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Economic analysis of the impact of electricity regulation

On the retail price of electricity, income transfers between producers and consumers, and economic growth



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This document provides summarized information on the objective, models and methods, validation process and results of the study **Economic analysis of the impact of electricity regulation**. The potential of the econometric tool developed in the study for regulatory analysis is also discussed.



Executive summary

This report provides summarized information on the objective, models and methods, validation process and results of the exhaustive research work **Economic analysis of the impact of electricity regulation**. The potential of the econometric tool developed in the study for regulatory analysis is also discussed.

Energy regulation undeniably has a significant impact on prices, income transfers and economic growth. Unfortunately, these effects have not been studied in depth using economic analysis.

The objective of this study is to develop and implement three econometric models in order to identify the impact of electricity regulations (1) on the retail price of electricity; (2) on income transfers between producers and consumers; and (3) on economic growth.

In this context, the aim of these models is to assess the impact of the regulation of the electricity sector and the changes introduced in this regulation on the economy throughout the period under consideration.

Following the performance metric approach, both the effects of renewable energy promotion costs and network costs on the retail electricity prices for households and industrial consumers are assessed in the retail price model. In the transfers' model, the impacts of the retail market liberalisation and the penetration of renewable electricity on consumers and producers' rents are evaluated through a wholesale market analysis. Finally, the growth model analyses the effect of renewable energy promotion costs and network costs on electricity consumption and economic growth.

At the heart of this study lies the development of three models. Once the first specifications of the models with the appropriate functional form have been defined, they needed to be validated and adjusted through their application to specific cases. In this stage, econometric estimations of the models were performed for the selected countries, namely Spain, the United Kingdom and Germany.

The team of InnoEnergy and the authors of this research and its models are opened to assist regulators aiming at deeper in the application of the developed econometric tool.

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Preamble

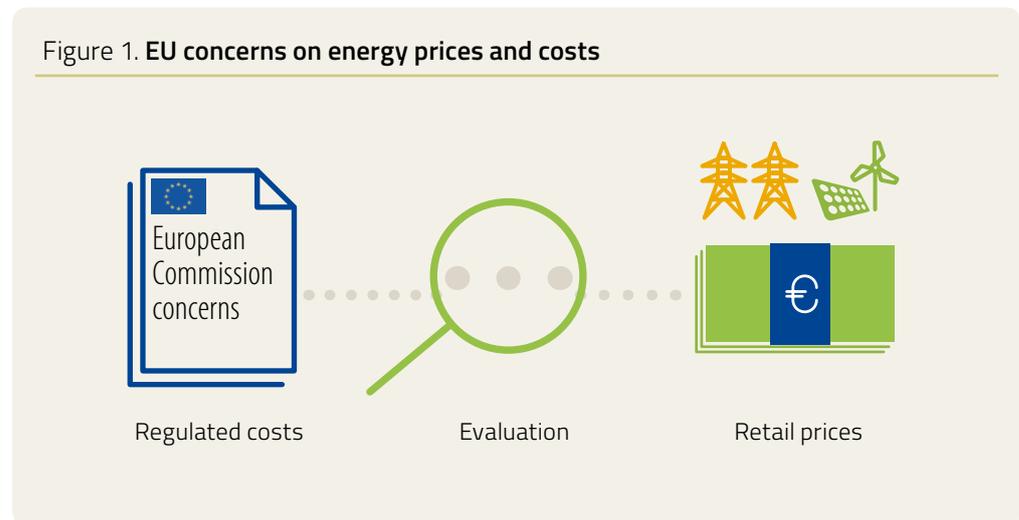
In the last decade it has become evident that the energy sector is in a turning point, **a new model is required to face the challenges of the upcoming years**. The required transformation of the traditional energy model, especially with regard to the environmental effects, has led to an inevitable and profound regulatory reform. From a regulatory perspective, the energy sector has witnessed a high level of activity at the European level. Three consecutive packages were adopted aiming at harmonising and liberalising the European Union (EU) internal energy market. In addition, the climate and energy package set ambitious targets for 2020 in terms of emissions reduction, penetration of renewables and energy efficiency. Climate and energy as an integrated policy within the EU has led to the trilemma of targets: competitiveness, sustainability, and security of supply. More recently, the European Commission has defined the 2050 roadmap and the 2030 targets as an intermediate step in energy and climate policy to achieve sustainable economic growth.

Unfortunately, the objectives pursued by the climate and energy policy of the EU -environmental sustainability, security of supply and competitiveness- are difficult to achieve simultaneously and even more if they are supported on market forces only. Therefore, priorities need to be set. When the energy policy objectives are analysed in detail, it becomes apparent that the environmental dimension has played an important role. Nevertheless, the economic crisis and its undesirable effects on the capacity of European economies to grow and create wealth, have increased the attention on competitiveness as one of the main concerns in the policy agenda. It is fundamental for industrial development and economic growth that European firms preserve or improve its competitiveness. Within this context -and having in mind the other energy policy objectives, since firms must compete in difficult environments-, **the basic question is on the role of energy in the operating cost and in the competitiveness**.

The **increasing concern in Europe about the recent evolution of energy costs and prices and its impact on the industrial competitiveness** is observable in the 2014 EU Communication 'For a European Industrial Renaissance'. Every day it becomes more important to secure an affordable access to energy and raw materials, since these are an important part of the costs in many industries.

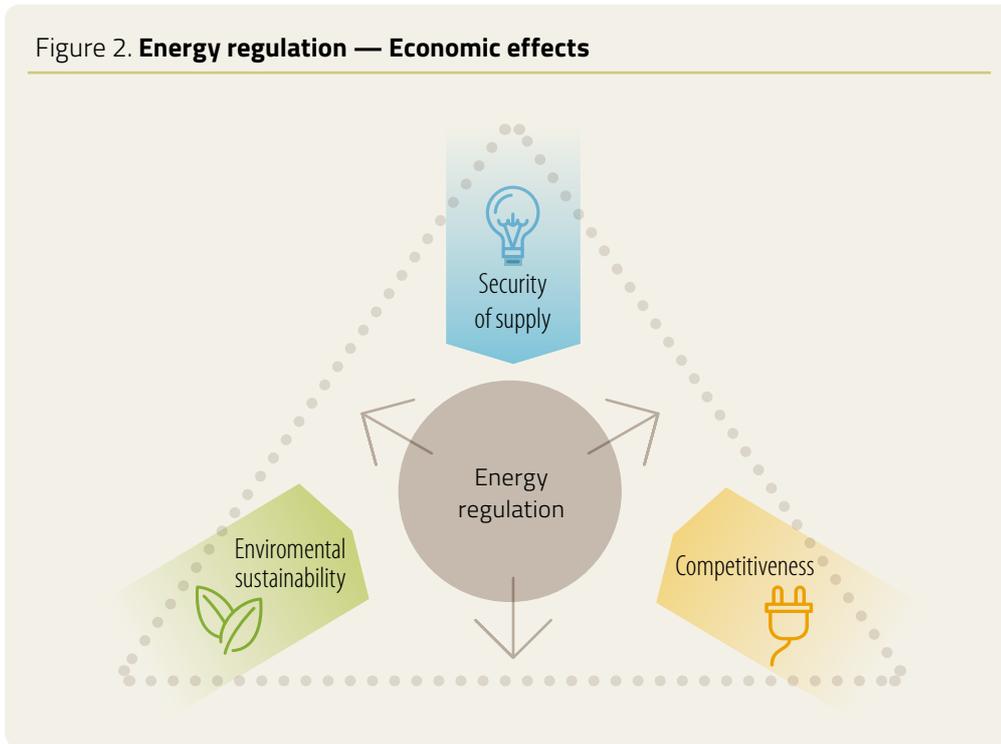
In so far as the evolution of energy costs negatively influences the competitiveness of energy intensive industries, it is fundamental to avoid disproportionate increases of those costs as a consequence of taxes, levies or other instruments introduced by Member States to enforce different policies. **This is essential to guarantee a good cost-effectiveness relation and contribute to improve EU competitiveness.** Therefore, the assumption of the upcoming objectives must follow an approach of costs effectiveness –affordable and competitive–, ensuring the security of supply and sustainability, while taking into account the current economic and political context.

Figure 1. EU concerns on energy prices and costs



The impact of energy costs and prices on industrial competitiveness depends on the weight that each energy source has on the final energy consumption matrix. Although electricity only represents 22% of total final energy consumed, this source has received especial attention as a competitiveness factor by the EU. It is worth mentioning that electricity is one of the main energy sources –along with natural gas– in the industrial sector (31%) and its consumption has increased at a high rate due to the progressive electrification of productive activities including transport. In addition, unlike other energy sources with prices being the result of international markets –and transportation costs–, the price formation mechanism of electricity is the result of events in regional and even national markets, leading to potential differences, and hence, some room for relative competitive advantage. Albeit the interior market has contributed to the development of competition conditions, which together with the increasing penetration of renewable energy has led to price reductions in the wholesale market, the retail segment is an increasing focus of concern in the EU. **The retail prices have been affected by the increasing trend of the regulated costs burdened by final consumers. Therefore, a profound understanding of the economic impact of electricity regulation is required, and the economic analysis developed in this study is deemed a relevant contribution to this end.**

Figure 2. **Energy regulation — Economic effects**



Energy regulation undeniably has a significant impact on prices, income transfers and economic growth. Unfortunately, these effects have not been studied in depth using economic analysis.

Given the importance of regulation for the electricity sector and for the whole productive system, an empirical study is carried out in this project in order to evaluate the economic effects of energy policy and of energy regulation on the electricity sector.



1. Study's objective and approach

The present structural organisation of the electricity market results from the common liberalisation process in Europe. A gradual process of liberalisation, introducing market principles in the different electricity segments where it was feasible, is widespread across Europe. That has allowed the separation of activities that could be carried out within a free market regime (generation and retail) from those that remained within a regulated monopoly (transmission and distribution).

Under this process, **the regulatory function appears as a key element, being responsible for the definition of the framework that guarantees the correct technical management of the power system, the coordination of the networks and the transparency of access conditions for all the agents participating in the power market.** In other words, in this process of liberalisation competition and regulation represent the two sides of the same coin. Real competition in power markets cannot be fully achieved without ensuring non-discriminatory network access and market functioning at the wholesale and retail levels.

Economic regulation must guarantee the recovery of all regulated costs in order to ensure the economic viability of the power system. In this context, energy regulation has a significant economic impact, which has to be considered ex-ante when designing energy policy initiatives.

Given the importance of regulation for the electricity sector and for the whole productive system, and considering the relevance of the ex-ante evaluation of the economic impact of regulatory change, an empirical approach to evaluate this impact is required. Therefore, **the objective of this study is to develop and implement three econometric models in order to identify the impact of electricity regulations (1) on the retail price of electricity; (2) on income transfers between producers and consumers; and (3) on economic growth.**

In this context, the **aim of these models is to assess the impact of the regulation of the electricity sector and the changes introduced in this regulation on the economy throughout the period under consideration.** To the extent that changes in these regulated costs are determined by decisions of a regulatory nature, the study and evaluation of the economic impact of any regulatory changes in the economy necessarily implies carrying out a previous analysis of the regulated cost associated with electricity supply.

The assessment and measurement of the impact of the reform processes and regulatory changes constitute a complex and challenging task to which this research study contributes. **This analysis has been carried out in this study through an assessment of the effects of regulatory changes based on the measurement and evaluation of outcomes** –in short, a performance metrics approach-. This approach has been widely used in academic studies for evaluating the impact of regulatory changes based on the results obtained for some specific economic indicators. Through this methodology, the study assesses an unsolved issue within the European energy policy, the evaluation of the economic impact of regulatory measures.

Econometric estimations of the models were performed for the selected countries, namely Spain, the United Kingdom and Germany. **All the three countries in which the models were applied represent relevant cases when analysing the impact of regulation.** Spain is a relevant case due to the isolated nature of the Iberian Peninsula and its high-reaching activity in renewable promotion policy. Likewise, besides being one of the largest economies in Europe, the UK, as the trailblazer in the electricity market liberalization process, is a highly interesting case. Finally, the German power system is the largest in Europe in terms of RES installed capacity. At the same time, from a regulatory perspective, Germany has introduced an ambitious energy transition program (the Energiewende) to decarbonise its economy.



2. The econometric models

Following the performance metric approach, both the effects of renewable energy promotion costs and network costs on the retail electricity prices for households and industrial consumers are assessed in the retail price model. In the transfers' model, the impacts of the retail market liberalisation and the penetration of renewable electricity on consumers and producers' rents are evaluated through a wholesale market analysis. Finally, the growth model analyses the effect of renewable energy promotion costs and network costs on electricity consumption and economic growth.

When evaluating the impact of regulation on final prices - **retail prices model** - it has to be pointed out that the analysis has been focused on those regulatory changes that imply an economic cost to be recovered through access tariffs or RES surcharge incorporated into the final price paid by industrial and domestic consumers. The evolution of energy costs is a matter of concern for the competitiveness of industries and consumers. Despite efficiency gains and the progressive opening of energy markets to competition, that have reduced wholesale electricity prices, retail prices have increased, showing that the price increase during this period has been strongly influenced by the regulated component.

In order to explain how the regulatory framework impacts on final electricity prices, it is important **to scrutinise and analyse the details of different components of retail prices**. In this study, the analysis of the evolution of the different components of the end consumer electricity price is carried out using data from EUROSTAT and the Council of European Energy Regulators (CEER). The prices used in this work cover the period from 2007 to 2013, as these are the first (and respectively the last) full years with complete retail price data for Member States and under the new Eurostat methodology that allow us to have **comparable data for EU Member States**. Separate component price data for production, network and taxes are not available prior to 2007.

Figure 3. Retail price model



Although the evolution of retail electricity prices might be affected by several factors, two regulatory aspects stand out and are the focus of this study, given their relevance: **the costs of support for electricity generation from renewable energy sources (RES-E) and the transmission and distribution network costs** (see Figure 4). The choice of these regulatory variables is based on their relevance on the final electricity prices paid by consumers.

Figure 4. Retail prices, renewable promotion cost and network costs

Figure 4a. Retail price vs renewable promotional cost. Spain

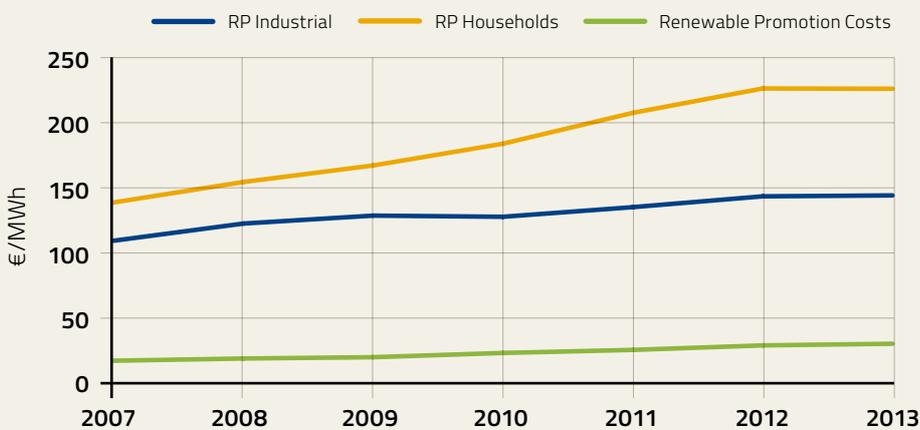


Figure 4b. Retail price vs network cost. Spain

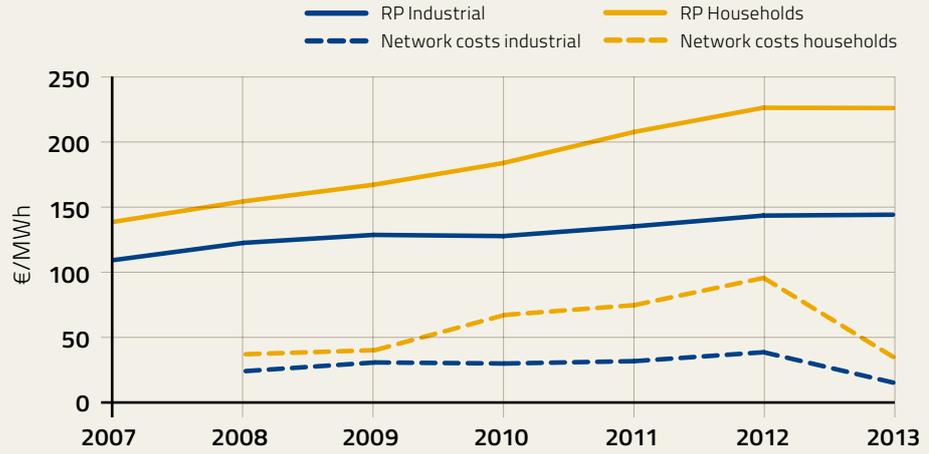


Figure 4c. Retail price vs renewable promotional cost. United Kingdom

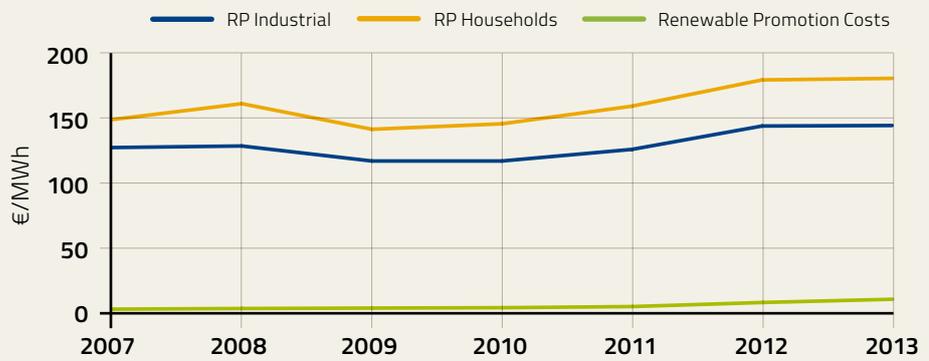


Figure 4d. Retail price vs network cost. United Kingdom

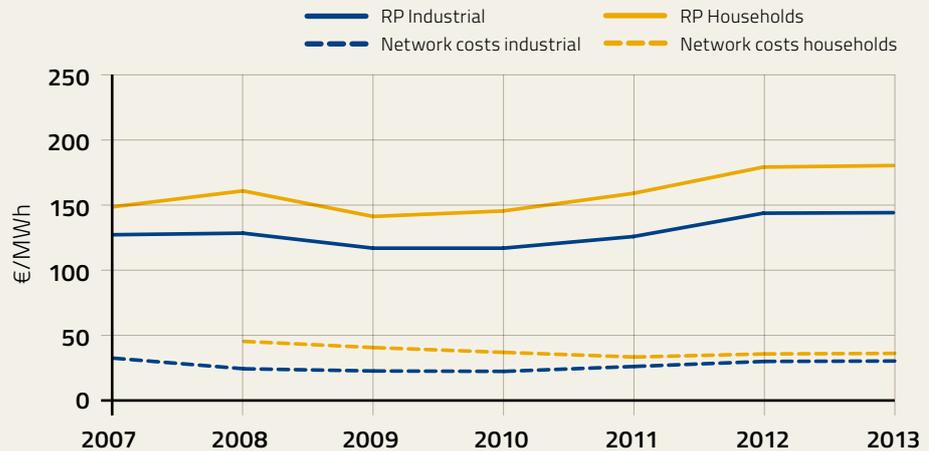


Figure 4e. Retail price vs renewable promotional cost. Germany

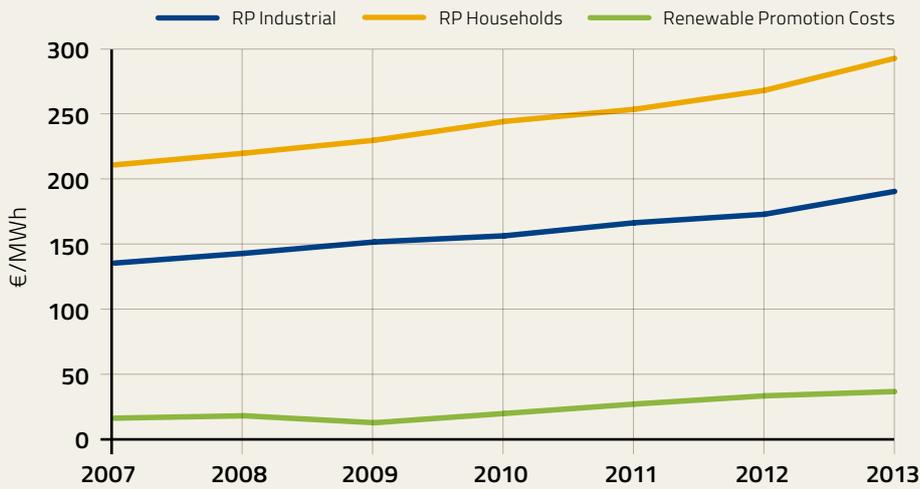
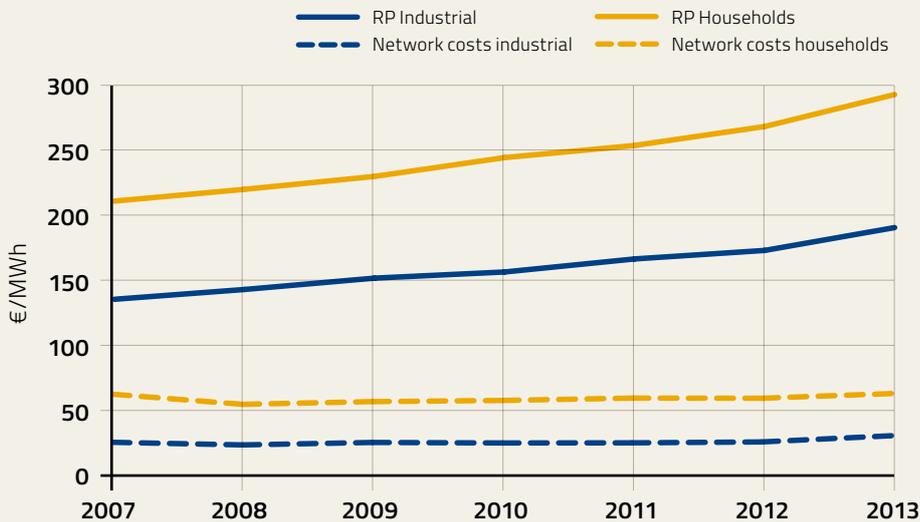


Figure 4f. Retail price vs network cost. Germany



Considering its different nature and power demand profile, the analysis is performed by discriminating according to the typology of consumers in **households** (DC band according to Eurostat classification) and **industrial electricity consumers** (IC band according to Eurostat classification). Both are the most representative consumer bands.

The underlying assumption in the **transfer model** is that **variations in market equilibrium conditions stemming from regulation necessarily result in a change in welfare and its distribution, resulting from new equilibrium prices in the wholesale market (see Figure 5).**

Within the electricity systems, the liberalized wholesale markets offer exceptional settings to

analyse rent transfers between producers and consumers (mainly represented by retailers) relying on the microeconomic foundations of welfare economics.

Figure 5. Wholesale equilibrium prices

Figure 5a. Spain

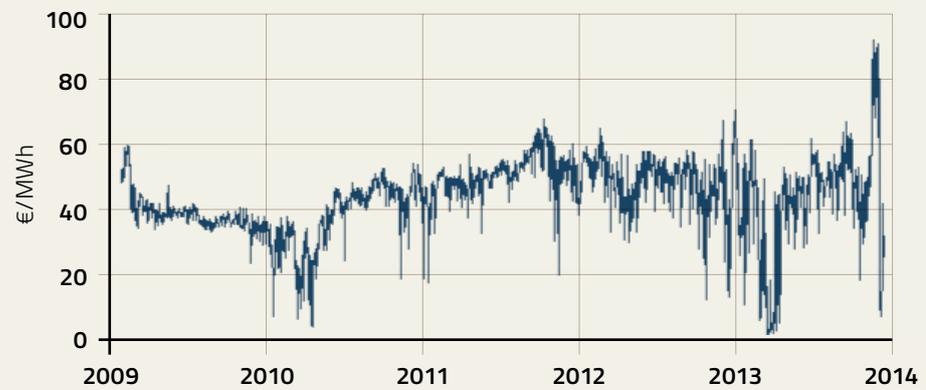


Figure 5b. United Kingdom

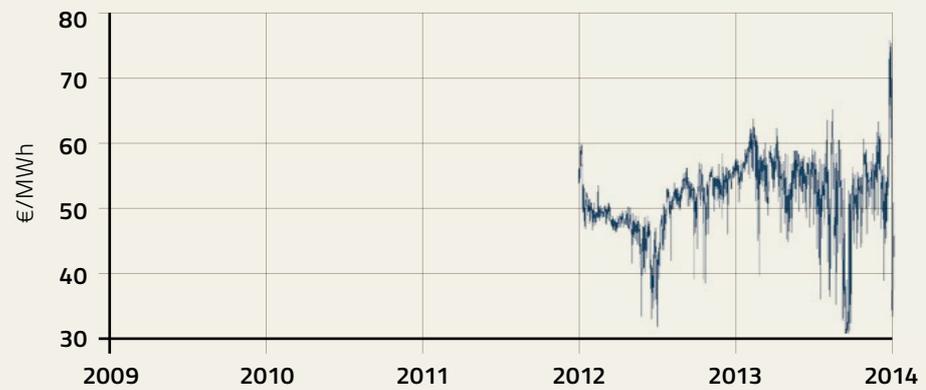
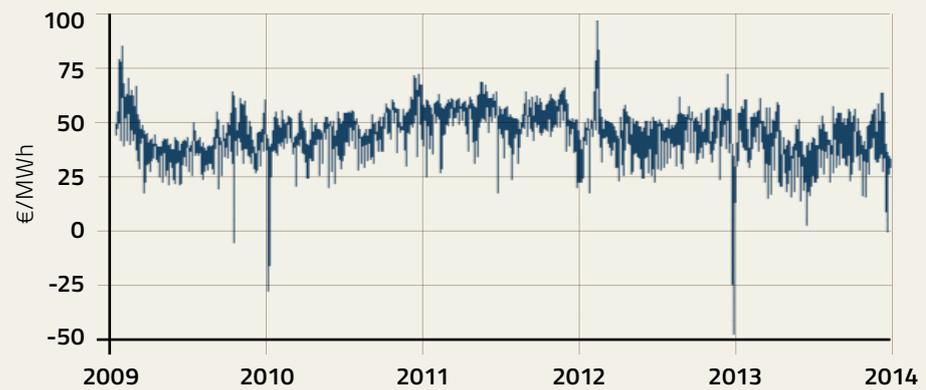


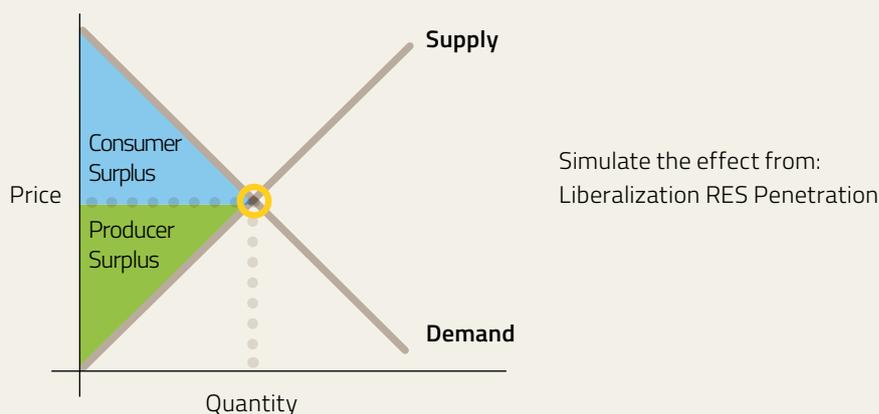
Figure 5c. Germany



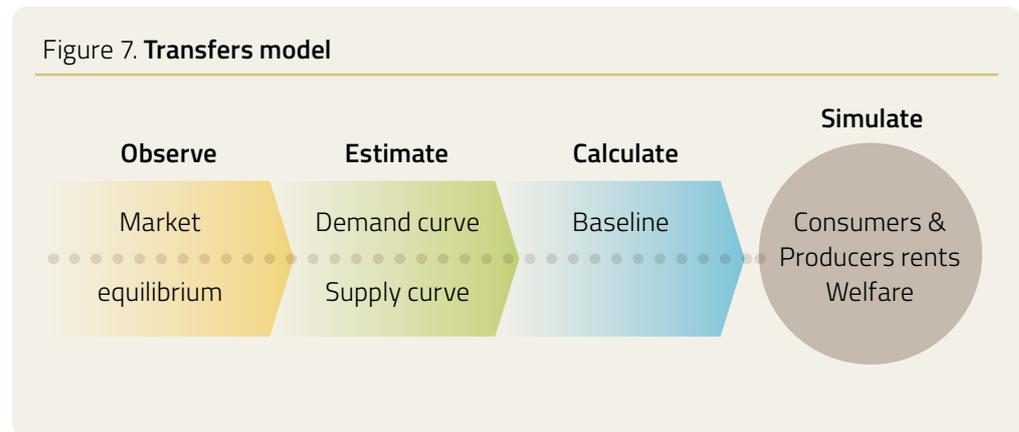
Economic theory defines the gains made by consumers as the **consumer surplus** and the profits made by producers as the **producer surplus**. A consumer is an economic agent that is willing to spend money to procure a good that will help to satisfy a need. The potential consumer's *willingness to pay* is defined as the maximum amount of money the agent would give away to access one unit of the good. The information about consumers' willingness to pay defines the demand schedule for goods. The consumers who purchase the product obtain a net gain that is equal to the difference between their willingness to pay and the price. **Every consumer of a good achieves some individual consumer surplus from participating into the market** that will be the result of multiplying the net gain by the quantity bought (also known as consumers' rents).

Similarly to the consumers of a good being willing to pay more for their purchase than the price they actually pay, the producers of a good would have been willing to sell it for less than the price they actually receive. One of the basic principles of economics is that **the true measure of the cost of doing anything is always its opportunity cost—the real cost of something is what you give up to get it**. This last statement makes it clear that there are some important differences between the definition of costs used by economists and those used in practice in managerial and even more particularly in financial accounting. Hence, the minimum price at which someone will sell a good is the cost of selling that good, including the opportunity cost. **The difference between the price that the producer actually gets and its cost—the minimum price at which he would have been willing to sell—is known as the producer surplus**. As in the case of the demand curve, it is possible to derive the supply curve from the cost -or *willingness to sell*- of different producers.

Figure 6. Transfer model – rents distribution between consumers and producers



In instances of market failure, there will be a net loss of measurable welfare. If **government intervention** occurs, this might tend to correct the market failure. This is a process where varying market conditions lead to different possibilities to generate revenues and the concepts of **consumer surplus** and **producer surplus** help us to understand how these revenues are shared among different agents. We simulate changes of the **liberalisation measure** and compute the corresponding changes in consumer surplus, producer surplus, and total welfare changes with respect to the baseline scenario, at the variables means. In the model, changes due to an increased **penetration of renewables** have been also simulated.



The main objective of the last model -the **growth model**- is the analysis of the effect of electricity regulation on economic growth. Understanding this effect is deemed essential for the assessment of regulatory policy. The assumption is that this impact takes place through the influence of regulation on electricity consumption. The approach being followed analyses the effects of energy regulation on final electricity consumption and then assesses the contribution of electricity consumption to economic growth.

The **relationship between electricity consumption and economic growth has been extensively analysed in the empirical literature**. Understanding the links and the direction of causality between these two variables has important implications for the design of energy and environmental policies. This relationship can be synthesized into four testable hypotheses known as the growth, conservation, neutrality and feedback hypotheses. **Previous empirical analyses carried out show different results**. This lack of consensus in the empirical literature is due to the differences in energy consumption patterns, different countries characteristics regarding their stage of development and institutional aspects, heterogeneity in climate conditions and the time period chosen for the studies (Payne, 2010; Ozturk, 2010). Therefore, having the economic theory supporting different hypotheses, the nature of the relation between electricity consumption and economic growth reminds an empirical question responding to context specific determinants.

Our main assumption when analysing the impact of regulation on economic growth is that this impact takes place by affecting electricity consumption (see Figure 8). Therefore, the approach followed identifies, in a first step, the effects of energy regulation on final electricity consumption, and, then, assesses the contribution of electricity consumption to economic growth.

Figure 8. GDP and electricity consumption

Figure 8a. Spain

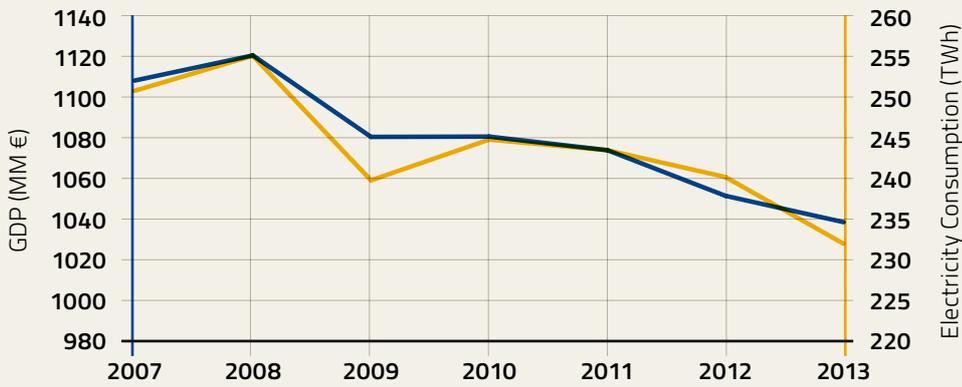
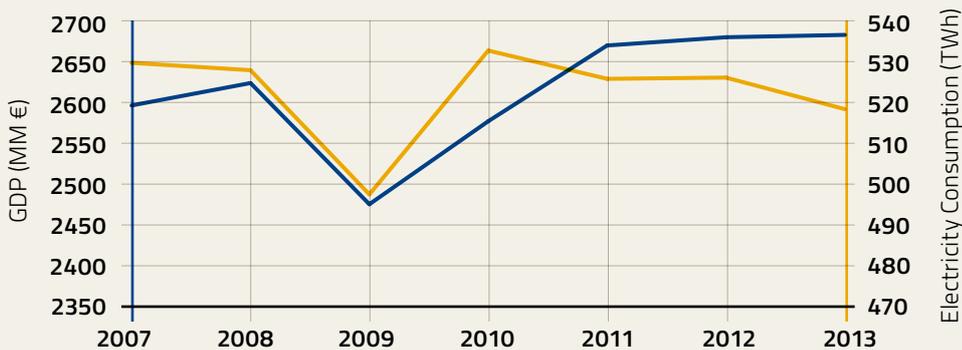
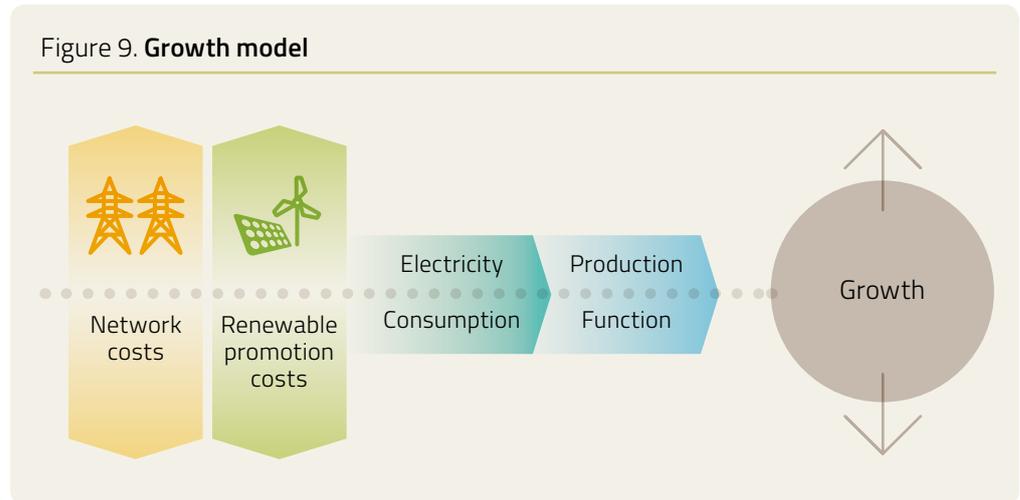


Figure 8b. United Kingdom



Figure 8c. Germany





As in the retail price model, the empirical estimation of the impact of **renewable energy promotion costs and network cost industries on economic growth** is also performed **using panel data econometric techniques** with information for all EU countries.



3. Validation process and results

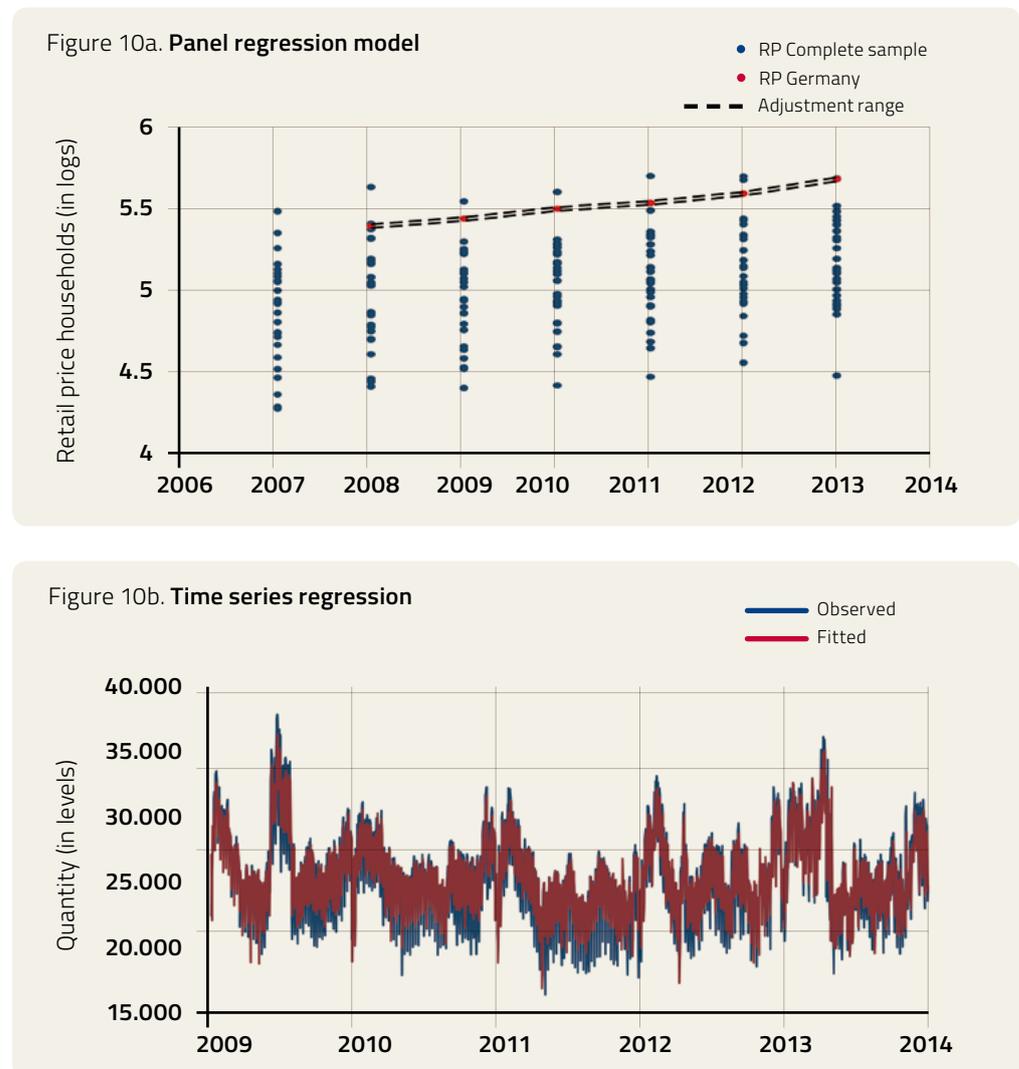
At the heart of this study lies the development of three models. During the first stage of the research study, prior tasks associated to the models and data have been undertaken. These tasks included a state-of-the-art review of the literature, a detailed review of all data sources, the consulting of specialists in each country making up the network of international centres conducting research studies, as well as data collection, and the cleansing and processing of the databases that were subsequently used in the estimations in order to decide on the first specification and functional form of the various models.

Once the first specifications of the models with the appropriate functional form have been defined, they needed to be validated and adjusted through their application to specific cases. The division of the model validation process by case study ensures, first, the frequent preparation and delivery of tangible results, and second, the readjustments required in the models to achieve the highest possible homogeneity across countries.

The validation confirmed the strength and robustness of the econometric models developed during the first stage of the study. **The validation process involves the application of the three models and the analysis** of its results from both a conceptual and a statistical perspective. This validation guarantees that each model is correctly defined and can be replicated to other countries. The general empirical approach being followed is one of econometric confidence and robustness. The validity of econometric models is based on probabilistic analysis, according to which the results of the estimations are acceptable within a specific degree of confidence. For this validation process, 90% has been defined as the acceptable degree of confidence, which is a standard percentage used in the literature. This implies that any result failing to comply with this condition would be non-significant for the model and hence not relevant for the analysis. Therefore, the result obtained in this study can be considered as valid and statistically representative of the reality behind the regulatory changes.

Figure 10 shows two graphical examples of the statistical validation, for a panel regression model (top) and time series regression (bottom). **In addition to the statistical validations in each case and model, a conceptual validation was performed based on the results obtained from the econometric estimations.**

Figure 10. Validation



- With the aim. to certify the strenght and robustness of the economic models, a validation process has been performed.
- Consisting on the application and calibration of the models and the analysis of its results on three different countries, Spain, United Kingdom and Germany.
- This validation, covering both conceptual and statistical validations, guarantees that each model is correctly defined and can be replicated to others countries.

Based on the results corresponding to the estimation of these models for the three cases, the most relevant insights in each case are provided in the following paragraphs:

Figure 11. Summary of insights from results

Model	Findings	Explanation/Interpretation
Price	Network Costs (NC): highly consistent results across countries exerting higher effect on households than on industrial consumers.	Potential impact on industrial competitiveness.
	Renewable Promotion Costs (RPC): responds more to country specific characteristics (low vs. high Renewable Energy Sources (RES) penetration countries). Higher effects on industrial consumers.	Costs containment measures. Relevance of regulatory cost assignment criteria.
Transfers	With increasing levels of liberalisation both consumers and producers are better off. Further RES penetration makes buyers better off and the rents of overall producers first decreases -with incipient levels of RES penetration- and then increases from the entrance of new agents.	The market is the best mechanism to allocate scarce resources: they generally make society as well off as possible given the available resources.
Growth	Results of the estimations in the growth model for the three countries support the "growth hypothesis". Any decrease of electricity consumption, for instance through increases of regulated costs or energy conservation policies, has a negative effect on economic growth.	From the strong relation between electricity consumption and growth observed, an increasing decoupling of growth and CO ₂ emissions is possible if electricity demand is increasingly covered with RES-E or if CCS technologies improve.

Retail prices

In all three countries the final customers' prices have increased considerably in previous years (2007-13).

While in Spain the retail prices have increased 45.9% for domestic customers and 17.4% for industrial customers, in the United Kingdom the increases were of 21% and 13%, and in Germany of 39% and 40%, for domestic customers and industrial customers, respectively.

Results from the model regarding the impact of the **network costs on retail prices** are highly consistent across countries. They have a greater **effect on households than on industrial consumers**. Industrial consumers may face lower network costs than residential consumers for several reasons: the industrial sector generally using connections with higher voltage (i.e., with lower charges), Ramsey's principle of optimal allocation of costs and, finally, industrial consumers being highly sensitive to the energy costs but less sensitive to network costs. More precisely results from the model indicates that a 1% increase of the network costs induces an increase 0.199% in the industrial retail price and 0.233% household retail price in Spain; in United Kingdom, the effects are 0.293% and 0.683% for the industrial and domestic prices; and in Germany, 0.458% and 0.626%, respectively.

Results regarding the impact of **renewable energy promotion costs on the retail electricity prices** are contingent upon country specific characteristics. While in the case of United Kingdom the effect

is lower for both industrial and residential consumers -which is closely related to the lower RES deployment levels in this country compared to other EU Member States-, in the cases of Spain and Germany renewable energy promotion costs have stronger influence on industrial consumers than on households. **The higher effect of RES promotion costs on industrial consumers should definitively be a major source of concern due to its potential impact on industrial competitiveness.** However, in the case of Germany given the exceptions of renewable promotion costs faced by the large (energy-intensive) industrial consumers, these are hardly affected by the impact of changes of those costs on their retail price. With respect to the specific results by country, the model indicates that a 1% increase of the renewable promotion induces an increase 0.304% in the industrial retail price and 0.105% household retail price in Spain; in United Kingdom, the effects are 0.005% and 0.032% for the industrial and domestic prices; and in Germany, 0.087% and 0.034%, respectively.

Transfers

Two main relevant insights are obtained from the validation of the transfers model applied to the cases under study.

In all cases and simulated scenarios **with increasing levels of liberalisation, both consumers and producers are better off** with respect to the baseline scenario. In general, with higher (simulated) percentages of liberalization. The market expansion effect allows for more transactions, and whereas producers gain the most in relative terms, consumers gain the most in absolute terms.

Further RES penetration makes consumers better off in all scenarios. Regarding the producers, their rents first decrease -with incipient levels of RES penetration as in United Kingdom- **and then increase with the growing penetration of renewables.** In countries such as Spain and Germany, with baselines including higher RES penetration, the producer rents are always increasing. From a consumer's and a society's perspectives, the main finding behind these results is that **the market is the best mechanism to allocate scarce resources.** Markets that satisfy certain conditions are a remarkably effective way to organize economic activity: they generally make society as well off as possible given the available resources.

Growth

The retail price model showed that renewable promotion costs and network costs caused an increase in the electricity prices which, in turn, involved a negative effect on electricity consumption -as confirmed in the consumption equation of the growth model-.

Our results of the estimations in the growth model for the three countries support the "growth hypothesis" on the relation between electricity consumption and growth. This hypothesis is based on the idea that energy, together with labour and capital, is a driver of economic growth.

A main economic implication is that **any decrease of electricity consumption, through energy conservation policies, has a negative effect on economic growth.** Furthermore, it should be highlighted that by no means this contradicts some recent reports (i.e. IEA, 2016) which suggest that CO₂ emissions are decoupled from economic growth at the world level. **Taking into account that a strong relation between electricity consumption and growth is observed, an increasing decoupling of growth and CO₂ emissions is possible if electricity demand is increasingly covered with RES-E (as suggested by IEA, 2016) or if CCS technologies improve.**



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4. The tool for regulatory analysis

As pointed out in the presentation of the main goals behind this study, the regulatory function appears as a key element in a liberalised framework. Regulation is responsible for the definition of the key elements that guarantee the correct technical management of the power system, the coordination of the networks and the transparency of access conditions for all the agents participating in the power market.

High quality and efficient economic infrastructures play a vital role in supporting a competitive and growing economy by providing services on which all businesses and citizens depend, especially in the case of the energy sector. At the same time, competitive markets are the best way in the long-run perspective to deliver these services to consumers and provide incentives to invest and improve efficiency and service quality. In this way, **economic regulation represents a key element of the regulatory function, since it must guarantee the recovery of all regulated costs in order to ensure the economic viability of the power system and to provide correct economic incentives.**

Nevertheless, all these incentives behind energy regulation have a **significant economic impact, which needs to be ex-ante considered when designing energy policy initiatives, in a context of increasing concern on economic competitiveness.** Although the relevance of energy costs is reduced compared to other cost components, their growth had a significant negative impact on industrial competitiveness and need to be evaluated.

In this context, the most relevant aspect of this study is that the **econometric tool** developed allows a first evaluation of the economic impacts of economic regulation. It is possible for the cases of Spain, United Kingdom and Germany to identify and evaluate the impact of regulation on final retail prices, on income transfers between producers and consumers and on economic growth.

It could also be a helpful tool for a policy designer in so far as it provides insights on the economic impact of different energy choices, guiding policy makers in assessing future developments of a successful framework for economic regulation of the energy sector. Any improvement in the existing regulatory regime which is able to enhance service quality for business and individual consumers has to be met efficiently. For this purpose, alternative regulatory improvements need to be evaluated ex ante.

Despite efficiency gains and the progressive opening of energy markets to competition that have led to reduced wholesale electricity and gas prices, retail prices for these essential energy inputs to industry have increased, making the evolution of energy costs a matter of concern for the competitiveness of industries. Being aware of this negative comparative evolution, the European Commission advocates the **previous evaluation of the impact of costs on competitiveness**. The econometric tool developed in this study aims to meet this need, providing an easy and user-friendly tool to carry out the required ex ante economic evaluations.

The analysis has been carried out for three representative economies, but **the approach can be extended to the analysis of other European economies**. One of the most relevant advantages of the econometric tool lies in its simplicity when providing a first estimation of the effects associated with the liberalisation process and the increasing market participation of renewable energy technologies. For those other European countries with specific policies fostering both aspects, the tool could provide relevant insights of the benefits in terms of welfare of the different policy measures adopted. Considering that the impact of RES penetration on price depends on the degree of market competition and on the shape of the merit-order function - in particular on the elasticity of supply -, results may differ by countries which means that an in-depth country-specific analysis of the expected effects for both consumers and producers is highly recommendable.

The team of InnoEnergy and the authors of this research and its models are opened to assist regulators aiming at deeper in the application of the developed econometric tool.

References

- Apergis N, Payne J. **Renewable energy consumption and economic growth: Evidence from a panel of OECD countries**, *Energy Policy* 2010; 38; 656-660.
- Becker F. **Calidad institucional y regulación económica, 2009**.
- Borenstein S, Bushnell J, Knittel C. **Market power in electricity markets: beyond concentration measures**, *Energy Journal* 1999; 20; 65-88.
- Ciarreta A, Zarraga A. **Electricity consumption and economic growth in Spain**, *Applied Economic Letters* 2010; 17, 1417-1421.
- Chisari et al. **Winners and losers from the privatization and regulation of utilities: Lessons from a general equilibrium model of Argentina**. The World Bank Economic Review 1999.
- Climont F, Pardo A. **Decoupling factors on the energy-output linkage: The Spanish case**, *Energy Policy* 2007; 35, 522-528.
- Costa-Campi M.T., Trujillo-Baute E. **Retail price effects of feed-in tariff regulation**. *Energy Economics* 2015; 51; 157-165.
- Cubbin, Stern. **The impact of regulatory governance and privatization on electricity industry generation capacity in developing economies**. The World Bank Economic Review 2006.
- European Commission, 2008. **Progress in creating the internal gas and electricity market**. Final report from the commission to the council and the European parliament. SEC (2008) 460.
- European Commission, 2010. **An Integrated Industrial Policy for the Globalisation Era Putting Competitiveness and Sustainability at Centre Stage**. Communication from the commission to the European parliament, the council, the European economic and social committee and the committee of the regions.
- European Commission, 2012. **Una industria Europea más fuerte para el crecimiento y la recuperación económica**. Comunicación de la comisión al parlamento Europeo, al consejo, al comité económico y social Europeo y al comité de las regiones.
- European Commission, 2014a. **Por un renacimiento industrial Europeo**. Comunicación de la comisión al parlamento Europeo, al consejo, al comité económico y social Europeo y al comité de las regiones.
- European Commission, 2014b. **Energy prices and costs report. Commission staff working document**. Accompanying the document. Energy prices and costs in Europe. Communication from the commission to the European parliament, the council, the European economic and social committee and the committee of the regions
- Dickey D, Fuller W. **Distribution of the estimators for autoregressive time series with a unit root**, *Journal of the American Statistical Association* 1979; 74; 366; 427-431.
- Doucet A, N. de Freitas, and N. Gordon, editors. **Sequential Monte Carlo Methods in Practice**. Springer, New York, 2001.
- Eurelectric Report. **Analysis of European power price increase**. Eurelectric studies.
- Federico G., 2010. **The Spanish Gas and Electricity Sector: Regulation, Markets and Environmental Policies**. Madrid.
- Green R; Newbery D. **Competition in the British electricity spot market**. *Journal of Political Economy* 1992; 100; 929-953.
- Klemperer P, Meyer M. **Supply function equilibria in oligopoly und uncertainty**, *Econometrica* 1989; 57; 1243-1277.
- Lasheras. **La regulación económica de los servicios públicos**, 1999.
- Ozturk. **A literature survey on energy-growth nexus**, *Energy Policy* 2010; 38; 340-349.
- Payne, J. **Survey of the international evidence on the causal relationships between energy consumption and growth**, *Journal of Economic Studies* 2010; 37; 53-95.
- Phillips P, Perron P. **Testing for a unit root in time series regression**. *Biometrika* 1988; 75.
- Pollitt. **Electricity liberalisation in the European Union: A progress report**, Cambridge working papers in Economics 0953, Faculty of Economics, University of Cambridge.
- Romer P. **Endogenous Technological Change**. *Journal of political economy*, October 1990.
- Solow R. **A contribution to the theory of economic growth**. *The quarterly journal of economics* 1956.
- Twomey, P.R., R. Green, K. Neuhoff and D. Newbery (2005). **A review of the monitoring of market power: the possible roles of transmission system operators in monitoring for market power issues in transmission systems**. *Journal of Energy Literature*; 11 (2); 3-54.
- Ventosa M, Baíllo A, Ramos A, Rivier M. **Electricity market modeling trends**. *Energy Policy* 2005; 33; 897-913.

Appendix I. Spain

Key electricity figures (2014)

Generation	
Electricity demand (GWh)	258,067
Demand coverage by technologies (%)	Nuclear (21.9), Wind (20.4%), Coal (16.4%), Hydro (15.4%), Combined Cycle (8.5%); Solar PV (3.1%); Solar Thermoelectric (2.0%); Renewable Thermal (1.9%); Cogeneration and other (10.4%)
Installed power capacity (MW)	108,142
Installed power capacity by tech (%)	Combined Cycle (25.1%); Wind (21.2%); Hydro (18.4%); Coal (10.6%); Nuclear (7.2%); Solar PV (4.3%); Solar Thermoelectric (2.1%); Renewable Thermal (0.9%); Cogeneration and other (9.9%)
Transmission Network	
Total Lines (Km)	42,760
Transformer capacity (MVA)	84,779
Retail Electricity Market	
Number of supplies (Thousands)	27,722 (96.9% of which are domestic)
Supplies in free market (%)	43
Volume of energy in free market (%)	83 (50% for domestic consumption)
Retail Price (€/MWh)	
Households	235.7 (EU average 205.7)
Industrial	141.2 (EU average 149.2)

Appendix II. United Kingdom

Key electricity figures (2014)

Generation	
Electricity demand (GWh)	319,100
Demand coverage by technologies (%)	Coal (32.9%), Gas (31.6%), Nuclear (20.7%), Wind (9.1%), Bioenergy (4.2%); Hydro (1.5%); Oil (0.14%)
Installed power capacity (MW)	76,970
Installed power capacity by tech (%)	Combined Cycle (41%), Steam (29%), Coal (25%), Nuclear (12%), Wind (5.8%), Hydro (5.3%), Other Renewables (2.7%)
Transmission Network	
Total Lines (Km)	14,744
Transformer capacity (MVA)	141,000
Retail Electricity Market	
Number of supplies (Thousands)	30,047 (92% of which are domestic)
Customers with non-home suppliers (%)	64
Retail Price (€/MWh)	
Households	201.3 (EU average 205.7)
Industrial	160.6 (EU average 149.2)

Appendix III. Germany

Key electricity figures (2014)

Generation	
Electricity demand (GWh)	627,800
Demand coverage by technologies (%)	Lignite (25%), Coal (19%), Nuclear (15%), Gas (10%), Wind (10%), Biomass (7%), Solar (6%), Hydro (4%)
Installed power capacity (MW)	202,500
Installed power capacity by tech (%)	Wind (19%), Solar (18%), Coal (17%), Gas (13%), Lignite (11%), Nuclear (6%), Hydro (5%), Biomass (4%)
Transmission Network	
Total Lines (Km)	641,153
Transformer capacity (MVA)	157,935
Retail Electricity Market	
Number of supplies (Thousands)	49,935,441 (92% of which are domestic)
Retail Price (€/MWh)	
Households	297.4 (EU average 205.7)
Industrial	199.2 (EU average 149.2)

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Economic analysis of the impact of electricity regulation

On the retail price of electricity, income transfers between producers and consumers, and economic growth.

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