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Which Are The Main Drivers Behind Residential Electricity Prices?

Ex-post Analysis for Germany, France, Italy and the United Kingdom

Oscar Matallana-Tost · Tobias Boßmann · Benjamin Pfluger · Rainer Elsland

Abstract Over the last decade the residential electricity price in most EU Member States has been increasing. Even after the introduction of significant reforms such as the liberalisation of the electricity market. This upward trend is in response to the development of different price components along the electricity supply chain. In order to identify and analyse these components for EU-Member States, a more detailed price apportionment than those offered by public sources like Eurostat and IEA is necessary. The methodology proposed in this study analyses the development of the residential electricity price and its main components between 2002 and 2012 for Germany, France, Italy and the United Kingdom. The main drivers of the price trends observed for these four countries are subsequently identified, quantified and compared. Furthermore, the residential expenditure on electricity in each country is examined in connection with the evolution of residential electricity consumption. The results show how and to what extent the residential electricity price for the selected EU Member States depends on price components such as the electricity wholesale price, the gross margin, network expenditures, energy taxes and other levies related to the decarbonisation of the national energy system. Furthermore, this detailed analysis of residential electricity prices throughout the last decade provides a sufficient data basis to draw some prospective conclusions in terms of a short-term price outlook.

Keywords European residential electricity price · Households · Price decomposition · End user price

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T. Boßmann, Dipl.-Ing. (✉) · O. Matallana-Tost, M.Sc. · Dr. B. Pfluger · R. Elsland, M.Sc.
Fraunhofer Institute for Systems and Innovation Research ISI, Breslauer Straße 48, 76139 Karlsruhe, Germany
e-mail: Tobias.Bossmann@isi.fraunhofer.de

Entwicklung der Bestandteile europäischer Haushaltsstrompreise

Eine vergleichende ex-post-Analyse für Deutschland, Frankreich, Italien und Großbritannien

Zusammenfassung Der Haushaltsstrompreis ist in den meisten EU-Mitgliedsstaaten in den letzten zehn Jahren gestiegen – selbst nach grundlegenden Reformen wie der Liberalisierung des Strommarktes. Dieser Trend ist auf die Entwicklung der verschiedenen Preisbestandteile entlang der Strom-Lieferkette zurückzuführen. Um diese Komponenten des Haushaltsstrompreises für die EU-Mitgliedstaaten zu identifizieren und zu analysieren, ist eine detailliertere Aufschlüsselung des Preises erforderlich als sie von den öffentlichen Quellen wie Eurostat und IEA bereitgestellt wird. Die in dieser Studie vorgeschlagene Methodik ermöglicht die Entwicklung des Haushaltsstrompreises und seiner wichtigsten Komponenten zwischen 2002 und 2012 für Deutschland, Frankreich, Italien und Großbritannien zu analysieren. Ausgehend von den Ergebnissen dieser Analyse werden die wichtigsten Einflussfaktoren der Preisentwicklung für diese vier Länder identifiziert, quantifiziert und verglichen. Darüber hinaus werden die Stromausgaben in den einzelnen Ländern im Zusammenhang mit der Entwicklung der Strompreise untersucht. Die Ergebnisse zeigen, in welcher Form und in welchem Umfang die Haushaltsstrompreise für Deutschland, Frankreich, Italien

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und Großbritannien von den einzelnen Preisbestandteilen abhängen wie dem Strom-Großhandelspreis, der Bruttomarge, Netzentgelte, Energie-Steuern und andere Abgaben im Zusammenhang mit der Dekarbonisierung des nationalen Energiesystems. Des Weiteren bietet diese detaillierte Analyse von Strompreisen für den Haushaltssektor über die letzten zehn Jahre eine umfassende Datengrundlage um prospektive Aussagen hinsichtlich eines kurzfristigen Preisausblicks zu treffen.

1 Introduction

Despite market liberalisation and political interventions to offset the price for electricity, electricity prices paid by residential customers have shown an increasing trend in most EU countries during the last decade (European Commission 2013a; Seeliger et al. 2011). Such an upward trend cannot only be explained by the rise of wholesale prices, but is also related to components such as supplementary supply charges, network expenditures, concessions, charges related to the promotion of electricity from renewable sources and any levies including value added tax (VAT). In particular, in Germany, the implementation of the Renewable Energies Act levy[1] has been an essential driver for the price increase in the last decade (BDEW 2011). Due to the limited disposable income of residents, the upwards trend of electricity prices has also become a more frequently discussed social issue (Buttermann et al. 2008; Darby 2012; Department of Energy & Climate Change in UK 2013a). In 2011 the number of German households that were not able to pay their electricity bills and were consequently cut off from their electricity supply was 312,000. In 2012 this number increased to 800,000. This means that, despite the fact that Germany is considered a wealthy country, the number of households unable to pay their electricity bills more than doubled in one year (Jalsovec 2012; Balcerowiak 2012).

This background emphasises the need to gain deeper insights into the upward trend of residential consumer prices and its main drivers in selected EU Member States. However, the previous literature and data availability in this field shows that only limited information is available. In addition, the studies analysing electricity prices and the databases available mainly provide information structured in broad and aggregated categories rather than in single price components. This makes comparisons between countries at a detailed level very difficult. Examples of such studies are: (i) Eurostat (European Commission 2013a) that categorises prices into three levels: price without taxes, price without value added tax (VAT) and, price including all taxes, and (ii) the quarterly published reports by the International Energy Agency (IEA) (IEA 2013a) which are also restricted to three levels: price without taxes, excise tax and VAT.

Nevertheless, there are some studies like the one published by VaasaETT Global Energy Think-Tank (VaasaETT and E-Control 2012) or by Cruciani (2011) which aim to embrace a more comprehensive approach by apportioning the prices in more detailed components such as: energy costs, distribution, energy taxes and VAT. In the same vein, the Commission for Regulation of Electricity and Gas (CREG) apportions electricity prices into supplier, network, taxes and VAT, after analysing the limitations of the methods used by Eurostat and VaasaETT (Commission de Régulation de l'Électricité et du Gaz 2010). The work undertaken by Seeliger et al. (2011) represents, to our knowledge, the most comprehensive analysis of the composition of residential electricity prices for different EU Member States (see also (Frontier Economics 2010). However, the comparison of residential electricity prices presented in this study is based on the broad categories of Eurostat. Therefore, it does not explicitly show the share of each price component or its relative influence on the total price. From this background, it can be concluded that there are no empirical studies comparing the household electricity prices among EU Member States in terms of detailed price components or main drivers.

This study aims to close this research gap. The data sources and the methodological approach used are presented in chap. 2. In the next step the development of the residential electricity price and its main components are analysed over the ten years from 2002 to 2012 for Germany, France, Italy and the United Kingdom, being the four largest electricity consuming countries in the EU (Chap 3). Based on this result, the main drivers of the price trends observed are identified, quantified and compared for these four countries. The residential expenditure on electricity in each country is analysed (Chap. 4) and finally, the article closes with conclusions on the main findings (Chap. 5).

2 Methodology and Data Gathering

2.1 Definitions

2.1.1 Consumer Group

The data used and analysed in this study is for customers consuming between 2,500 to 5,000 kWh annually. Selecting a single consumer group facilitates the comparison and possible aggregation of data from different sources and this group represents the electricity consumption of an aver-

[1] The Renewable Energies Act levy (*EEG-Umlage* in German) is a political instrument to promote the production of energy from renewable sources in Germany. For more information about this levy see ÜNB (2012).

age European household (European Commission 2013a; IEA 2013a). In fact, most of the information available on residential electricity prices is for this consumer group (see Chap. 2.2).

2.1.2 Price Components

There are different approaches of apportioning the charges that constitute the residential electricity price, and this study aims to incorporate all major charges relevant to EU Member States. In order to ensure comparability, clearly distinguishable general price components are defined as follows:

- Wholesale price (WP): Bulk electricity purchasing cost for which the spot market price represents a decisive indicator. However, it has to be clarified that almost all utilities purchase only parts of their portfolio on the spot market. In order to hedge risks, a certain share is most often obtained through futures or over-the-counter (OTC) contracts. Spot market day-ahead prices have a signalling effect on the prices of OTC contracts. Given the respective market liquidity, they are seen as an appropriate indicator for the wholesale electricity price, at least in the German and Austrian market (Holler and Haberfellner 2006).
- Supply (S): Basic electricity price before any official levy or consumption tax is applied.
- Gross margin (GM): The difference between total supply and wholesale price. It can be understood as the part of the electricity price that is added to the WP by the utility supplier in order to cover any operating costs (costs associated with operation, distribution, maintenance and technical improvement) and to achieve a profit margin. Furthermore, as discussed above, the WP only partially represents the costs that utilities have for acquiring the respective capacities. Long-term contracts, limiting short-term price risks on the spot markets, can also become liabilities after price drops, e.g. during and after the financial crisis of 2008. In this case, the margin discussed here represents an upper estimate.
- Network (N): Charges related to the maintenance and development of the electricity network.
- Green Energy Contribution (GEC): Levies used to promote the production of energy from renewable sources.
- Concession (C): Charges related to the use of public infrastructure, regional taxes, donations or special contributions.
- Energy tax (ET): The taxes on electricity consumption other than VAT and the contribution to storage funds.
- Value added tax (VAT): The traditional consumption tax paid by residential customers.

An illustration of these price components is presented on the right hand side of Fig. 1. The figure compares the apportionment of the residential electricity price in this study with the comparatively broad price categories provided by Eurostat and IEA (European Commission 2013a; IEA 2013a).

2.2 Data Sources and Distribution of Price Components

Most of the data gathered on electricity prices is from the annual average revenues received by electricity companies of the respective EU Member States in the period 2002–2012 and published by official sources. The information related to the national electricity consumption refers to the data reported by Enerdata (Enerdata 2013). When this study was performed, the most recent values on electricity consumption published by Enerdata were those for 2010 (Enerdata 2013).

The following is a description of the assignment of official price data to each price component for the selected countries:

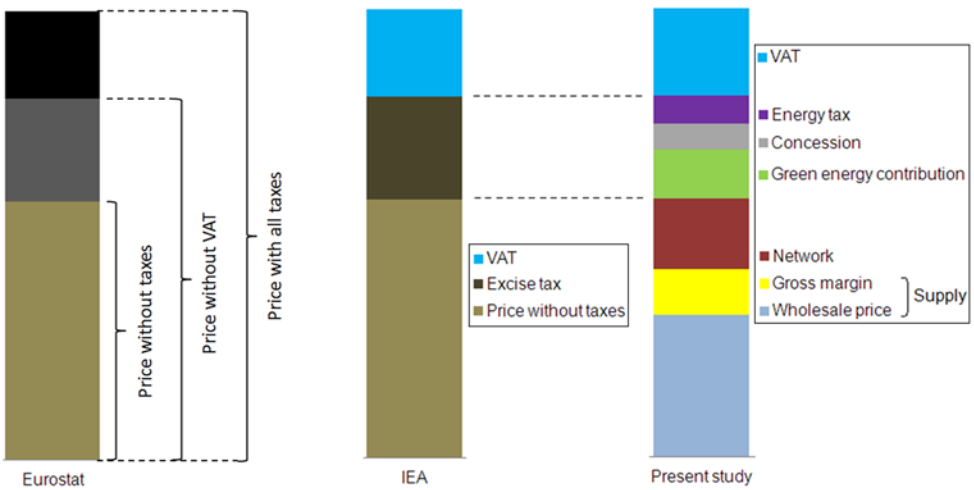

Fig. 1 Components of the residential electricity price by source (European Commission 2013a; IEA 2013a)

Germany. The electricity wholesale price corresponds to the day-ahead prices of the European Energy Exchange EEX (EEX 2013). The supply component and the network charges for the years 2002 to 2005 are based on the annual revenues published by the German Federal Ministry of Economics and Technology (Frontier Economics 2010). For the subsequent years, data from the German Federal Network Agency for Electricity, Gas, Telecommunications, Post and Railway (BNA) was used (Frontier Economics 2010; Bundesnetzagentur 2012). The BNA is responsible for the regulation of the network charges in Germany (Bundesnetzagentur 2012). The value of the concession corresponds to the official German levy for the use of public infrastructure (Frontier Economics 2010; Bundesnetzagentur 2012). The energy tax corresponds to the German levy called *Eco tax* which aims to reduce polluting activities through taxation and create economic incentives for the efficient use of energy (IEA 2013a; Umweltbundesamt 2013). The green energy contribution component is the Renewable Energies Act levy (REA levy). This levy aims to promote the production of energy from renewable sources (ÜNB 2012). Operators of renewable power facilities receive fixed feed-in tariffs or additional compensation payments on top of the wholesale electricity price. This support mechanism is financed through revenues from selling renewable electricity on the spot market and via the GEC, which is added on top of the end user electricity price for residential and commercial customers and most industrial customers. However, there are some privileged industrial users who pay a fixed lower amount rather than the whole resulting fee. The level of the German GEC depends on several factors such as the current level of the feed-in tariff, the evolution of installed capacities of renewable power plants, the feed-in supplied from renewable sources and the wholesale price of electricity (ÜNB 2012). The value added tax in Germany represents a fixed percentage mark-up on the overall product price (IEA 2013a).

France. The electricity wholesale price equals the day-ahead prices[2] of the European Power Exchange, EPEX (Commission de régulation de l'énergie 2013b). The supply component is calculated based on the price before taxes published by the IEA (IEA 2013a). The network charges correspond to the "CTA" (*Contribution Tarifaire sur les prestations d'Acheminement*). In turn, the charge of the CTA is based on the levy "TURPE" (*Tarif d'Utilisation des Réseaux Publics d'Electricité*) and the TURPE is a levy for the use of public infrastructure which has a fixed and a variable component (EDF 2010). The CTA is calculated as a percentage of the fixed component (EDF 2010; Commission de régulation de l'énergie 2013a) and the value of the concession corresponds to the CSPE (*Contribution au service public de l'électricité*). The energy tax comprises municipal and departmental taxes (Commission de régulation de l'énergie 2013a; IEA 2013a) but green energy contribution does not apply to this country. The value added tax represents a fixed percentage of the total price (IEA 2013a).

Italy. The electricity wholesale price corresponds to day-ahead prices published in the *Quarterly Reports on European Electricity Markets* (European Commission 2013b). The supply component and the network charges are based on the revenues reported by AEEG (Autorità per l'energia elettrica e il gas 2013). The energy tax equals the National Consumption Tax (NCT or *l'imposta nazionale erariale di consume*) (Autorità per l'energia elettrica e il gas 2013) but the price component of concession does not apply to this country. The green energy contribution includes the following charges (Autorità per l'energia elettrica e il gas 2013):

- The incentive for renewable and assimilated sources (known as *A3*)
- The levy for the promotion of energy efficiency (known as UC7)
- The charges for the safety of nuclear power and territorial compensation (known as A2 and MCT respectively)
- Other minor charges

Value added tax in Italy is calculated as a fixed percentage of the total price (IEA 2013a).

United Kingdom. The electricity wholesale price corresponds to the average of the monthly series published by Ofgem (Ofgem 2013b). The supply component and the network charges are based on the separate revenues reported by large, vertically integrated electricity suppliers in the United Kingdom (UK) (Ofgem 2013b). The energy tax represents the Carbon Emissions Reduction Target (CERT) adopted in 2008. The CERT is a statutory obligation on the six largest energy suppliers of the UK to reduce carbon dioxide emissions in the residential sector. The CERT compels suppliers to spend a fixed amount per customer on efficiency measures or renewable technologies each year. In order to finance such measures, suppliers include a CERT-charge in the electricity bill paid by residential customers (IEA 2013a; Ofgem 2013c). Analogous to the CERT-charge, the residential electricity bill in the UK includes a charge to finance the expenses related to the Renewables Obligation (RO) adopted in 2002. The RO places an obligation on UK electricity suppliers to source an increasing proportion of electricity from renewable sources (IEA 2013a; Ofgem 2013a). A concession related price component is not relevant in the

[2] Since 2011 retail companies benefit to a limited extent from the NOME law ("Nouvelle Organisation du Marché de l'Electricité") which requires the main utility supplier EDF to sell 100 TWh of its production at a fixed rate to competing retail companies (Ministère de l'écologie 2010). This price is not considered in this study.

Table 1 Components of the residential electricity price for the selected EU Member States

Price component	Germany	France	Italy	UK
Supply	Wholesale price + other supply costs before network charges and taxes			
Network	Charges for the maintenance and development of the electricity network			
Concession	Local taxes	CSPE	n/a	n/a
Energy tax	Eco tax	Local taxes	NCT	CERT
GEC	REA levy	N/A	A3, UC7, A2	RO
VAT	National tax			

UK but value added tax, as in the other countries is based on a percentage of the total price (IEA 2013a).

Table 1 offers an overview of the contributions considered for each selected EU Member State.

2.3 Inflation Adjustment

To ensure comparability, all prices are transferred into real prices to isolate the effects of inflation (Boardman 2011). The nominal values were transformed into real values by using the national Consumer Price Index (CPI)[3] (Destatis 2012; Boardman 2011). The CPI expresses the ratio of costs to purchase a standard basket of goods and services in a particular year compared to the cost of the same basket in a base year (Boardman 2011). The prices and costs in this study are presented in real terms, using the year 2012 as reference (real € 2012).

3 Composition of Residential Electricity Prices for Germany, France, Italy and the United Kingdom

3.1 Germany

The development of the residential electricity price in Germany between 2002 and 2012 is presented in Fig. 2, along with the absolute contribution of its single components. During the period, the German residential electricity price exhibits an upward trend of nearly 40 %: the price increased from 18.4 ct/kWh in 2002 to 25.6 ct/kWh in 2012. Figure 2 shows that there are three components which are primarily responsible for this trend: the whole sale price, the gross margin and the green energy contribution.

Wholesale Price. The wholesale price (WP) featured an increasing trend from the year 2002 onwards and culminated in the year 2008 at a level of 7.8 ct/kWh being about 160 % above that of 2002. In the subsequent years the price fell to the region of 4.5 to 5.5 ct/kWh.

[3] The CPI is part of the national statistics published by EU Member States.

The development of the German WP until 2008 is typical for many European countries. Until 2008, it is largely driven by the rise in fuel prices which occurred between the Iraq War and the Global Financial Crisis (European Communities 2009a; OECD 2011). Since the electricity mix of Germany contains a high proportion of conventional fuels (fossils and nuclear accounted for about 78 % in 2012) (Arbeitsgemeinschaft Energiebilanzen e. V. 2013), the WP is very sensitive to changes in fuel prices.

Another factor affecting the wholesale prices in Germany during that period was the outdoor temperature. The wholesale prices increased by 61 % between 2004 and 2005. The beginning of 2005 was marked by low temperatures and the rather dry weather over the previous winter lead to significant increases in the day-ahead markets. This effect might have been enhanced by the rise in carbon certificate prices which occurred at the same time (Bundesnetzagentur 2012; European Commission 2013b). The year 2006 was characterised by a very hot and dry summer causing operational problems for some thermal power plants and thus a general increase in wholesale prices in that year (European Commission 2013b). The relatively low price in 2007 can be seen as the result of a mild winter and a significant drop in prices of emission certificates; throughout 2007 the over-supply of EU Allowance Units (EUAs) for 2007 become increasingly evident, leading to the price of virtually zero in the second half of the year. The price for emission permits for 2008 was significantly higher, which, along with the high fuel prices, caused a strong increase in the WP.

In turn, the price drop between 2008 and 2009 is mostly related to the passing of the oil price peak (European Communities 2009b; OECD 2011). Between July and December 2008, the Brent oil price and coal price dropped by 71 % and 58 %, respectively (European Commission 2009). However, in Germany the effects of the economic crisis, causing lower demand, were absorbed at first by the low generation from wind energy; the latter has become an increasingly influential factor for the German WP over time.

Since 2008, the electricity wholesale prices in Germany have remained relatively stable due to the increase in wind and solar power generation and the fall of carbon certificate prices. These both counterbalance the further increase of fossil fuel prices (ÜNB 2012; European Commission 2013b).

Gross Margin. The value of the gross margin (GM) hovered around 1.6 ct/kWh until 2008 before electricity wholesale prices reached a peak. However, since 2009 the GM element has remained around 3.5 ct/kWh which represents a share of about 14 % of the total. The reasons behind this development are diverse and difficult to assess but they follow, in some respects, the structure of the local electricity wholesale and retail markets. Changes in factors such as the

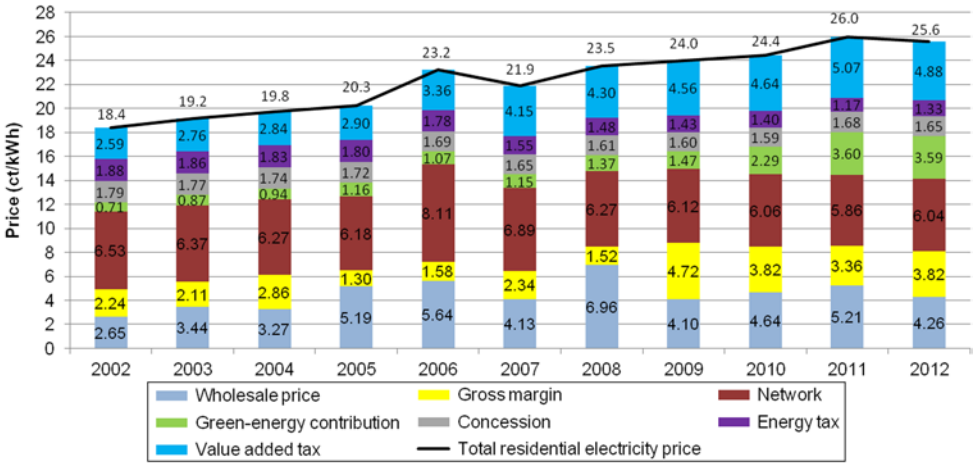

Fig. 2 Residential electricity price for Germany by component in the period 2002–2012 (real € 2012)

costs associated with operations, distribution, maintenance and technical improvements also affect the GM contribution. There are other aspects that are related to the particular costs and market strategies of electricity supply companies that are unknown to the public but may affect the development of GM. For example, the GM increase from 2008 to 2009 might be explained by the long-term electricity procurement of retail companies via futures during the years 2007 and 2008 at prices far above the spot market price in 2009. Resulting additional costs were eventually reallocated to the GM component in 2009.

Green Energy Contribution. The increase of the Green Energy Contribution (GEC) of 408% between 2002 and 2012 is related to the increase of electricity from renewable sources (BDEW 2011; BMU 2012). The total share of this component increased from 3.8 to 14% of the total price during this period. A significant increase in renewable energy sources between 2002 and 2012 is seen in both total installed capacity (+334%) and feed-in electricity (+198%). It is sourced especially from wind, photovoltaics and biomass facilities (ÜNB 2012). The amount of compensation to be paid by the GEC has been officially calculated by the Transmission System Operators (TSOs) along with the number of industrial users who only contribute a discounted amount (ÜNB 2012). The discounted proportion paid by the industrial privileged users rose from 0% in 2002 to 19% in 2012 (ÜNB 2012). This intensified the increase of the GEC for the residential sector.

Other Components. Figure 2 shows a different trend for the price components besides WP, GM and GEC. The amount of the concession remained comparatively constant at around 1.68 ct/kWh, while the energy tax exhibited a decreasing trend until 2009 (−24%) but it has remained around 1.30 ct/kWh since then. The contribution of the network charges has remained around 6.2 ct/kWh after two regulations put in force by the BNA in 2006 and 2008 (Bundesnetzagentur 2012) and the value of VAT reacts to the increase in other price components, since it is a fixed percentage of the total price. The VAT contributions from 2007 onwards are greater than those of the previous years due to the increase from 16 to 19%.

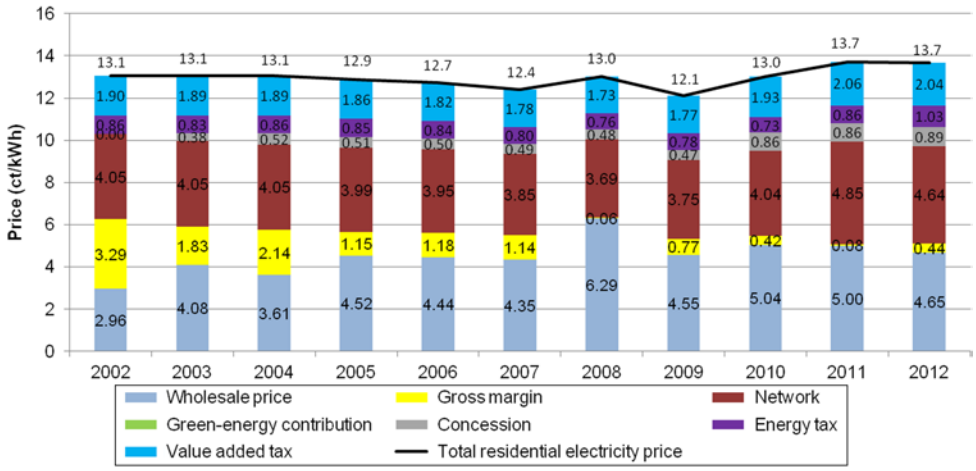

Fig. 3 Residential electricity price for France by component in the period 2002–2012 (real € 2012)

3.2 France

The residential electricity price in France has increased from 13.1 ct/kWh in 2002 to 13.7 ct/kWh in 2012, as shown in Fig. 3. During the first 8 years of the period, the price exhibited a slightly decreasing trend (−7% between 2002 and 2009) which was interrupted by a price leap in 2008. After a fall in 2009, the price rose again to a level of 4% above that of 2002. There are three components which are primarily responsible for this development: the wholesale price, the gross margin and network charges.

Wholesale Price. In terms of its total share, the WP is one of the main components of the residential electricity price in France (around 35%). The WP experienced a steady growth from 3 to 4.5 ct/kWh in the period 2002–2005. Since then it levelled off at around 4.7 ct/kWh with the exception of the year 2008 when it reached 6.3 ct/kWh. That corresponded to 48% of the overall residential electricity price in that year.

The price stability can be mainly explained by the fact that most of the power production in France comes from nuclear reactors (around 75% in 2012) with only little production from fossil fuels (around 11% in 2012) (Kondziella et al. 2011). This generally leads to a reduced vulnerability to high crude oil prices. Nonetheless, French generation capacity is relatively scarce, especially given the high share of electrical heating in France; consequentially, cold winters or even forecasts of low temperatures drive up the spot market price. In 2008, the availability of the nuclear power plants was low; during summer 12–15 of the 58 plants were down for maintenance (European Communities 2008b). In the beginning of the year, forecasts of low availability of nuclear plants drove prices up (European Communities 2008a). Furthermore, the prices of the French spot market are increasingly correlated to the German spot market. Therefore, the oil price peak and high EUA prices did affect the French power sector indirectly through high electricity import prices and expensive peak load power plants.

Gross Margin. The decreasing trend of the GM from 3.3 ct/kWh in 2002 to 0.44 ct/kWh in 2012 (−86% over the whole period) reflects in some measure to the particular process of deregulation of the French electricity market. The deregulation took place in different stages, where different segments of the market were gradually opened to competition (Commission de régulation de l'énergie 2013b). Between 2000 and 2004 the market segment related to industrial customers, companies and local government agencies was opened. By 2007 all customers were able to select their electricity suppliers, including residential customers. Nevertheless, the current French electricity market still retains regulated elements. Since 2007, any customer can select between contracts under regulated tariffs (offered by incumbent suppliers only) and contracts at market prices (offered by both incumbent suppliers and alternative suppliers) (Commission de régulation de l'énergie 2013b). Since most of the contracts are still regulated (93% in 2012), the alternative suppliers are forced to reduce gross margins in order to increase their market share. In 2007 the market share of alternative suppliers for residential customers was 0.1% whereas in 2012 it had reached 6.9% (Commission de régulation de l'énergie 2013b).

Network. The value of the network charges represents another significant component of the residential electricity price in France (around 31% on average). This price component remained around 4 ct/kWh until 2010, but increased after that due to an increment of 2.56% in the TURPE. The increase in the TURPE was promoted by the French Energy Regulation Commission (CRE) to finance investments for the further development of the network (Commission de régulation de l'énergie 2013a).

Other Components. The value of the energy tax showed a slightly decreasing trend until 2010 but in 2011 returned to the levels of 2002 (around 0.9 ct/kWh). This trend is explained by an official amendment of the municipal and departmental taxes which occurred in 2004. This reduced the average contribution of the energy tax in France (IEA 2013a). Although the municipal and departmental taxes were increased in 2011 and 2012 (IEA 2013a), reaching 1 ct/kWh in 2012, the total share of energy tax remained around 7% during the whole period. A similar situation holds true for the price component related to concessions. Even though the concession has increased during the observed period (+134%, since 2003), its total share did not exceed the level of 6%. The total share of VAT remained constant at around 14% throughout the period.

3.3 Italy

The residential electricity price in Italy is characterised by a slightly upward trend (+15% over the whole period), from 19.4 ct/kWh in 2002 to 22.3 ct/kWh in 2012, despite minor variations observed along this period (see Fig. 4). There are three components which are primarily responsible for the increase in the Italian residential electricity price: the wholesale price, the gross margin and the energy tax.

Wholesale price. The value of the WP increased by 12% between 2002 (7.0 ct/kWh) and 2012 (7.8 ct/kWh), reaching its peak in 2008 (10.6 ct/kWh). It accounts on average for around 40% of the overall residential electricity price. Since the general energy mix of Italy strongly depends on fossil sources (around 83% in 2010), the value of WP for this country is very sensitive to changes in fossil fuel prices

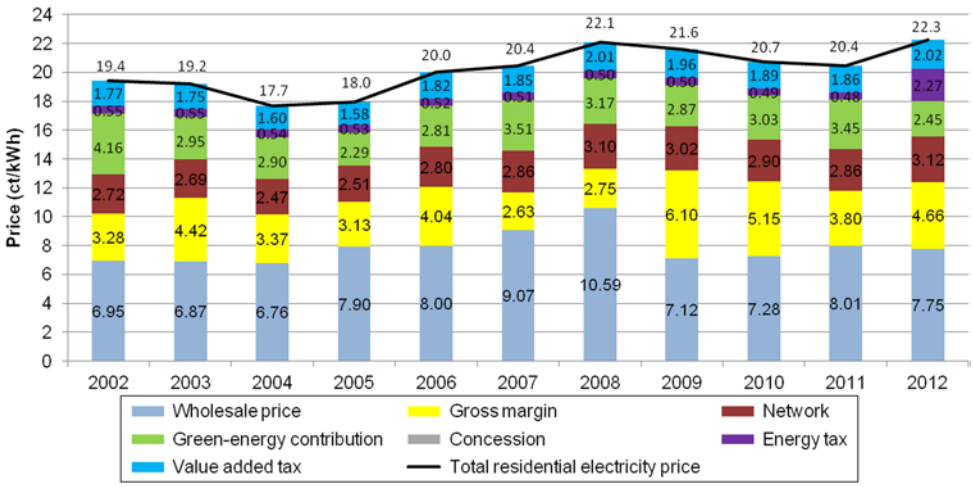

Fig. 4 Residential electricity price for Italy by component in the period 2002–2012 (real € 2012)

(Axpo Italia 2013; Connaissance des énergies 2012). The main component of the national electricity generation mix is natural gas (around 40 % in 2012) (Axpo Italia 2013). The share of gas used for power generation is significantly higher than in all other Western European countries. The strong correlation between oil and gas prices thus makes Italian spot market vulnerable to changes in the oil price, which is observable especially between 2004 and 2008.

Furthermore, the Italian wholesale price is generally among the highest in Europe, which is caused by several reasons. Besides high gas prices, bottlenecks within the Italian transmission grid and insufficient transfer capacity to the neighbouring countries are further sources of inefficiencies; although Italy imports a significant share of its electricity, high differences exist between spot market prices in Italy and its neighbouring countries. For these reasons, the drop in spot market prices that took place is Germany and France in the end of 2008 can also be observed in Italy, but the Italian price remains on a generally higher level.

Gross Margin. Before 2009, the GM was around 3.4 ct/kWh, but it then increased to around 4.9 ct/kWh. Over the whole period, the GM increased by 42 % and accounted for 21 % of the overall residential electricity price in 2012. The Italian Regulatory Authority for Electricity and Gas (AEEG) regulates the electricity price offered to residential customers and this regulation is based on the average costs reported by electricity companies operating in the country. The increase in GM can be explained by the rise in the average costs companies claimed to bear during the observed period (Autorità per l'energia elettrica e il gas 2013). Moreover, the ability to switch supplier which has been available to residential customers since January 2007 has been only minimally taken up. In 2011, 77 % of all residential customers were still served by their original supplier (European Commission 2011a).

Energy Tax. The energy tax contributed to the rise in the residential electricity price observed between 2011 and 2012, as it increased by 383 %. This was due to new legislation that increased the amount of the Italian National Consumption Tax (NCT) from around 0.47–2.27 ct/kWh in this period (Autorità per l'energia elettrica e il gas 2013, Enel 2013; IEA 2013a).

Other Components. The value of the GEC decreased between 2002 and 2012 by 42 % due to changes in the regulation put in force by the Italian Regulatory Authority for Electricity and Gas (AEEG) in 2006 and 2007 (Autorità per l'energia elettrica e il gas 2013). The aim of the new regulation was the reduction of the costs associated with the incentive for renewable and assimilated sources which represented more than 90 % of the total GEC in Italy (Autorità per l'nergia elettrica e il gas 2013). The total share of the network charges remained at around 14 % during the whole period and the proportion of VAT remained constant at 9 %.

3.4 United Kingdom

The development of the residential electricity price in the UK between 2002 and 2012 is depicted in Fig. 5. Despite the variations observed during this period, the price exhibits an upward trend from 13.1 to 17.6 ct/kWh (+35 % on the whole) with an intermediate peak of 16.2 ct/kWh in 2007. There are four components which are primarily responsible for such an increase: the wholesale price, the gross margin, network charges and the energy tax.

Wholesale Price. The power market of the UK is different from the markets discussed so far. Firstly, its island location means that is connected to fewer neighbours, decoupling the UK market to some degree from continental Europe, where it is linked closely only to the French market. Furthermore, the spot market's liquidity is significantly below that of

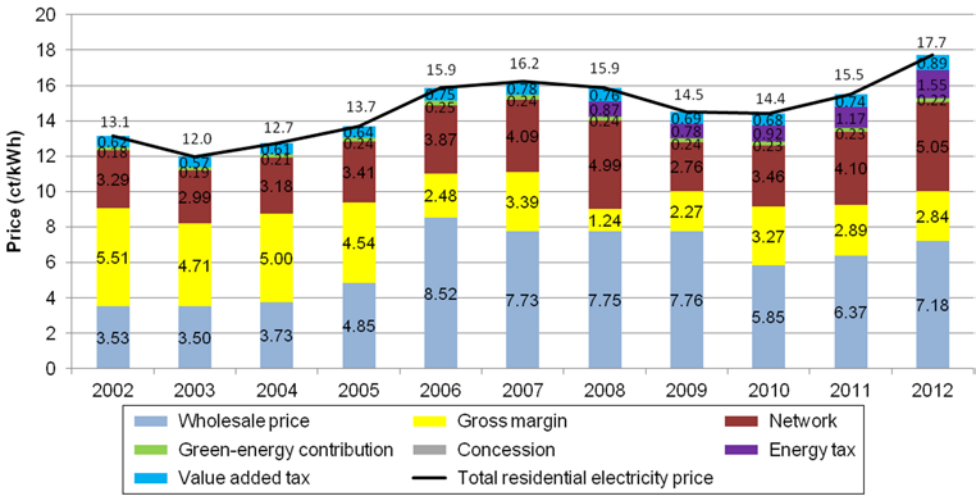

Fig. 5 Residential electricity price for the United Kingdom by component in the period 2002–2012 (real € 2012)

other European markets (Ofgem 2009), and electricity is traded mostly OTC. This causes the spot market price of the power exchange APX to be relatively volatile (Ofgem 2009) and only partly representative for the UK wholesale electricity market. The comparatively high level of the wholesale prices observed in Fig. 5 for all years is also related to the level of market concentration in the electricity generation sector in the UK. Around 70% of the total electricity generation in the UK has been controlled by only six large companies since the liberalisation of the electricity market[4] (Woo et al. 2003; Pond 2009; Sheffield Energy Resources Information Services 2012; European Commission 2011b), which are also highly vertically integrated.

The WP increased by 97% between 2002 and 2012, i.e. from 3.5 to 7.2 ct/kWh, following the changes in crude oil prices (European Commission 2013b; Department of Energy & Climate Change in UK 2013b) and in 2012, it accounted for 55% of the overall electricity price. Most of the electricity generated in the UK comes from coal (35% in 2012) and gas (28% in 2012) (Department of Energy & Climate Change in UK 2013c). This means that the value of the WP is strongly related to the price of fossil fuels and to the price of EUAs. The marked increases in the WP observed between 2005 and 2006 (+75%) and between 2010 and 2012 (+23%) largely follow a rise in gas prices (European Commission 2013b; Department of Energy & Climate Change in UK 2013c). It can be observed that the financial crisis affected the UK WP more slowly than this was the case for the countries discussed so far. One central reason is that industrial power demand contributes less to total power consumption in the UK; the relative drop in power demand was thus smaller.

Gross Margin. In the years 2002 until 2005 the GM was of the order of 4.9 ct/kWh. By 2008, it had dropped to its minimum of 1.2 ct/kWh before stabilising again at a level of roughly 2.8 ct/kWh. Its contribution to the overall price dropped from 42% in 2002 to 16% in 2012.

Although the electricity supply market in the UK was completely open by May 1999, with the aim of reducing prices by promoting competition (Department of Energy & Climate Change in UK 2013b), since 2002 about 70% of electricity generation and 97% of the electricity retail market in the UK have been controlled by six companies[5] (Woo et al. 2003; Sheffield Energy Resources Information Services 2012; Department of Energy & Climate Change in UK 2013b; European Commission 2011b). The low competition in both sectors may influence the total contribution of the basic electricity price before taxes (*supply* component) to the price, and therefore the relative share of the GM. A fact that supports this thesis is that the total share of the GM remained relatively high between 2002 (42%) and 2005 (33%) within a period characterised by low competition in the electricity retail market (Woo et al. 2003; Sheffield Energy Resources Information Services 2012; Department of Energy & Climate Change in UK 2013b). Subsequently, residential customers reacted to the increase in electricity prices by switching their electricity supplier to get a cheaper contract (Pond 2009), so that the average switching rate increased by 150% between 2005 and 2006 (Pond 2009). Since 2007 the annual increase in the average switching rate has been relatively low, reaching only 6% between 2011 and 2012 (Department of Energy & Climate Change in UK 2013b).

[4] In 2012 71% of the electricity generation in the UK was dominated by six companies: RWE (16%), EDF (15%), EON (13%), Scottish & Southern (13%), ScottishPower (7%) and Centrica (7%). See Pond (2009) and Sheffield Energy Resources Information Services (2012).

[5] It has been reported that in 2012 around 98% of the retail market was owned by the same six companies mentioned in the previous foot note. See Pond (2009) and Sheffield Energy Resources Information Services (2012).

Network. The network price component shows an overall upward trend (+54% over the whole observation period). The national transmission operators (TSOs) justify the hike in network charges with the investments needed on new electricity transmission networks to overcome the capacity constraints for new renewable and other low carbon electricity generation sources (Department of Energy & Climate Change in UK and Ofgem 2013). The charges for building and maintaining the network have also increased.

Energy Tax. The value of energy tax follows the development of the Carbon Emission Reduction Target (CERT). The CERT came into effect in 2008, representing around 0.9 ct/kWh (Hough et al. 2012; Energy Saving Trust 2013). Since 2008, there have been multiple governmental amendments to restructure and extend the CERT which have resulted in an increase of its overall contribution to the residential electricity price (Ofgem 2013c). This increment is especially significant between 2009 and 2012, where the value of CERT increased by 98%. In 2012, it grew to 1.6 ct/kWh, representing 9% of the overall electricity price.

Other Components. The value of the GEC did not change considerably and its total share remained around 1.5% during the whole period. The total share of VAT remained constant at 5%.

4 Comparison of Residential Electricity Prices, Drivers and Costs Between Germany, France, Italy and the United Kingdom

4.1 Comparison of Price Levels

Figure 6 presents the development of the residential electricity price between 2002 and 2012 for the selected countries. A general upward trend can be observed for all four countries, but there are major differences in the price levels: the prices are higher in Germany and Italy, compared to those in the UK and France. In 2012 residential customers in Germany paid 11.9 cents or 87% more per kilowatt-hour than their counterparts in France.

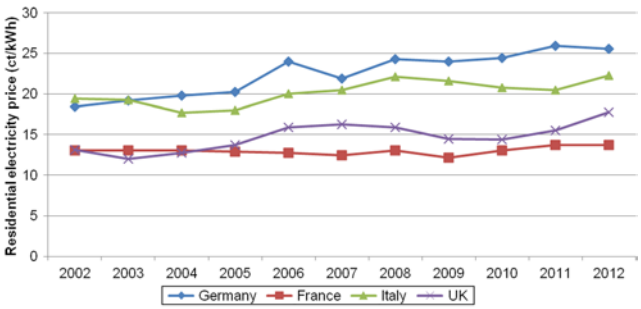

Fig. 6 Residential electricity price for Germany, France, Italy and the United Kingdom in the period 2002–2012 (real € 2012)

The elevated German price level results primarily from network charges, GEC and VAT, being the highest among all countries (in absolute terms, see Fig. 7). In 2012, these three components represented 56% of the entire residential electricity price. Another reason is the comparatively high profit margin, being the second highest in 2012 behind Italy.

In Italy, network charges, GEC and VAT are approximately 50% lower than in Germany in 2012. Instead, the supply component as sum of WP and GM exceeds by far the level of all the other countries. In 2012 it equals 12.4 ct/kWh compared to 10.0 ct/kWh in the UK, 8.1 ct/kWh in Germany and 5.1 ct/kWh in France.

The UK electricity price is the second lowest among the four countries. The bulk of the price consists of the WP, representing 41% of the total price in 2012. The wholesale price itself is the highest in Italy (7.8 ct/kWh) and the UK (7.2 ct/kWh), followed by France (4.7 ct/kWh) and Germany (4.3 ct/kWh). Further 28% of the total price are related to network charges. Both components, WP and network charges, are similarly dominant in the French electricity price.

With regard to the overall sum of taxes and levies as share of the total price, Germany features the highest proportion (2002: 38%, 2012: 45%), followed by Italy (33% and 30%), France (21% and 29%) and last by the UK (6% and 15%).

4.2 Comparison of Price Drivers

With regard to the price growth rate over the ten year period, Germany and the UK experience the most significant increase of 39% and 35% respectively. Table 2 and the results from Chap. 3 indicate that these two countries have the following factors in common: (i) both countries rely strongly on fossil fuels which is reflected in the evolution of the wholesale price, and (ii) both countries have a particular charge related to the decarbonisation of the energy system (increase in GEC for Germany, increase in ET for the UK).

In Germany, the GEC and VAT represent the most relevant drivers for price increase in Germany[6], whereas the impact of wholesale price growth is comparable to the impact of increasing gross margin. Note that the share of the charges related to the decarbonisation of the energy system has gained particular relevance in Germany where the share of the green energy contribution increased by more than 400% between 2002 and 2012.

[6] This does not necessarily mean that the installation of renewable energy sources (RES) increased the electricity price by 16%, since RES contribute likewise to a reduction in wholesale prices, which is also known as the merit order effect (Sensfuß et al. 2008).

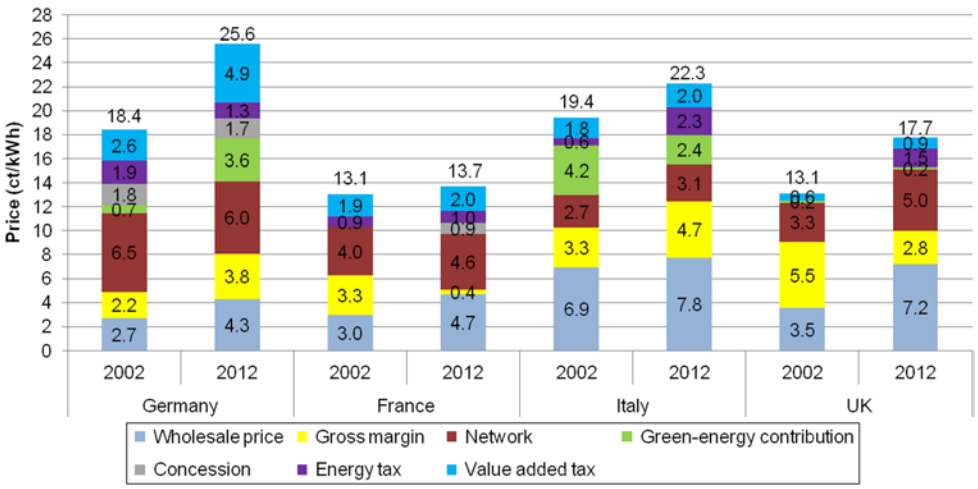

Fig. 7 Residential electricity price components for Germany, France, Italy and the United Kingdom, 2002 vs. 2012 (real € 2012)

Table 2 Contribution of components to price increase between 2002 and 2012 (values represent percentage points compared to the total price in 2002)

Country	WP (%)	GM (%)	N (%)	GEC (%)	C (%)	ET (%)	VAT (%)	*Total (%)*
Germany	+9	+9	−3	+16	−1	−3	+12	*+39*
France	+12	−22	+5	–	+7	+1	+1	*+5*
Italy	+4	+7	+2	−9	0	+9	−1	*+15*
UK	+28	−20	+13	0	0	+12	+2	*+35*

In the UK instead, the impact of increasing wholesale prices is twice as strong as the one from the increasing energy tax, but nearly fully compensated by the reduction in GM.

The residential electricity price in Italy shows a moderate increase (15%), which is primarily influenced by a rising ET, and the further rise of GM and WP (due to the reliance on fossil fuels). The declining trend of the GEC constrains the price increase. In Italy the contribution of the GEC to the overall electricity price nearly halved, given the declining trend of the GEC and the increase of the overall price.

The French residential electricity price features the lowest increase of only 5%. This can be explained by the fact that the wholesale price is the lowest of all countries, experiencing only limited growth. Moreover, this price increase and the growth of concession and network charges are compensated by a significant decline of the gross margin due to deregulation.

In all countries the drop in wholesale prices from 2008 to 2009 is associated with an increase of the gross margin by factor of two in Italy and the UK, factor three in Germany and factor 13 in France.

4.3 Comparison of the Costs of Residential Customers

The electricity consumption of an average residential customer (defined as the overall national electricity consumption of the residential sector divided by the number of registered households) and the related electricity costs (as the product of the average electricity consumption and the mean electricity price) are presented by country in Fig. 8. Between 2002 and 2010[7], the average residential electricity consumption experienced a general decreasing trend in Germany (−3%), Italy (−9%) and the UK (−15%), but an increase in France (+6%). However, given the strong increase in the German electricity price, Germany stands out as being the country with the largest increase in electricity costs for an average residential customer (+29%), followed by France (+6%). In contrast, the average costs have decreased in the UK (−7%) and Italy (−3%) over the same period. Correlating the electricity price to the electricity consumption for each of these countries shows that the coef-

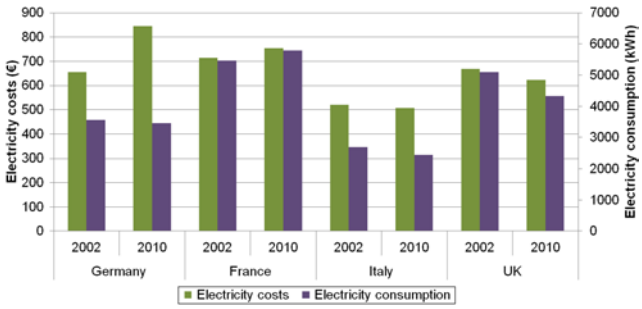

Fig. 8 Average residential electricity costs and consumption for Germany, France, Italy and the United Kingdom, 2002 vs. 2010 (real € 2012)

[7] As explained in chap. 2, data on electricity consumption after 2010 were not available at the moment of elaborating this study.

ficient of determination lies within a range of 11 % (France) to 42 % (UK) which means that there is only a limited link between electricity prices and electricity consumption.

Obviously, this is just a simplified statistical analysis which does not allow any direct causal conclusions between electricity price and electricity consumption. Hence, the results have to be interpreted with caution due to the following simplifications:

- First, household electricity costs vary largely depending on several factors such as the number of occupants per household, the ownership rate, the efficiency of end-uses and the type of heating system installed.
- Second, the usage of residential end-uses and thus energy demand is in general only price sensitive to a very limited extend.
- Third, as well as the usage the investment decision is by far not only related to an assumed energy carrier price development of a decision maker. Rather, further criteria are included in the investment decision process e.g. the electricity cost to investment ratio, consumer preferences or infrastructure restrictions.
- Fourth, the focus on electricity as one of the residential energy carriers is rather narrowed considering the fact that less than 1/3 of an average households energy consumption are attributed to electricity (Germany: 19 %, Italy: 21 %, UK: 23 %, France: 30 %; these are all figures for 2010).

Hence, drawing a conclusion regarding the number of German households that are not able to pay their electricity bills and consequently cut off from their electricity supply requires a more detailed analysis by further considering the disposable income per household.

5 Conclusions

5.1 Lessons Learned of Historic Price Evolution

In order to identify the main drivers of residential electricity prices for selected EU-Member States along the electricity supply chain, a decomposition approach is applied that breaks down the total electricity price by a set of components which are defined in a consistent transnational manner. This study provides a higher disaggregated apportionment of price components than those offered by public sources, e.g. Eurostat and IEA for the different countries or BDEW (2013) for Germany, to analyse their contribution to the residential electricity price development for Germany, France, Italy and the United Kingdom. Further additional value is provided by the duration of the observation period of a whole decade to emphasize the changes throughout the years and not just a single year analysis like exposed in recently published studies analysing the residential electricity prices, e.g. (Enel 2010) for Italy or (Ofgem 2013d) for the UK.

The results show that all countries have featured an increase in residential electricity prices over the past 10 years, in particular Germany and the UK by more than 30 %. While the increase in wholesale prices represents the main reason in UK and France, the impact from environment related levies is even higher in Germany and Italy. Analyzing the aggregate development of the wholesale price and the gross margin emphasizes that a decrease of the wholesale price, especially when comparing 2008 and 2009, is not directly passed to the customer in the short-run and instead is absorbed as producer surplus. With regard to the price level, German and Italian electricity prices clearly exceed the level of the UK and France, being nearly twice as high due to high taxes and levies added on top of the supply and network costs in Germany or the comparatively elevated gross margin in Italy.

Comparing the analyzed countries in terms of average electricity costs per household shows that in Germany the electricity costs increased the most (+29 %) between 2002 and 2010 despite a decrease of electricity consumption by 3 %. In contrast, the average costs have decreased in the UK (−7 %) and Italy (−3 %) over the same period. In order to fully understand the interactions between electricity consumption and electricity costs a separate holistic assessment is required.

5.2 Short-term Price Outlook

Analyzing the composition of residential electricity prices in the four selected Member States over the last decade leads to a very heterogenic picture when comparing the evolution on a component level. Thus, to draw some prospective conclusions in terms of a short-term price outlook the country-specific characteristics have to be taken into account. Despite the fact that electricity price forecasting is by nature an issue associated with a high level of uncertainty some general trends can be witnessed at the level of individual components to estimate qualitative pathways in the upcoming months and years.

Beginning with the wholesale price, there are three main factors influencing price evolution in all four countries: the price development of emission allowances (EUA) from the European Emission Trading System (ETS), the evolution of fossil fuel prices and the future contribution of renewable energy sources (RES) to the overall national electricity generation. Given that in 2013, EUA prices remained constantly below the level of 7 €/t_{CO_2} (EEX 2013), the European Parliament voted in December 2013 in favour of a "backloading" strategy which implies withholding 900 million EUAs from auction in 2014. Despite an expected price increase

of up to 100 % (ICIS 2013), the impact on electricity prices in countries relying heavily on carbon intensive fossil fuels (mainly UK and Germany) is expected to be very limited, since prices below 15 €/t_{CO_2} are not expected to have an impact on the price competitiveness between coal and gas fired power plants.

With regard to fossil fuel prices, hard coal prices featured a decrease of nearly 50 % over the past three years, partially related to increased exports from the US due to shale gas extraction and export increase from Indonesia (IEA 2013b). This trend may reverse into a stabilisation and mid-term increase of prices due to significant demand increase from emerging economies and most likely over-estimated shale gas expectations in the US (EnergyWatchGroup 2013). The crude oil and natural gas price increase, observed over the years after the economic crisis in 2007/08, has turned into an overall stabilisation in 2013, which may continue within the next months (European Commission 2013c).

More significant impacts are related to the wholesale price reducing effect of RES (also referred to as merit-order effect (Sensfuß et al. 2008)). The RES share in national electricity generation mix is presumably increasing according to the National Renewable Energy Action Plans (European Commission 2013d). Mainly in countries featuring a high share of OPEX intensive oil and gas fired power plants (i.e. a steep merit-order curve), such as Italy, substantial wholesale price reductions can be expected from the enhanced use of renewable sources. Summing up these three factors one may expect a relatively stable trend of wholesale prices in the short-term, with RES counterbalancing a potential increase in fossil fuel prices (in particular hard coal) through the merit-order effect.

With regard to the evolution of the gross margin, the observable downward trend of the previous years in UK is supposed to occur also in Germany and Italy, given an increased competition among retailers due to a further implementation of the EU Internal Market in Electricity Directive (European Commission 2009c). Additional gross margin reduction may be related to an increasing supplier shifting behaviour of consumers and an adjustment of the standard supplier assignment[8] towards more economic tariffs.

Network charges potentially increase further in the near future due to two main reasons. Additional grid investments are required within the upcoming decades as a result of outdated infrastructure, an increasing supply contribution from volatile RES, need for additional international net transfer capacities and the increasing number of decentralised generation units. Moreover, the latter issue causes a declining utilization of the transmission grid which leads to higher specific transmission charges and concession levies.

Financing of RES is done in the countries observed either by the introduction of a green energy contribution or by raising the energy tax. The further uptake of RES generation capacities will be reflected by the respective increase of related levies. The rate of increase depends on the detailed design of the support mechanism, the cost allocation to the different types of consumers (residential, commercial, industrial) and the development of the wholesale market prices. It is clear that under the current compensation mechanism the green energy contribution or the energy tax is going to increase further in the future in line with RES installation. However, due to alternative variations of financing there is high uncertainty about the concrete path.

The value added tax, having remained constant over the past years in three of the four countries, is not supposed to additionally influence the overall price in the near future.

To summarize, in the short-term the overall price evolution is mainly subject to uncertainty in fossil fuel price development (currently stabilised) and an increasing trend in RES related levies.

Thinking beyond the short-term horizon residential electricity prices will mostly depend on the expansion trajectory of RES capacities, in two respects: Increasing generation from RES will trigger a reduction of wholesale prices, a simultaneous increase of network and concession charges as well as of the green energy related levy and limiting the impact of fossil fuel price development on overall electricity prices. Apart from that, substantial RES shares will challenge the current market functionality and make market players call for new types of market mechanism such as capacity markets, which may lead to the introduction of additional price components in the residential electricity price.

[8] Von der Fehr and Hansen (2010) state that passive consumers not switching their supplier often pay prices far more expensive than the cheapest available rates.

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