17)	**2009** (22.91)	
Murcia	**2006** (0.58)					
C. Valenciana	**2013** (14.34)	**2013** (14.34)				
Total collection	**44.02**	**177.81**	**13.92**	**43.63**	**39.95**	**298.46**

* Expected revenue collection in 2014

Source: Economics for energy,' Impuestos energético-ambientales en España, 2013'.

3.4 MAIN CONCLUSIONS ON ENERGY AND ENVIRONMENTAL TAXES

Four important general conclusions can be derived from this section:

- Energy and environmental taxes respond to three main objectives: environmental corrections, collection of revenues and energy-related rent-seeking. These objectives are sometimes aligned, although other times they might be contradictory. Therefore, important is that they are prioritized by policymakers.
- Energy and environmental taxes should comply with several evaluation criteria, specially with its energy and environmental effectiveness, its fiscal viability and its social acceptability, which largely depends on the distributional incidence of the tax.
- Environmental taxes have been widely applied in developed countries, especially in Europe.
- A rapidly changing field such as the energy and environmental one requires (innovative) changes in the taxation policy applied. New taxes, as levies on the use of vehicles or adjustment taxes in the frontiers, may play an important role in the long term and can ensure tax collection and regulatory survival of energy and environmental taxation.

Looking at the special case of Spain, the main conclusions are:

- Spanish energy and environmental taxes are below the average of its neighbouring countries. This is especially evident for the case of motor fuels.

- These low levels of energy and environmental taxation do not respond to the high energy dependency of Spain, neither to the global environmental challenges it is facing.

III. DATA AND METHODOLOGY

This section describes the data and methodology used to estimate the incidence of the grid tariff across income distribution and to compare it, as an alternative option to RES financing, to the incidence of a tax on the consumption of home and motor fuels depending on their generated CO_2 emissions and their heat content. The primary aim is to determine whether, and to what extent, a carbon tax or a tax on the heat content[19] of the fuels used by Spanish households are less regressive than the grid tariff.

The origin of the problem analysed in the present paper derives from the nature of both the carbon and the heat content taxes, on the one side, and the grid tariff on the other side. While the first two taxes hit all forms of energy, the grid tariff is applied only to electricity consumption. Following the existing literature described on Section II, to the extent that energy is a less necessary product than electricity, the carbon or heat content taxes would be less regressive than the grid tariff. This is because, as it has already been described, motor fuel consumption more closely follows income than electricity consumption does. Furthermore, as the demand for home fuels is typically less income elastic than the demand for motor fuels, we expect the former to be regressive among households' incomes while the latter to be progressively distributed.

The present study uses micro data from the Spanish statistical office (Instituto Nacional de Estadística – INE) which carries annual surveys regarding household's expenditure on all consumer goods, including electricity, home and motor fuels. The survey (Encuesta de Presupuestos Familiares – EPF) also provides information about the total quantities consumed. For the study, the last survey available at the moment was used, which refers to 2012 and has a sample of approximately 24,000 households[20].

1. ADULT-EQUIVALISED EXPENDITURE ON ENERGY PRODUCTS

The survey provides information about household expenditure per income segment, in such a way that the sample is distributed among 8 monthly income levels. Additionally, the sample has been partitioned by adult-equivalised total expenditure in order to take into account both differences in households' size and composition[21].

Table 15 and *Table 16* show adult-equivalised expenditure in each energy commodity (electricity, home fuels and motor fuels) and for each income level, respectively. These data are provided by INE.

Table 15: Annual adult-equivalised expenditure by energy product (€)

Electricity - Adult-equivalised total expenditure [€]	Town Gas, NG, Butane & Propane - Adult-equivalised total expenditure [€]	Gasoil, Fueloil, Lamp oil & Others - Adult-equivalised total expenditure [€]	Coal, Coke, Wood, Charcoal & Peat - Adult-equivalised total expenditure [€]	Gasolines, Diesels & Lubricants - Adult-equivalised total expenditure [€]
€ 465.85	€ 161.39	€ 66.13	€ 7.41	€ 823.88

Source: Instituto Nacional de Estadística (INE)

[19] It should be clarified that the alternatives here studied are not a carbon tax and a heat content tax on their selves but a tax depending on these physical characteristics of the fuels analysed.

[20] According to INE, in 2012, Spain's household population was 17,406,000.

[21] INE uses the OECD equivalence scale whereby the head of household weights 1, all other members aged 14 or older weight 0.5 each, and those younger than 14 weight 0.3 each.

Table 16: Annual adult-equivalised total expenditure per income segment (€)

Income Segments	Regular Net Monthly Income [€]	Adult-equivalised total expenditure [€]	Electricity, Gas & Others - Adult-equivalised total expenditure [€]	Use of Personal Vehicles - Adult-equivalised total expenditure [€]
1	≤ 499€	€ 9,091.23	€ 482.47	€ 612.40
2	500€ - 999€	€ 11,542.59	€ 626.50	€ 675.18
3	1,000€ - 1,499€	€ 13,867.88	€ 658.03	€ 1,085.57
4	1,500€ - 1,999€	€ 15,822.04	€ 692.49	€ 1,266.19
5	2,000€ - 2,999€	€ 17,628.16	€ 746.23	€ 1,488.70
6	2,500€ - 3,999€	€ 19,699.44	€ 742.29	€ 1,608.87
7	3,000€ - 4,999€	€ 22,713.13	€ 791.63	€ 1,963.26
8	≥ 5,000€	€ 29,914.52	€ 1,022.26	€ 2,336.57
National Average	-	**€ 16,525.31**	**€ 702.72**	**€ 1,305.14**

Source: Instituto Nacional de Estadística (INE)

Unfortunately, the EPF does not report information on adult-equivalised expenditure in each energy product per income segment. Thus, to estimate individual expenditure on each commodity, it has been calculated the weight of each segment's overall energy expenditure with respect the national average energy expenditure. For each segment, the weight of energy expenditure has been applied throughout the different energy products consumed by multiplying by the corresponding adult-equivalised expenditure per energy product. The calculated weights are shown on *Table 17* below:

Table 17: Weighted energy expenditure per income segment

Income Segments	Electricity, Gas & Others - Adult-equivalised total expenditure [€]	Electricity, Gas & Others - Adult-equivalised total expenditure [%]	Use of Personal Vehicles - Adult-equivalised total expenditure [€]	Use of Personal Vehicles - Adult-equivalised total expenditure [%]
1	€ 482.47	69%	€ 612.40	47%
2	€ 626.50	89%	€ 675.18	52%
3	€ 658.03	94%	€ 1,085.57	83%
4	€ 692.49	99%	€ 1,266.19	97%
5	€ 746.23	106%	€ 1,488.70	114%
6	€ 742.29	106%	€ 1,608.87	123%
7	€ 791.63	113%	€ 1,963.26	150%
8	€ 1,022.26	145%	€ 2,336.57	179%
National Average	**€ 702.72**	**100%**	**€ 1,305.14**	**100%**

Note that weights are also applied to adult-equivalised expenditure on the use of personal vehicles in order to estimate the segment's expenditure in motor fuels, as 'use of personal vehicles' include other non-energy related expenses, such as car repairs, purchase of spare parts, vehicle inspections, lubricants, tolls and parking costs[22].

Finally, the estimated energy expenditures have been divided by the adult-equivalised total expenditure of each segment in order to calculate the share of each energy expenditure over the total annual expenditure of a household.

[22] INE, '*EPF: Clasificación de bienes y servicios. COICOP*'.

1.1 ENERGY EXPENDITURE ASSUMPTIONS

By applying the overall energy expenditure weights on the different energies consumed (which was an obligated choice as no information was provided by INE with regard to expenditure per energy product by income segment), the analysis is assuming homogeneous expenditure of a given income segment among four different energy products, namely electricity, gas, heating gasoil and coal; and using a different weight by segment for motor fuels. This assumption is compatible with the primary assumption underlying the study which (supported by empirical studies) states that motor fuel consumption (i.e. expenditure) more closely follows income than home fuel or electricity consumption does. Electricity and home fuel expenditures can be therefore, for this analysis, treated under homogeneous consumption patterns provided that they are analysed separately from motor fuels patterns.

This same assumption has been adopted for determining motor fuel expenditure when separating it from other non-energy related costs by applying expenditure weights of each income segment on the average national expenditure on motor fuels. In this case, it is being assumed that for as long as households' incomes increase, higher will also be their expenditure on car maintenance and on motor fuels.

2. HOUSEHOLDS' EXPENDITURE ON RES BY INCOME SEGMENT

As the EPF refers to 2012, in order to determine the cost of RES support for each household segment the analysis has used the total support given to RES generation as of December 2012, which accounted for 8.518 billion Euros[23].

The first assumption for the estimation of the share of RES paid by electricity customers has been to apply the social bonus to the two poorest income segments and the 2.0A tariff to the rest (this assumption will be explained in more detail in subsection 2.1). Following this assumption, the study derives the weight of the incomes generated to the system by each grid tariff[24] with respect to the overall collected income[25]. Then, the calculated weights have been applied to the total cost on RES for 2012, thus estimating the contribution to RES financing from households subject to 2.0A tariff and benefiting from the social bonus. The incomes by tariff as well as their proportional contribution to RES financing in 2012 are shown on *Table 18*.

In 2012, the regulated tariff was established through a specific auction called CESUR which settled the base price of electricity every three months. Along with other costs, the CESUR costs, the grid tariff and the commercial margin where the main components of the last resort tariff paid by regulated customers. *Table 19* shows the disclosure of the costs paid within the regulated tariff 2.0A during the four quarters of 2012. By applying the weight of RES support paid by each customer type to the grid tariff costs they have paid in 2012, we can estimate the share of the grid tariff that is destined to finance RES (as *Table 20* shows). Note that RES support has been calculated after deducting the taxes that were in force in

[23] CNMC, 'L*iquidación de las primas equivalentes, primas, incentivos y complementos a las instalaciones de producción de energía eléctrica en régimen especial. Mes de producción 12/2012'.*

[24] Data provided by CNMC, '*Informe 35/2012 de la CNE sobre la propuesta de orden por la que se establecen los peajes de acceso a partir de 1 de enero de 2013 y las tarifas y primas de las instalaciones del régimen especial*'.

[25] It should be noted that deficit costs have not been take into account. However, this is not relevant when estimating the weights of each grid tariff within the system's incomes as the proportional parameters to be applied would not defer.

2012, namely the electricity tax (4.864%) and the VAT (18% until 31st August and 21% from 1st September to 31st December).

Table 18: Contribution to RES financial support by grid tariff

	Incomes from Access Tariff 2012 [€]	Incomes from Access Tariff 2012 [%]	Contribution to RES Support in 2012 [€]
Social Bonus 1 kW < P ≤ 10 kW	**€ 599,810,000**	**4.07%**	**€ 346,368,703**
Pc ≤ 10kW	**€ 7,208,515,000**	**48.87%**	**€ 4,162,658,161**
2.0 A (P ≤ 10kW)	€ 6,786,758,000	46.01%	€ 3,919,108,662
2.0 DHA (P ≤ 10kW)	€ 421,747,000	2.86%	€ 243,543,725
2.0 DHS (P ≤ 10kW)	€ 10,000	0.00%	€ 5,775
10 < Pc ≤ 15kW	**€ 974,524,000**	**6.61%**	**€ 562,752,562**
2.1 A (10 < P ≤ 15 kW)	€ 766,849,000	5.20%	€ 442,827,718
2.1 DHA (10 < P ≤ 15 kW)	€ 207,671,000	1.41%	€ 119,922,534
2.1 DHS (10 < P ≤ 15 kW)	€ 4,000	0.00%	€ 2,310
Pc > 15kW	**€ 2,553,096,000**	**17.31%**	**€ 1,474,321,119**
3.0 A	€ 2,553,096,000	17.31%	€ 1,474,321,119
MV	**€ 2,940,335,000**	**19.93%**	**€ 1,697,937,715**
3.1 A	€ 921,576,000	6.25%	€ 532,176,996
6.1	€ 2,018,759,000	13.69%	€ 1,165,760,719
HV	**€ 475,314,000**	**3.22%**	**€ 274,476,741**
6.2	€ 260,662,000	1.77%	€ 150,522,930
6.3	€ 105,566,000	0.72%	€ 60,960,568
6.4	€ 109,086,000	0.74%	€ 62,993,242
TOTAL	**€ 14,751,594,000**	**100%**	**€ 8,518,515,000**

Table 19: Disclosure of tariff 2.0A in 2012 (€/MWh)

	2.0.A			
	1Q - 2012	**2Q - 2012**	**3Q - 2012**	**4Q - 2012**
CESUR Auction (base)	52.99	51.00	56.25	49.25
"Apuntamiento"	3.00	1.22	1.27	2.50
Balancing Markets	3.19	2.10	2.93	5.52
Risk Premium	0.00	0.00	0.00	0.00
Capacity Payments	9.81	9.81	9.81	9.81
Market Operator (OMEL)	0.02	0.02	0.02	0.02
System Operator (REE)	0.00	0.02	0.07	0.07
Losses	9.66	8.98	9.85	9.40
Energy Costs	**78.68**	**73.16**	**80.20**	**76.57**
Grid Tariff	**124.68**	**96.23**	**96.23**	**96.23**
Commercial Margin	**6.09**	**6.09**	**6.09**	**6.09**
Last Resort Tariff	**209.45**	**175.48**	**182.52**	**178.89**
Grid Tariff / Last Resort Tariff	**59.5%**	**54.8%**	**52.7%**	**53.8%**

Source: CNMC.

Table 20: Grid tariff costs and RES support per income segment (€)

		Grid Tariff Costs					RES Support
Income Segments	**Grid Tariff**	**1Q**	**2Q**	**3Q**	**4Q**	**Average 2012**	**2012**
1	Social Bonus	€ 37.77	€ 34.79	€ 33.45	€ 34.13	€ 140.14	€ 5.70
2	Social Bonus	€ 49.04	€ 45.18	€ 43.44	€ 44.32	€ 181.98	€ 7.40
3	2.0 A	€ 51.51	€ 47.45	€ 45.62	€ 46.55	€ 191.14	€ 87.94
4	2.0 A	€ 54.21	€ 49.94	€ 48.01	€ 48.99	€ 201.15	€ 92.54
5	2.0 A	€ 58.42	€ 53.81	€ 51.74	€ 52.79	€ 216.76	€ 99.72
6	2.0 A	€ 58.11	€ 53.53	€ 51.47	€ 52.51	€ 215.61	€ 99.20
7	2.0 A	€ 61.97	€ 57.09	€ 54.89	€ 56.00	€ 229.94	€ 105.79
8	2.0 A	€ 80.02	€ 73.72	€ 70.88	€ 72.31	€ 296.93	€ 136.61

2.1 ASSUMPTIONS REGARDING HOUSEHOLDS' EXPENDITURE ON RES

In order to estimate households' expenditure in RES support it has been assumed that households with an annual income lower than €12,000 are eligible to benefit from the social bonus[26]. Because the social bonus is not given only to low income households[27], there might be some households receiving the bonus that belong to higher income segments. However, in contrast to low income households where we estimate all of them benefit from a reduction on the electricity bill, we also estimate that in higher income households the ones benefiting from a reduction are a minority within their segment.

3. DISTRIBUTION OF RES SUPPORT AMONG HOME AND MOTOR FUELS

The next step has been to subtract from the electricity bill the portion paid by households to RES support and to redistribute this surcharge among the other energy products consumed, which affect less regressively to households' income distribution. *Table 21* shows total expenditure on electricity per income segment after deducting from the electricity bill the corresponding RES surcharges.

Table 21: Annual electricity expenditure per income segment without RES support (€)

Income Segments	Grid Tariff	Initial Expenditure on Electricity [€]	Expenditure on Electricity without RES Support [€]
1	Social Bonus	€ 319.84	€ 314.14
2	Social Bonus	€ 415.32	€ 407.92
3	2.0 A	€ 436.22	€ 348.29
4	2.0 A	€ 459.07	€ 366.53
5	2.0 A	€ 494.69	€ 394.97
6	2.0 A	€ 492.08	€ 392.89
7	2.0 A	€ 524.79	€ 419.00
8	2.0 A	€ 677.68	€ 541.07

The analysis proposed is to reallocate the total costs of RES support (€8.5 billion) among the consumption of motor fuels (namely gasoline 95, gasoline 98 and diesel) and home fuels (gasoil, coal and natural gas), depending on two of their physical characteristics: their heat content and their generated CO_2 emissions. Important is to mention that the implicit assumption in redistributing the costs among other fuels than electricity is that household energy demand is unresponsive to price changes on home and motor fuels, which is a reasonable assumption only for the short term.

3.1 SECTORAL ALLOCATION OF RES SURCHARGES ACCORDING TO THE HEAT CONTENT OF HOME AND MOTOR FUELS

The aim of the analysis is to determine the amount of RES surcharges that should be allocated to each fuel type depending on the heat content consumed in Spain for home and motor fuels, measured in gigajoules (GJ). First of all, using the data published by CORES[28] on fuels consumed in 2012 in Spain (see Appendix *Table A1*), the study has calculated the amount of GJ consumed by type of fuel. Secondly, the heat content consumed by fuel type

[26] The social bonus represents 20% reduction with respect to the 2.0A tariff.
[27] Pensioners, large families and households with all its members unemployed are also eligible to receive the social bonus.
[28] Corporación de Reservas Estratégicas de Productos Petrolíferos, '*Informe estadístico anual 2012*'.

has been weighted with respect the overall energy consumed in Spain, in order to determine the share of RES financing that each fuel should take charge of (shown on *Table 22)*. Finally, the analysis has estimated the price increment that each fuel should suffer in order to cover the total support of RES in 2012 (shown on *Table 23*).

Table 22: Energy consumption by fuel type (GJ) and corresponding RES allocation (k€) – According to the heat content

	Gasoline 95	Gasoline 98	Gasoil A	Gasoil C	Coke	Natural Gas	TOTAL
Consumption (tep)	4,648,103	367,197	23,150,710	2,989,916	2,522,625	22,982,453	**56,661,004**
Consumption (GJ)	194,606,769	15,373,807	969,273,935	125,181,793	105,617,264	962,229,345	**2,372,282,912**
Distribution by Quantity & Heating Content	8.2%	0.6%	40.9%	5.3%	4.5%	40.6%	**100%**
Corresponding RES surcharge (k€)	**€ 698,804**	**€ 55,205**	**€ 3,480,518**	**€ 449,509**	**€ 379,256**	**€ 3,455,222**	**€ 8,518,515**

Consumption converted to tep from CORES data (see Appendix Table A1) using the conversion factors from Table A3.

Table 23: RES by fuel type (c€/unit) and corresponding price increments (%) – According to the heat content

	Gasoline 95 [c€/l]	Gasoline 98 [c€/l]	Gasoil A [c€/l]	Gasoil C [c€/l]	Coke [c€/k]	Natural Gas [c€/m^3]
Price 2012 (VAT not included)	74.02	82.00	78.56	71.21	9.72	76.21
RES Price	11.65	11.65	13.77	13.77	11.65	15.12
Total Price	**85.67**	**93.65**	**92.33**	**84.98**	**21.37**	**91.34**
Price Δ [%]	**16%**	**14%**	**18%**	**19%**	**120%**	**20%**

Gasolines, gasoils and natural gas prices from CORES, 'Informe estadístico anual 2012'*; coke price from INE.*

As shown on *Table 22* and *Table 23*, according to the national quantities consumed and their corresponding heat content, diesel fuel (gasoil A – 40.9%) should support the highest portion of RES support, closely followed by natural gas (40.6%), to cover 2012 RES surcharges. With regard to the price increment the analysed fuels should experience, coke is by far the most affected fuel due to its comparatively low current price, and should increase its price by 120%. In contrast, gasoline 98 would be the least affected regarding price increments (14%) due to its comparatively low consumption.

3.2 SECTORAL ALLOCATION OF RES SURCHARGES ACCORDING TO CO_2 EMISSIONS FROM HOME AND MOTOR FUELS

As an alternative to RES allocation depending on the fuels' heat content, the study has also analysed the distribution of such surcharges according to the CO_2 emissions generated from home and motor fuels' consumption in Spain. Using the same data sources and following the same structure as on the previous analyse, the results per fuel type are shown on *Table 24* and *Table 25*.

Also under this scenario, the most affected fuel is diesel fuel, which would be entitled to support approximately 45% of the total 2012 RES surcharge. However, regarding price increments, coke would have to experience the greatest increase, by more than 170%. This is because coke would be charged the highest RES price as it is the fuel with the highest CO_2 emissions factor.

Table 24: Energy consumption by fuel type (GJ) and corresponding RES allocation (k€) – According to C0₂ emisisons

	Gasoline 95	Gasoline 98	Gasoil A	Gasoil C	Coke	Natural Gas	TOTAL
Consumption (tep)	4,648,103	367,197	23,150,710	2,989,916	2,522,625	22,982,453	**56,661,004**
tCO_2	13,479,498	1,064,871	70,841,173	9,149,142	10,393,215	53,778,940	**158,706,840**
Distribution by Quantity & CO_2 emissions	8.5%	0.7%	44.6%	5.8%	6.5%	33.9%	**100%**
Corresponding RES surcharge (k€)	**€ 723,506**	**€ 57,156**	**€ 3,802,367**	**€ 491,076**	**€ 557,851**	**€ 2,886,559**	**€ 8,518,515**

Consumption converted to tep from CORES data (see Appendix Table A1) using the conversion factors from Table A3.

Table 25: RES price by fuel type (c€/unit) and corresponding price increments (%) – According to C0₂ emisisons

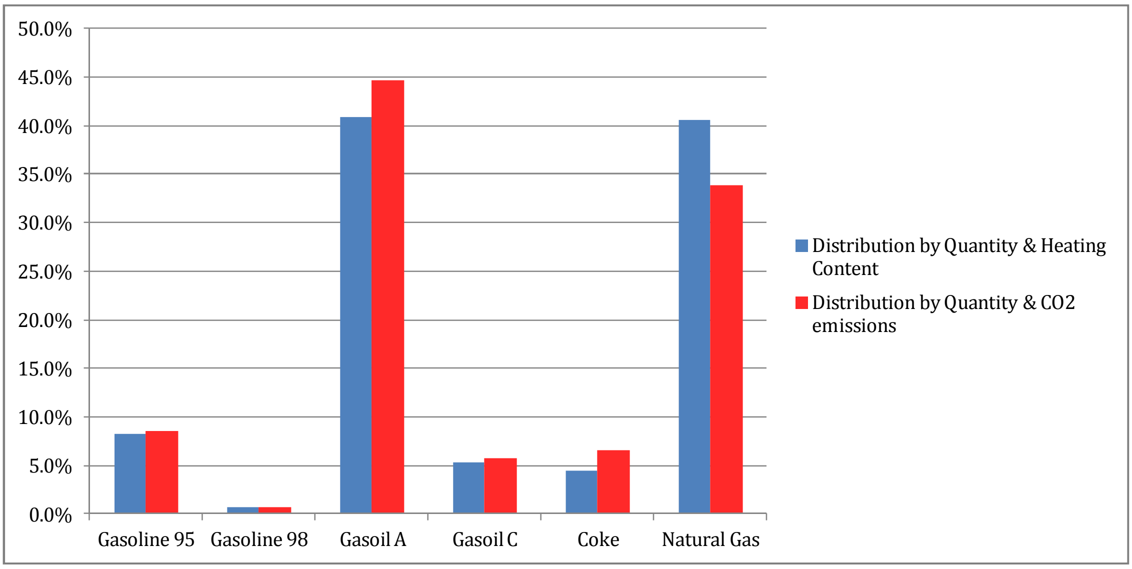
	Gasoline 95 [c€/l]	Gasoline 98 [c€/l]	Gasoil A [c€/l]	Gasoil C [c€/l]	Coke [c€/k]	Natural Gas [c€/m^3]
Price 2012 (VAT not included)	74.02	82.00	78.56	71.21	9.72	76.21
RES Price	12.07	12.07	15.04	15.04	17.14	12.64
Total Price	**86.09**	**94.07**	**93.60**	**86.25**	**26.86**	**88.85**
Price Δ [%]	**16%**	**15%**	**19%**	**21%**	**176%**	**17%**

Gasolines, gasoils and natural gas prices from CORES, 'Informe estadístico anual 2012'*; coke price from INE.*

3.3 COMPARISON OF SCENARIOS: HEAT CONTENT VS CARBON CONTENT

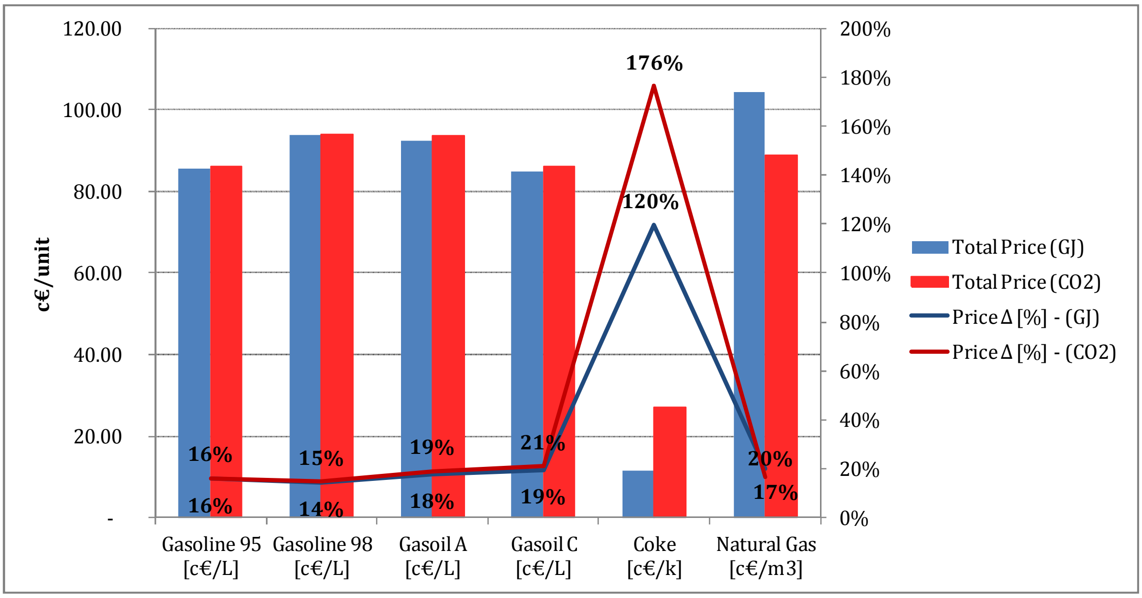
As shown on *Figure 29*, diesel and natural gas would be the greater contributors to RES financing. However, depending on the parameters evaluated for each fuel, the total contribution level changes. For diesel, the contribution to RES would be higher if the parameter evaluated is CO_2 emissions, while the opposite occurs for natural gas with respect to the heat content.

Figure 29: Contribution to RES financing by fuel type (%)



With regard to price increments, coke is by far the most affected fuel, experiencing a higher increment on its price when contribution is indexed to CO_2 emissions. Regarding final prices (i.e. current price plus RES price), all prices are higher under the emissions scenario, except for natural gas. By fuel type, gasoline 98 and diesel are the most expensive fuels under the emissions scenario, while under the heat content scenario natural gas would be the most expensive one. Coke, in spite of the important impact on prices, remains the cheapest fuel under both scenarios.

Figure 30: Final prices (c€/unit) and price increments (%) by fuel type

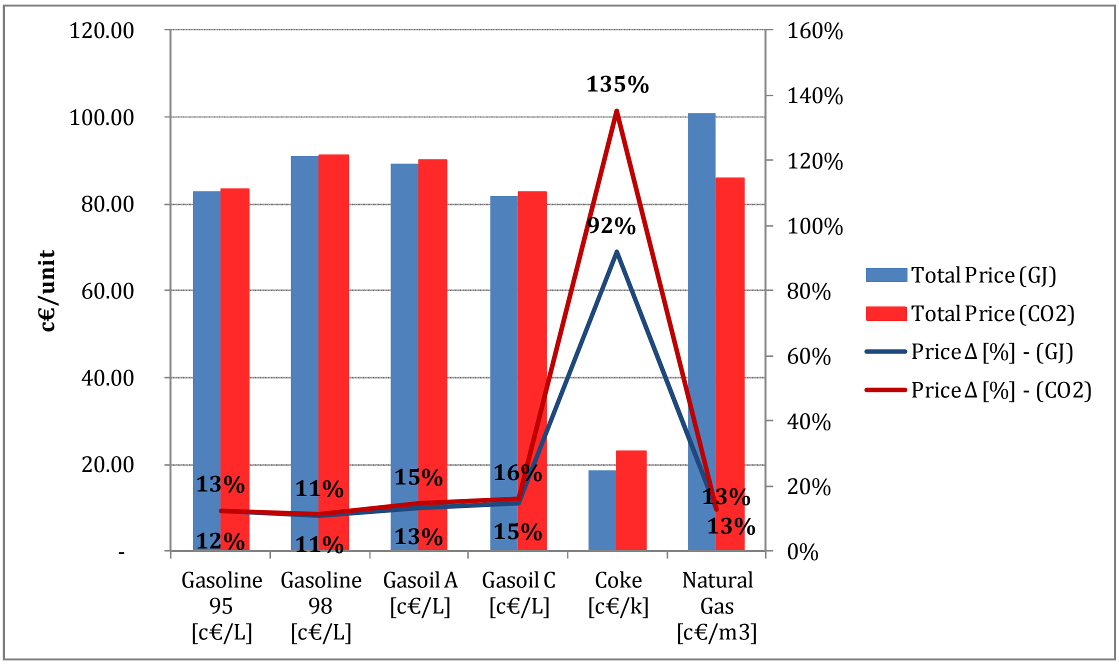


3.4 DISTRIBUTION OF RES SUPPORT WITHOUT INCLUDING THE SHARE ATTRIBUTABLE TO THE ELECTRICITY SECTOR

Because electricity represents 23.2% of the total gross final consumption in Spain in 2012[29], we consider that transferring the entirety of the costs of RES support would not be the best alternative as the responsibility of each sector within the final consumption should also be considered. Therefore, we have also developed the analysis for the distribution of 6.542 billion Euros.

Under this new scenario, the proportional contribution of each fuel would not change with respect allocating the total cost of RES. However, price increments, due to the distribution of a smaller quantity, show less marked increases. Coal continues to be the most affected fuel. In general, the responding patterns remain unchanged, and prices are the only variables affected by the new cost allocation. *Figure 31* below shows new final prices and corresponding price increments of the different fuels.

Figure 31: Final prices (c€/unit) and price increments (%) by fuel type – Allocation of 6.5 billion €

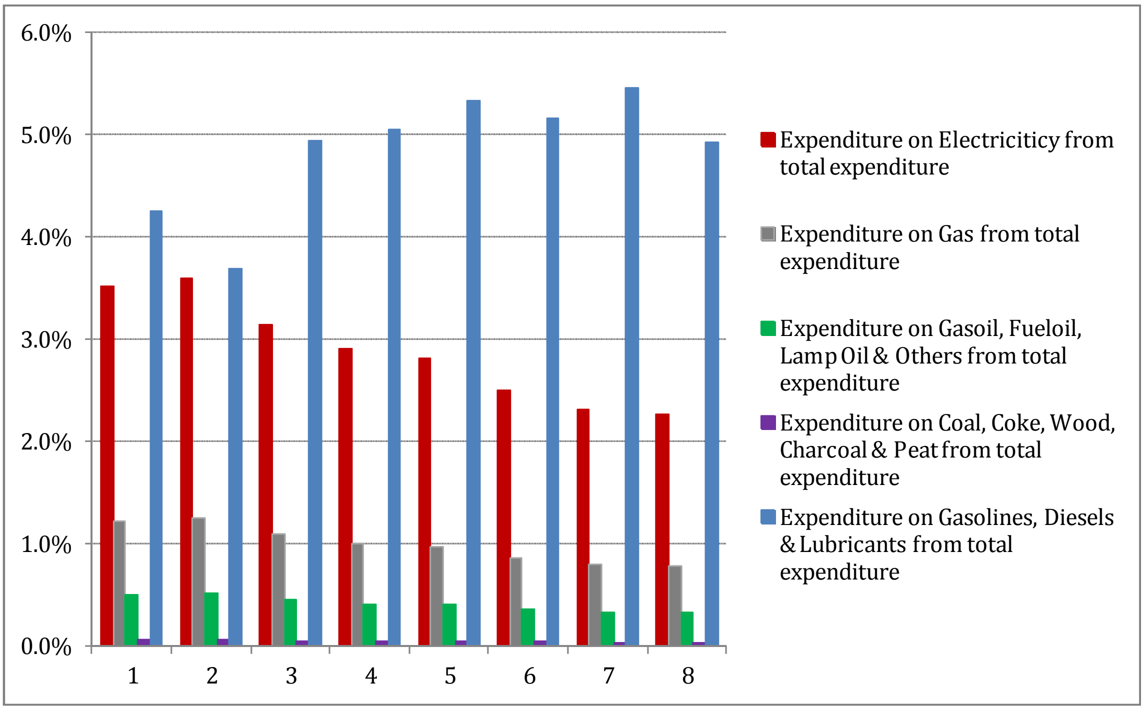


29 IDAE, '*Evolución mensual de consumos de energía final en España. Año 2012*'.

IV. RESULTS

Electricity expenditure proved to be high regressively distributed across households, as well as home fuels, although these later energy products represent a much smaller portion from total expenditure and the regressiveness effect is much less pronounced. As *Figure 32* shows, electricity represents 3.5% and 3.6% from the overall expenditure in the lowest income segments, while in the richest segment it accounts for 2.3%. By contrast, expenditure on motor fuels has proved to be progressive, growing from 4.3% or 3.7% in the poorest segments, up to 5.5% and 4.9% in the richest ones.

Figure 32: Expenditure on each energy product from total expenditure per income segment (%)



With the aim of reducing the regressive effect of electricity expenditure across households, the study has proposed to redistribute RES surcharges among home and motor fuels, based on the heat content and the CO_2 emissions of the fuels consumed. The first step has been to subtract from the electricity bill the portion of the grid tariff destined to finance RES. *Figure 33* compares the current expenditure on electricity with the final expenditure after subtracting from the grid tariff RES surcharges.

Furthermore, as explained on Section III, the tariff structure of the Spanish system has the peculiarity that low income households can benefit from a reduction on the electricity bill (the Social Bonus). Thus, the portion of RES supported by those households receiving the bonus is lower than for those which are not entitled to benefit from the subsidy. This explains why the reduction when subtracting the share of RES support is higher for richer segments than for poorer ones.

Interesting is also to compare per income segment the new expenditure on electricity with respect the overall expenditure. *Figure 34* shows the difference on the share of electricity expenditure from the overall expenditure of a household with respect the base case. As anticipated, the change is small for lower income households which benefit from the Social Bonus than for higher income ones. However, the change is smaller as annual income increases from the third segment (the first segment not benefiting from the bonus). This means that the benefit on households' disposable income of subtracting RES financing from the electricity bill is higher for lower income households than for higher income ones.

Figure 33: Comparison between annual expenditure on electricity with and without RES surcharges (€)

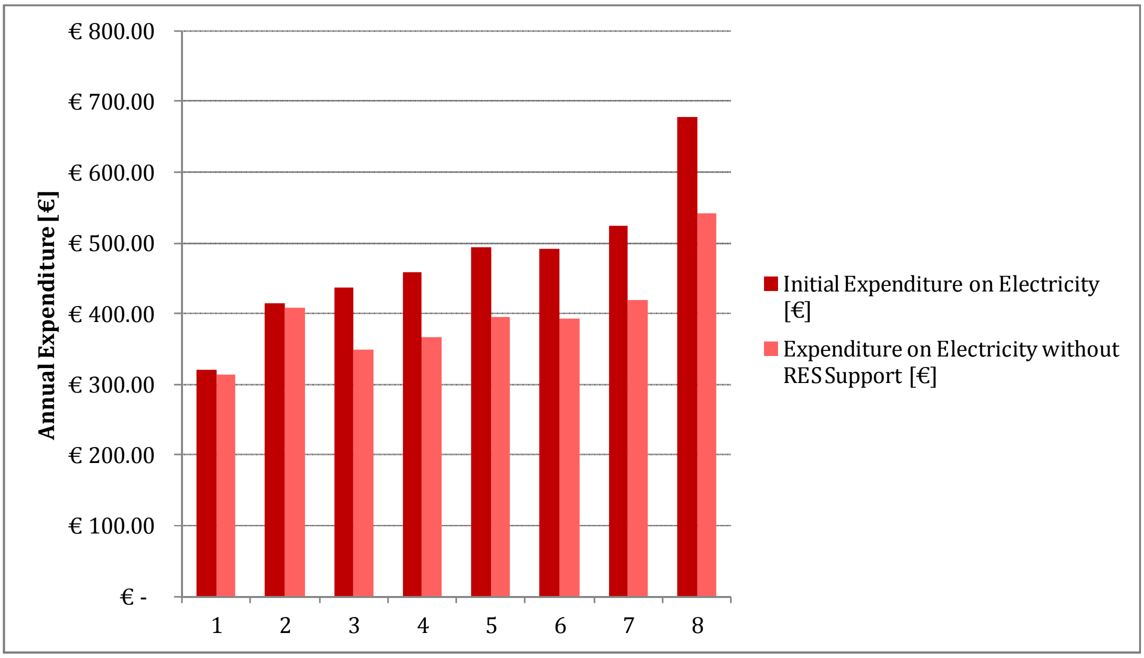
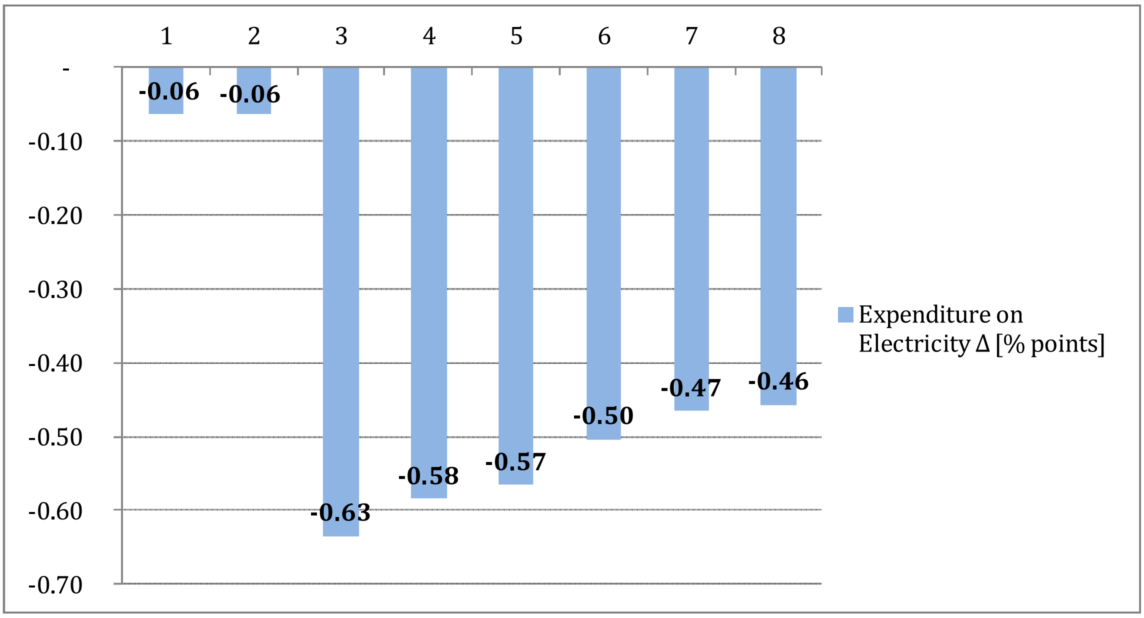


Figure 34: Change on the share of electricity expenditure from overall expenditure with respect the base case (% points)



The next step has been to transfer the price increments of home and motor fuels to households' annual expenditure on such fuels. The increments have been applied to net expenditures and subsequently, we have applied the corresponding VAT to allow the comparison of both current expenditures with expenditures incremented by RES support. Therefore, the relevant analyse is to compare the portion of the new incremented expenditures with the annual overall expenditure of households per income segment, and to see the induced changes on the slopes of each fuel consumed with respect to the slopes of the base case (see *Figure 32*). *Figure 35* and *Figure 36* show the change on the share of different home and motor fuels' expenditure with respect the base case under the heat content and the CO_2 emissions scenarios, respectively.

Figure 35: Change on the share of home and motor fuels expenditure from overall expenditure with respect to the base case (% points) – Heat content scenario

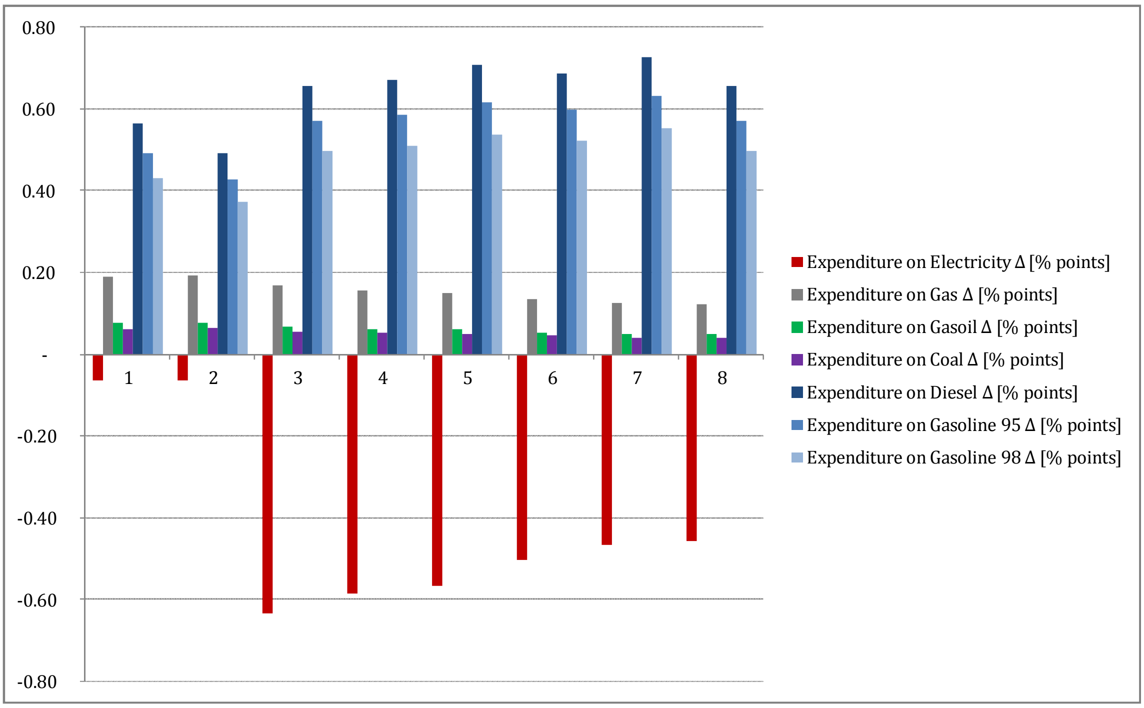
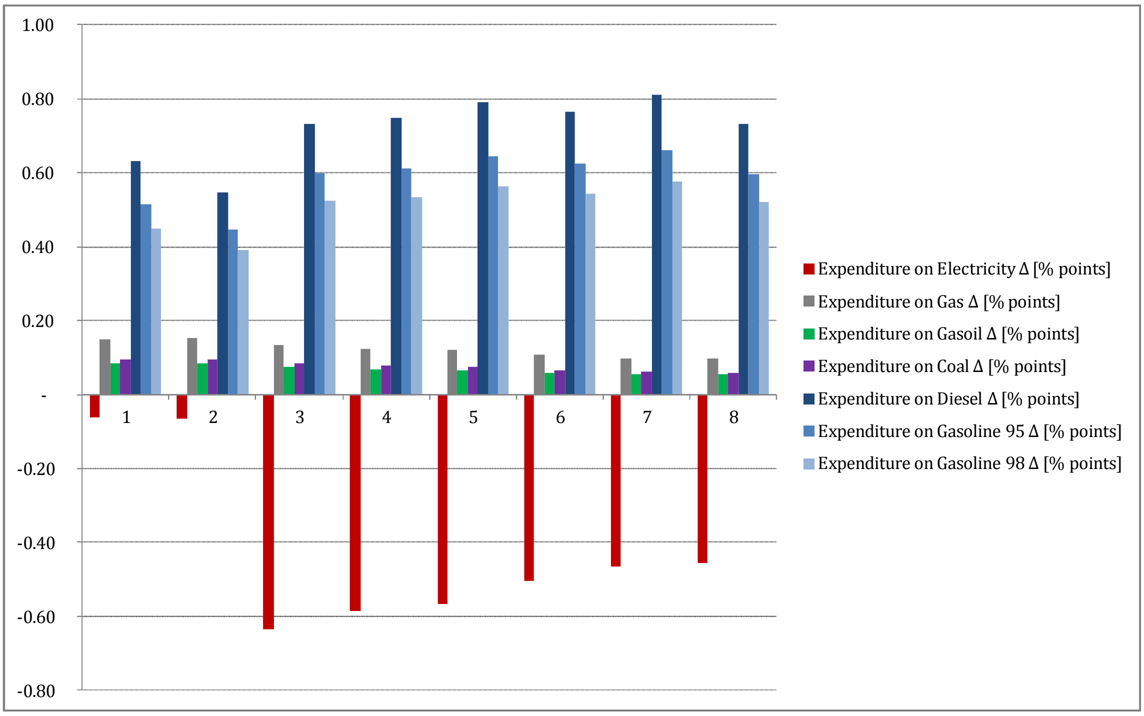


Figure 36: Change on the share of home and motor fuels expenditure from overall expenditure with respect to the base case (% points) – CO_2 emissions scenario



Under the CO_2 emissions scenario, home and motor fuels expenditures are greater in proportion to overall expenditure than on the heat content scenario. This is true for all fuels except for natural gas, which annual expenditure is more significant with respect to overall expenditure when RES surcharges are distributed depending on the heat content.

Finally, the general picture of households' expenditure by fuel type in 2012 with respect to their overall expenditure is shown on *Figure 37* for RES surcharges distributed according to the heat content and on *Figure 38* for such surcharges reallocated depending on the CO_2 emissions generated by each fuel.

Figure 37: Expenditure on each energy product from total expenditure per income segment – Distribution depending on the heat content (%)

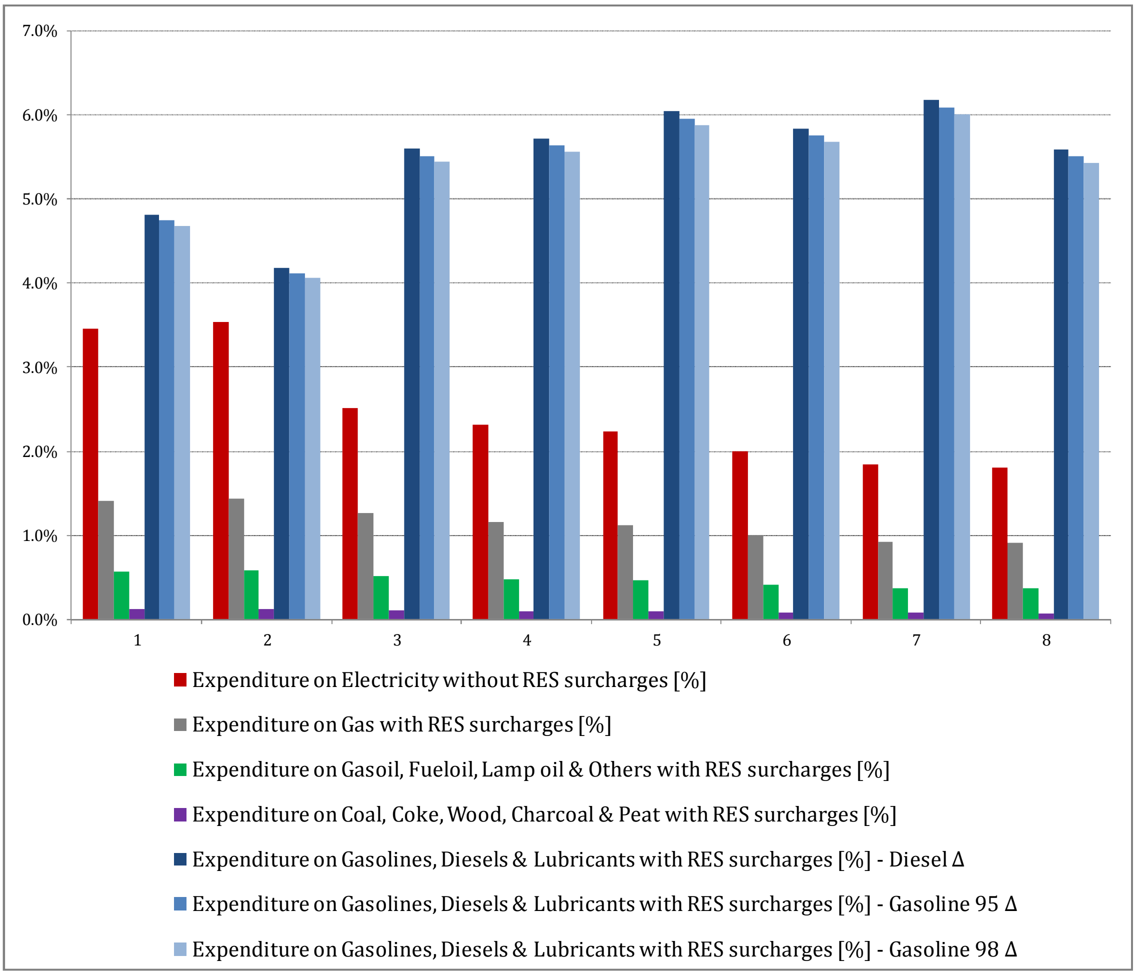
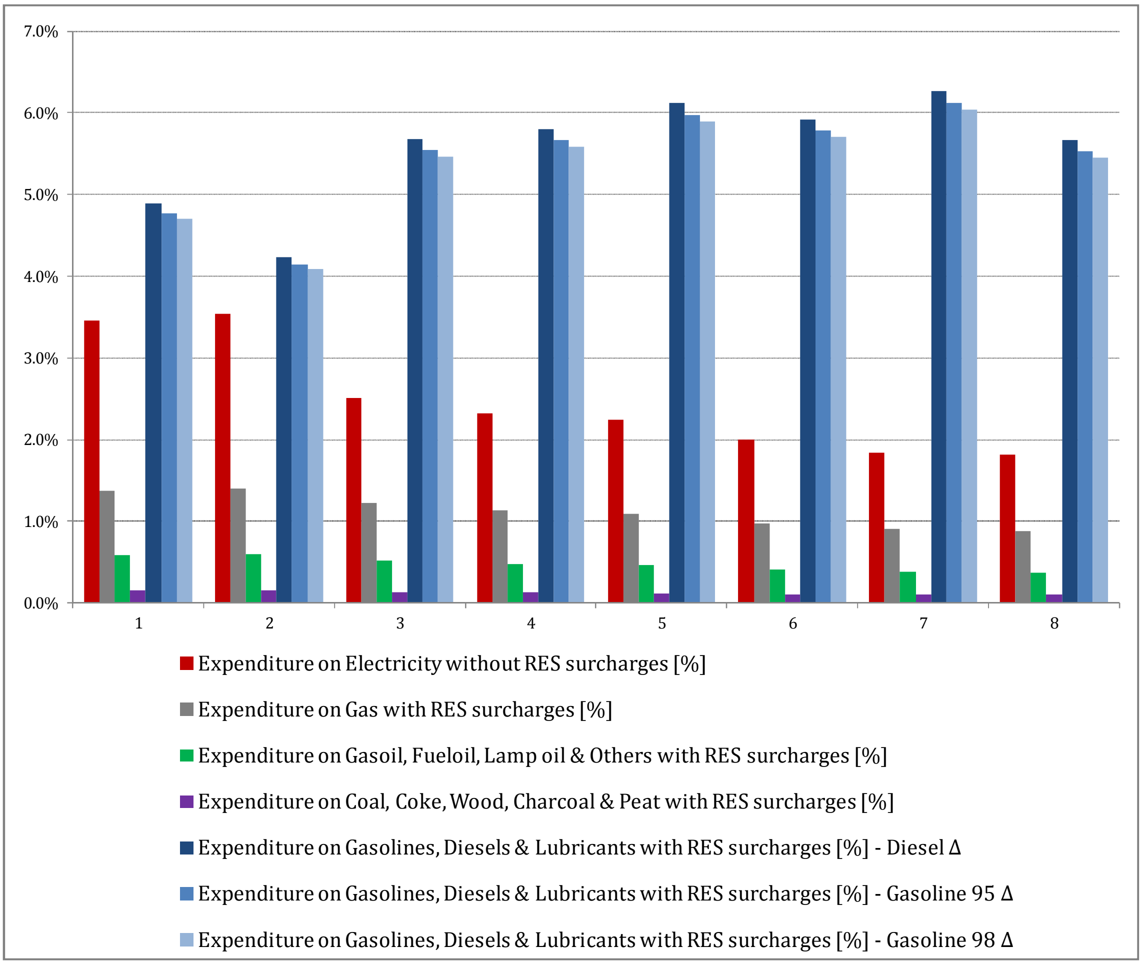


Figure 38: Expenditure on each energy product from total expenditure per income segment – Distribution depending on generated CO_2 emissions (%)



With the reallocation of RES surcharges the slope of the electricity expenditure curve is now flatter between the third and the eighth segments than in the base case scenario. Note that the difference between these segments on the initial case was of 0.88 percentage points, while under both the heat content and the CO_2 emissions' proposals is of 0.70 percentage points. In contrast, the regressivity of electricity expenditure under the proposed scenarios is now higher between the two lower income segments and the richer ones. This is because low income segments contribute in a smaller portion to RES financing due to the electricity subsidy they benefit from.

With regard to home and motor fuels, the expenditure increments are small with respect to the total expenditure of households. Nevertheless, the allocation of RES surcharges among motor fuels (diesel, gasoline 95 and gasoline 98) has affected more progressively the distribution of such fuels across income segments. The differences between the second poorest segment and the richest one under the three scenarios are shown on *Table 26*. The progressivity effect is the highest for diesel under the CO_2 emissions proposal.

Table 26: Differences on the share of motor fuels with respect to total expenditure between the second poorest segment and the richest one (% points)

	Base case [% points]	Heating content scenario [% points]	CO_2 emissions scenario [% points]
Diesel	1.24	1.40	1.42
Gasoline 95		1.38	1.39
Gasoline 98		1.36	1.37

Regarding the changes on home fuel expenditure, *Table 27* shows the variation with respect the base case of the regressivity effect. Comparing *Table 26* and *Table 27* it can be stated that the progressivity gained by motor fuels is higher than the regressivity obtained with home fuels, thus creating a more evenly distribution of RES surcharges across households.

Table 27: Differences on the share of home fuels with respect to total expenditure between the richest segment and the poorest one (% points)

	Base case [% points]	**Heating content scenario [% points]**	**CO_2 emissions scenario [% points]**
Gasoil C	- 0.18	- 0.20	- 0.21
Natural Gas	- 0.43	- 0.50	- 0.49
Coke	- 0.02	- 0.04	- 0.05

V. CONCLUSIONS

The present paper has investigated the incidence, across income distribution, of the RES surcharges paid within the grid tariff in Spain. Driven by exponential investment in RES technology, RES surcharges in Spain have increased about 600% between 2004 and 2013, ending to represent approximately 16% of the electricity price paid by an average household. Although European RES and emissions targets are for all sources of energy, the costs of RES support are exclusively charged to electricity consumers. Because electricity is a first necessity good, more than other energy product, the current mechanism in place to finance RES investment is questionable because of the regressiveness of such a system. Moreover, following the medium and long-term European climate and energy framework guidelines, it is reasonable to think that RES capacity will continue to grow and therefore, to analyse alternative mechanisms that allow to recover RES costs in a more equitable way.

Following this reasoning, the present study has considered both a tax based on the heat content and another one based on the carbon content as means for recovering the cost of RES support alternative to the grid tariff. In a context were Spanish energy and environmental taxation is well below the European average, both taxes would apply to home and motor fuels. The difference between the grid tariff method and the ones proposed is that whether the former is exclusive for electricity, the latter hit all forms of energy. Following the existing studies that suggest that energy is a less necessary good than electricity, we expected to demonstrate that a carbon tax and a heat content tax would be less regressively distributed among households.

The methodology used proposes to subtract from the electricity bill the overall RES costs and to reallocate them among the consumption of gasoline, motor and heating diesel, coke and natural gas; based on the fuels' heat and carbon contents. On the one hand, the results obtained show that electricity expenditure is very regressively distributed across Spanish households, in contrast to motor fuels, which are highly progressive. On the other hand, the subtraction of RES surcharges from the electricity bill would allow for a considerably more equitable distribution of such costs among different income segments. Furthermore, the inclusion of RES costs within home fuels expenditure would result in a very small increase of the regressivity effect across households, while the progressivity effect would be higher if such costs are included within motor fuels expenditure. Therefore, it can be concluded that a mechanism based on the heat or carbon content of fuels would more evenly distribute the costs of RES support across income segments than the current grid tariff does.

The alternatives proposed present three positive characteristics. First, they have no cost, as it shifts a burden from electricity to home and motor fuels, not adding a new one. Second, they achieve greater equity. And third, for the carbon content case, it involves earmarking. With regard to this last advantage, a carbon tax would be more visible to customers than the grid tariff. According to many empirical studies[30], earmarking the revenues from environmental taxes increases their popularity.

The analysis has distributed the total costs of RES support in 2012 among some fuels consumed others than electricity. However, we consider that because electricity represents approximately 23% of the gross final energy consumed in Spain in 2012, the

[30] Kallbekken *et al.* (2011), Kallbeken and Sælen (2011), Hsu *et al.* (2008), Dresner *et al.* (2006).

electricity sector (i.e. electricity consumers) should take charge of the equivalent share it is responsible for.

Finally, important is to mention that the implicit assumption in redistributing the costs of RES support is that household energy demand is unresponsive to the price increments suffered by home and motor fuels, what is a reasonable assumption only for the short term. Therefore, we encourage other studies to develop a model that could take into account the dynamic efficiency that could be derived from more expensive energy prices, and to further assess the distributional effects shown on the present paper that could occur in a wider time horizon. Additionally, the present study is limited to the household sector, what suffices for the purpose of showing the fundamental difference in distributional effects between the grid tariff and the alternatives analysed. However, to take the effects on the rest of the economy into account, an economy-wide model would be needed.

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APPENDIX

Table A1: Quantities consumed (tonnes & GWh)

	Gasoline 95 [ton]	Gasoline 98 [ton]	Gasoil A [ton]	Gasoil C [ton]	Coke [ton]	Natural Gas [GWh]
Consumption 2012	4,557,000	360,000	21,084,000	2,723,000	3,255,000	267,286

Source: CORES, 'Informe estadístico anual 2012'.

Table A2: Density factors for fuels (gr/l)

	Gasoline 95	Gasoline 98	Gasoil A	Gasoil C
Density factor	760 gr/l	760 gr/l	834 gr/l	834 gr/l

Table A3: Conversion factors to tep (l/tep)

	Gasolines [l/tep]	Gasoils [l/tep]	Coke [t/tep]
units/tep	1,290	1,092	1.29

Table A4: Emissions factors (tCO_2)

ktep	Gasolines	Gasoils	Coke	Natural Gas
tCO_2/tep	2.90	3.06	4.12	2.34

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