PRICES AND COSTS OF EU ENERGY

Final Report

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Date: 29 April 2016

Reviewer: Ann Gardiner

This study was ordered and paid for by the European Commission, Directorate-General for Energy,

SERVICE CONTRACT

CONTRACT NUMBER – ENER/A4/FV-2015-395/SER/SI2.712709

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Abstract

In the period between 2008 and 2015, retail prices for electricity and gas have generally increased, with the exception of gas in industry which shows a slight decrease in the statistics. Higher energy costs and prices have been cited as a factor in decreasing competitiveness of industry in many EU Member States. This report looks at the drivers for developments in energy costs and how these affect households and the European industry. An econometric analysis disaggregates the main drivers in retail costs for electricity and natural gas. Policies determining the increasing number of taxes and levies are analysed one by one on the national level. The impact of prices on industrial competitiveness is analysed for 15 energy intensive sectors, and five energy intensive products. The effects differ strongly by sector and by country. The analysis of energy expenditures in households is split by income levels. In every European Member State, the main impact of increasing retail prices is on households with low income.

Summary

There is an ongoing debate in Europe on the impact of expenditure on energy for households and industries and the role of energy prices. In the period between 2008 and 2015, retail prices for electricity and gas have generally increased, with the exception of gas in industry which shows a slight decrease in the statistics. Higher energy costs and prices have been cited as a factor in decreasing competitiveness of industry in many EU Member States. Energy prices in Europe have increased, but there is a large variation in the price changes for final consumers, particularly because of differences in national energy and climate policies.

This report looks at the drivers for developments in energy costs, and how these affect households and European industry. Prices are not however, the only component driving energy expenditure. Total expenditure is also determined by the level of energy consumption, which is influenced by the total level of activities and also efficiency measures. The price discussion is put into the context of these other factors.

This detailed overview of price developments and their drivers provides important information for the discussion about the future energy policy in Europe, in particular about the role of the Energy Union.

Energy retail prices have mostly increased despite some falls in commodity prices

European retail prices rose in the period 2008-2015: for the average electricity price by 15-25%, for the average gas price up to 10%, although there is an exception in gas for industrial users which showed a 1% decline over the period. For globally traded energy carriers like oil and coal, prices were volatile, increasing until 2012, but then decreasing in recent years. This analysis considers three components of retail prices: energy, network, and taxes and levies. On the national level, the average values for these three components often develop in different directions.

The energy component of retail price is determined by wholesale prices and by costs associated with supply (e.g. billing, supplier margins). In the electricity sector wholesale prices are driven by fuel shares in the generation mix, commodity prices and market features: like access to resources, the degree of competition and integration with neighbouring markets. Price decreases are generally caused by competition, cross border exchange of power and a higher share of electricity from renewable energy sources. During the assessed period, (wholesale) pricing of natural gas in the EU underwent large changes: from oil indexed pricing to spot market oriented pricing. In North Western Europe, prices have been significantly affected by both the crude oil price and LNG import prices between 2008 and 2015. In Central Europe the introduction of competitive gas markets has significantly decreased the impact of oil on the border prices for natural gas. As a consequence, Central European Member States were able to profit from the drop of spot gas prices in 2014.

On average, the network component to the retail price for both gas and electricity has remained relatively stable over the period 2008-2015. Increasing shares of electricity production from

renewable energy sources are having an impact especially on distribution grids, but connection costs are often covered by special levies, or they are included in renewable energy surcharges. The effect of the network component on total retail prices depends on the consumer category. Large consumers in particular who are connected to the medium voltage or high voltage grids profit from lower network costs as they do not use distribution grids. Tariff structures for industrial consumers often favour demand patterns with little variation over time.

Since 2008, the taxes and levies component has increased for electricity, largely due to support for renewable energies and CHP. These payments add to the energy and environmental taxes that are paid on the use of energy carriers in Europe. In most countries and for most energy uses these excise duties have been constant for the whole period from 2008 to 2015. Value added taxes on household retail prices are applied as percentages of the total retail price, including on the sum added by all other taxes and levies. Their nominal effect increased with increasing total prices. Some countries additionally raised the percentages of the value added tax. The total effect of the taxes and levies component on energy retail prices depends on the energy carrier, the energy use and the consumer group. In electricity prices, there are different rates for consumers depending on total consumption, grid connection, electricity cost intensity and applied processes. Taxes and levies on gas and oil product prices mainly depend on the processes the energy is used for. Some excise tariffs on gas and oil differ by consumer segment, on rare occasions, tariffs are lower for high consumption classes.

Rising prices challenge households with low income

The decrease of 11% in total household energy consumption in Europe between 2008 and 2014 was not sufficient to compensate for the increase in energy retail prices. Hence, annual expenditure on energy for European households in this period has risen in nearly all Member States, with a significant variation between, and even within, countries.

Countries in which household consumption is split amongst a few energy carriers are more exposed to specific price-changes or supply restrictions for these energy products. Heating plays an important role in energy consumption for households, which can be seen especially in cold winters, as in 2010. Depending on the country, residents keep their homes warm using natural gas, heating oil, wood or electricity. Price changes in natural gas, for example, have had a large impact on energy expenditures in the Netherlands, Italy and the UK; while changes in oil prices have mainly affected households in Ireland and Luxembourg.

In some countries, increasing average energy costs have been compensated by increasing average income, thus, mitigating price effects. However, low income households have high shares of residential energy expenditures and are affected most by changes in energy retail prices. A number of countries introduced policies to support households with low income to keep their standards of living, either through issuing allowances to cover costs for heating, or by reduced tariffs per unit of energy. In medium income households, the share of energy costs for transportation is higher.

Changes in retail prices affect industries in different ways

EU average electricity prices for industry are in the range of average prices amongst key competitor countries of the EU. However, national differentiation in the EU is very high. The highest electricity prices in Europe are higher than for all competitors examined and the lowest lower. Gas prices for EU industry are higher than those of most competitors examined.

Energy demand in 2014 by industrial consumers was 12% lower than in 2008, largely due to the financial crisis. For the industry sectors analysed in this study, the decrease in energy consumption exceeded the price increases, so total expenditure decreased between 2008 and 2013. In the energy intensive industries analysed in detail, both the share of energy purchases in total production costs and absolute expenditure on energy declined in the period 2008-2013.

Prices for individual companies vary considerably. The individual energy price depends on the firm's supply strategies, synergies and specific regulations. Additionally, governments provide reduced rates, exemptions or compensation from taxes and levies based on criteria, such as risk of competitiveness, energy costs intensity or energy efficiency status.

Analysing the positioning of EU industry versus key competitor countries is a complex endeavour, because competitiveness is driven by several additional factors beyond the energy price. For the EU sectors examined, the share of energy costs in production was lower than in the US and higher than in Japan. In the US, cost shares are falling more rapidly. Gross operating surplus as percentage of production costs is smaller in the EU industry sectors analysed than Japan and the US.

Despite higher gas (and in some cases electricity) prices compared to some competitors, Europe is still a net exporter of many products, for example finished steel and aluminium products. As gas prices have been decreasing rapidly in some competitor countries it may be that there is a lag effect in this observation. The EU lost market share to particularly China in certain sectors, including steel, paper and aluminium. This is despite higher energy intensity in China and comparable (or higher) gas and electricity prices. Part of this loss in market share can be attributed to government support to industry in China and to undervalued exchange rates.

The changes in energy prices are an important but not the only challenge to the traditional business model of energy intensive industry. In current times of overcapacities and associated market consolidation in energy-intensive sectors, energy prices are one factor in deciding where to pursue production. In the long run, structurally low prices and other structural factors, such as a move to specialised and higher added value products, capacity costs and market proximity are likely to have more impact.

Résumé

Il y a un débat en cours sur l'importance des dépenses en matière d'énergie pour les ménages et les industries en Europe. Entre 2008 et 2015, les prix de détail de l'énergie et du gaz ont généralement augmenté, avec l'exception du gaz dans l'industrie, qui a baissé légèrement. Les intervenants de l'industrie ont cité les coûts et les prix de l'énergie plus élevés comme un facteur qui diminue la compétitivité dans de nombreux États membres de l'UE. En effet, les prix de l'énergie en Europe ont augmenté, mais il y a une grande variation dans les changements de prix pour les consommateurs finaux, en particulier en raison des différences dans les politiques énergétiques et climatiques nationales.

Ce rapport se penche sur les moteurs de l'évolution des coûts énergétiques et la façon dont ceux-ci affectent les ménages et l'industrie européenne. Cependant, les prix ne sont pas la seule composante qui influence les dépenses d'énergie. Le total des dépenses est également déterminé par le niveau de consommation d'énergie, qui est influencée par le niveau total des activités ainsi que des mesures d'efficacité. La discussion des prix est mise dans le contexte de ces autres facteurs.

Cette vue d'ensemble détaillée de l'évolution des prix et de leurs inducteurs fournit des informations importantes pour la discussion sur la future politique énergétique en Europe, en particulier sur le rôle de l'Union de l'Energie.

Alors que les prix des matières premières baissent, les prix de détail de l'énergie augmentent pour la plupart

Les prix de détail européens ont augmenté dans la période 2008-2015: le prix moyen de l'électricité de 20-30%, le prix du gaz jusqu'à 10%, bien que le prix du gaz dans l'industrie ait baissé de 1% dans cette période. Pour les vecteurs énergétiques commercialisés à l'échelle mondiale, comme le pétrole et le charbon, les prix ont été volatils, avec une augmentation jusqu'en 2012 et une baisse dans ces dernières années. Cette analyse prend en compte trois composantes des prix de détail, à savoir l'énergie, le réseau et les impôts et taxes. Ces composantes développent souvent dans des directions différentes.

La composante énergétique des prix de détail est déterminée par les prix de gros et par les coûts associés à l'offre (par exemple la facturation, les marges des fournisseurs). Dans le secteur de l'électricité, les prix de gros sont déterminés par les parts de combustible dans le mix de production, les prix des matières premières et les caractéristiques du marché, comme l'accès aux ressources, le degré de concurrence et l'intégration avec les marchés voisins. Les baisses de prix sont généralement causées par la concurrence, les échanges transfrontaliers d'électricité et une plus grande part de l'électricité à partir de sources d'énergie renouvelables. Au cours de la période évaluée, la tarification des prix (gros) du gaz naturel dans l'UE a subi de grands changements: d'une structure de prix indexée à celle du pétrole à une tarification orientée au marché au comptant. Dans le nord-ouest de l'Europe, les prix sont affectés de manière significative à la fois par le prix du pétrole brut et les prix

d'importation de GNL. En Europe centrale, la mise en place des marchés du gaz concurrentiel a diminué de manière significative l'impact du pétrole sur les prix à la frontière pour le gaz naturel. En conséquence, les États membres d'Europe centrale ont été en mesure de tirer profit de la baisse des prix spot du gaz en 2014.

En moyenne, le composant de réseau au prix de détail pour le gaz et l'électricité est resté relativement stable sur la période 2008-2015. L'augmentation de la part de production d'électricité à partir de sources d'énergie renouvelables a un impact particulier sur les réseaux de distribution, mais les coûts de connexion sont souvent couverts par des prélèvements spéciaux ou ils sont inclus dans les suppléments d'énergie renouvelable. L'effet du composant de réseau sur le total des prix de détail dépend des consommateurs individuels. Les grands consommateurs, en particulier, qui sont connectés au réseau de moyenne tension ou au réseau de haute tension profitent des coûts de réseau inférieurs car ils n'utilisent pas des réseaux de distribution. Les structures tarifaires pour les consommateurs industriels favorisent souvent des modèles de demande avec peu de variation au fil du temps.

Depuis 2008, la composante des impôts et taxes a augmenté pour l'électricité, en grande partie grâce à l'appui des énergies renouvelables et de la cogénération. Ces paiements sont supplémentaires aux taxes sur l'énergie et l'environnement qui sont payés pour l'utilisation de vecteurs énergétiques en Europe. Dans la plupart des pays et pour la plupart des utilisations énergétiques ces droits d'accises ont été constants pendant toute la période de 2008 à 2015. Les taxes sur la valeur ajoutée sur les prix de détail des ménages sont appliquées en pourcentage du prix de détail total, y compris tous les autres impôts et taxes. Leur effet nominal a augmenté avec la hausse des prix totaux. Certains pays ont augmenté en outre les pourcentages de la taxe sur la valeur ajoutée. L'effet total de la composante des impôts et taxes sur les prix de détail de l'énergie dépend du vecteur énergétique, l'utilisation de l'énergie et le groupe de consommateurs. Pour les prix de l'électricité, il y a des taux différents pour les consommateurs en fonction de la consommation totale, le raccordement au réseau, l'intensité du coût de l'électricité et des processus appliqués alors que pour les prix du gaz et des produits pétroliers l'effet est souvent pareil pour tous les consommateurs, mais en fonction de l'utilisation du vecteur énergétique.

L'augmentation des prix constituent un défi pour les ménages à faible revenu

La diminution de 11% de la consommation totale d'énergie des ménages en Europe entre 2008 et 2014 n'a pas été suffisante pour compenser l'augmentation des prix de détail de l'énergie. Par conséquent, les dépenses annuelles sur l'énergie pour les ménages européens dans cette période a augmenté dans presque tous les États membres, avec une variation significative entre et au sein des pays.

Les pays dans lesquels la consommation des ménages se concentre sur quelques vecteurs énergétiques sont plus exposés aux prix-changements spécifiques ou des restrictions d'offre pour ces produits énergétiques. Le chauffage joue un rôle important dans la consommation d'énergie pour les ménages, ce qui se manifeste dans les hivers particulièrement froids, comme en 2010. Selon les pays, les habitants gardent leurs maisons chaudes en utilisant le gaz naturel, l'huile à chauffage, le bois ou l'électricité. Les effets des variations de prix du gaz naturel, par exemple, a eu un impact important sur les dépenses d'énergie aux Pays-Bas, en Italie et au Royaume-Uni, tandis que les variations des prix du pétrole ont touché principalement les ménages en Irlande et au Luxembourg.

Dans certains pays, l'augmentation des coûts énergétiques moyens ont été compensés par l'augmentation du revenu moyen, atténuant les effets sur les prix. Toutefois, les ménages à faible revenu ont des parts élevées de dépenses énergétiques résidentielles et sont les plus touchés par les changements dans les prix de détail de l'énergie. Un certain nombre de pays ont introduit des politiques visant à aider les ménages à faible revenu afin de maintenir leur niveau de vie, soit par des quotas pour couvrir les coûts de chauffage ou de tarifs réduits par unité d'énergie. Dans les ménages à revenu moyen, la part des coûts de l'énergie pour le transport est plus élevée.

Les variations des prix de de détail affectent les industries de différentes façons

Les prix de l'électricité moyens pour l'industrie dans l'UE sont dans la gamme des prix moyens entre les principaux pays concurrents de l'UE. Cependant, la différenciation nationale dans l'UE est très élevée. Les prix les plus élevés de l'électricité en Europe sont plus élevés que pour tous les concurrents examinés et le prix les plus bas sont plus bas. Les prix du gaz pour l'industrie de l'UE sont plus élevés que ceux de la plupart des concurrents examinés.

La demande d'énergie par les consommateurs industriels en 2014 était de 12% inférieur à celui de 2008, principalement en raison de la crise financière. Pour les secteurs de l'industrie analysés dans cette étude, la diminution de la consommation d'énergie a dépassé les augmentations de prix, donc les dépenses totales ont diminué entre 2008 et 2013. Dans les industries à forte intensité énergétique analysées en détail, à la fois la part des achats d'énergie dans les coûts totaux de production et les dépenses absolues sur l'énergie ont diminué dans la période 2008-2013.

Les prix pour les entreprises individuelles varient considérablement. Le prix de l'énergie individuelle dépend des stratégies d'offre de l'entreprise, des synergies et des règlements spécifiques. En outre, les gouvernements offrent des tarifs réduits, des exonérations ou des compensations de taxes et de prélèvements sur la base de critères tels que le risque de la compétitivité, l'intensité des coûts de l'énergie ou de l'état de l'efficacité énergétique.

En analysant le positionnement de l'industrie européenne versus les principaux pays concurrents est une entreprise complexe, parce que la compétitivité est motivée par plusieurs facteurs supplémentaires au-delà des prix de l'énergie. Pour les secteurs de l'UE examinés, la part des coûts de l'énergie dans la production était inférieure à celle des États-Unis et plus élevé qu'au Japon. Aux Etats-Unis, les partages des coûts baissent plus rapidement. Excédent d'exploitation brut en pourcentage des coûts de production est plus faible dans les secteurs de l'industrie de l'UE analysés que le Japon et les États-Unis.

Malgré des prix du gaz plus élevés (et dans certains cas, de l’électricité) par rapport à certains concurrents, l'Europe reste un exportateur net de nombreux produits, par exemple de l’acier fini et des produites en aluminium. Comme les prix du gaz ont diminué rapidement dans certains pays concurrents, il se peut qu’un effet de retard existe dans cette observation. L'UE a perdu des parts de marché à la Chine en particulier dans certains secteurs, y compris de l'acier, du papier et de l'aluminium. Ceci est malgré le fait que l'intensité énergétique est plus élevée en Chine et les prix du gaz et d'électricité sont comparables (ou plus élevés). Une partie de cette perte de part de marché peut être attribué à l'appui du gouvernement à l'industrie en Chine et aux taux de change sous-évalués.

Les variations des prix de l'énergie sont un élément important, mais pas le seul défi pour le modèle d'affaires traditionnel de l'industrie à forte intensité énergétique. Dans les temps actuels de surcapacités et la consolidation du marché associé dans les secteurs à forte intensité énergétique, les prix de l'énergie sont un facteur pour décider où poursuivre la production. À long terme, les prix structurellement faibles et d'autres facteurs structurels tels que le passage à des produits spécialisés et des produits à plus haute valeur ajoutée, les coûts de capacité et la proximité du marché sont susceptibles d'avoir plus d'impact.

Glossary

Definitions

Price of energy: The amount of money for which an amount of energy is sold on the wholesale or retail market

Price components: Retail prices for energy consist of three components: energy, network and taxes/levies.

Sub-components: Classification of elements within components via their main purpose.

Elements: Smallest entity of quantifications for the impact of specific policies, fiscal measures, and constituents of supply costs.

Cost of energy: Energy price multiplied by energy consumption.

Direct impact: This refers to those taxes and levies, as well as policies, requiring the delivery of certificates, which change the retail prices for energy directly.

Indirect impact: Several policies affect the generation mix, supply routes and energy market systems. These will also ultimately affect the retail price, but in a more indirect way, for example by changing the wholesale price.

Consumption bands: Statistical groups of consumers according to their yearly consumption.

Abbreviations

AGEB	Arbeitsgemeinschaft Energiebilanzen
APX	Amsterdam Power Exchange
AT	Austria
B	Brussels
BE	Belgium
Belpex	Belgium Power Exchange
CAISO	California Independent System Operator
CAPEX	Capital expenditures
CO_2	Carbon dioxide
CY	Cyprus
CZ	Czech Republic
DE	Germany
DG ENER	Directorate-General for Energy
DG TAXUD	Directorate-General for Taxation and Customs Union
DK	Denmark
DSO	Distribution system operator
EC	European Commission
ECB	European Central Bank
EE	Estonia
EEX	European Energy Exchange
EL	Greece
ENTSO-E	European Network of Transmission System Operators for Electricity
EPEX	European Power Exchange
ERCOT	Electric Reliability Council of Texas
ES	Spain
ETS	Emission Trading Scheme
EU	European Union
F	Flanders
FI	Finland
FR	France
GDP	Gross domestic product
GOG	Gas-on-Gas Competition
GRP	Government regulated prices
HDD	Heating Degree Days
HICP	Harmonised Index of Consumer Prices
HR	Croatia
HU	Hungary
IE	Ireland
IEA	International Energy Agency
IMF	International Monetary Fund

IT	Italy
JRC	Joint Research Centre
kWh	Kilowatt hour
LMDI	Log mean divisia index
LME	London Metal Exchange
LNG	Liquid natural gas
LT	Lithuania
LU	Luxembourg
LV	Latvia
MS	Member State
MT	Malta
MURE	Energy efficiency policies and measures (French : Mesures d'Utilisation Rationnelle de l'Energie)
MWh	Megawatt hour
NACE	Statistical Classification of Economic Activities in the European Community – From the French, Nomenclature Statistique des activités économiques dans la Communauté européenne
NL	Netherlands
NO	Norway
NWE	Northwestern Europe
O&M	Operation & maintenance
OECD	Organisation for Economic Co-operation and Development
OPE	Oil-price escalation
OPEX	Operational expenditure
OTC	Over the counter
PJ	Petajoule
PJM	Pennsylvania-New Jersey-Maryland Interconnection
PL	Poland
PPP	Purchasing power parity
PT	Portugal
RCA	Revealed comparative advantage
RES	Renewable energy sources
RO	Romania
SBS	Structural Business Statistics
SE	Sweden
SI	Slovenia
SILC	Statistics on Income and Living Conditions
SK	Slovakia
SME	Small and medium-sized enterprises
TR	Turkey
TSO	Transmission system operator
UEC	Unit Energy Costs
UK	United Kingdom

UN	United Nations
US	United States of America
USGS	United States Geological Survey
VAR	Vector auto regression
VAT	Value added tax
W	Wallonia
WB	World Bank

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1 Introduction

Energy price and cost developments are of major importance to the European economy. In this study, we distinguish between energy prices, which are the prices paid by customers either on the wholesale (e.g. at a power exchange) or retail level (e.g. by a householder); energy price components (energy component, network component, taxes and levies); and energy costs. Energy costs for a consumer is the price of the product multiplied by the quantity of energy purchased.

The price of energy and the development of prices are important, as they impact European industrial competiveness, and disposable income for citizens in numerous ways. In recent years, higher energy costs and prices in most EU Member States have been identified by a large number of stakeholders as one of the reasons for decreasing competitiveness of EU industry. It is therefore, important to determine the drivers of energy prices and to understand how policy can affect those drivers. Additionally, it is useful to compare the level and evolution of energy prices in EU Member States and their major trading partners, and to analyse the impact of price and cost evolution on industrial competitiveness and household expenditure. The insights gained from understanding these drivers will be an important contribution to policy discussions on the European energy system.

This report provides insight into the wholesale and retail prices of electricity, natural gas and petroleum products in the Member States of the European Union and in their major trading partners. The study assesses the evolution, composition and drivers of energy prices, to give insight on their impact on industrial competitiveness, and on the social implications of household energy expenditure. This insight is gained by building on existing statistical information, some of which is newly collected by DG ENER, and supplementing this with detailed information about regulatory impacts of single policies on prices at the national level.

In the next section, we describe the development of energy retail prices and discuss how retail prices are formed. In section 3, we describe the different retail price components and discuss their drivers. An analysis of the role of energy in household expenditures is given in Section 4. The impact of energy costs on industrial production and competitiveness is discussed in Section 5. This section also includes case studies which examine this in more depth for selected industry sectors.

2 Energy retail price developments

Retail prices refer to the prices paid by the end consumer e.g. households or industry. On average, retail prices for energy have been increasing in the period from 2008 to 2015. The development over time depends on the energy carrier and the country. In this section, we describe the development of total retail prices for electricity, natural gas and oil products in European Member States, Norway and Turkey. The analysis is based on statistical data from the European Commission. All calculations are conducted and all results are presented in nominal values.

2.1 Electricity

Figure 1 shows the development of total electricity prices for households with a consumption between 2500 and 5000 kWh/year (Band DC) from 2008 to 2015. The information is based on an ad-hoc data collection conducted by the European Commission for every second year between 2008 and 2015. The EU-28 average of electricity prices is given by a weighted average of the ad-hoc data. It increased by approximately 25% from €16.6 ct/kWh in 2008 to €20.9 ct/kWh in 2015. Countries in the legend are ranked by their prices in 2015. In all years, Denmark shows the highest prices. On average, households in Denmark with a consumption between 2500 and 5000 kWh/year paid €30.6 ct/kWh in 2015. With a price of €29.5 ct/kWh in 2015, Germany ranks second highest. The lowest prices can be found in Bulgaria, with a price of €9.4 ct/kWh in 2015. The lowest prices can be found in Bulgaria, with a price of €9.4 ct/kWh in 2015.

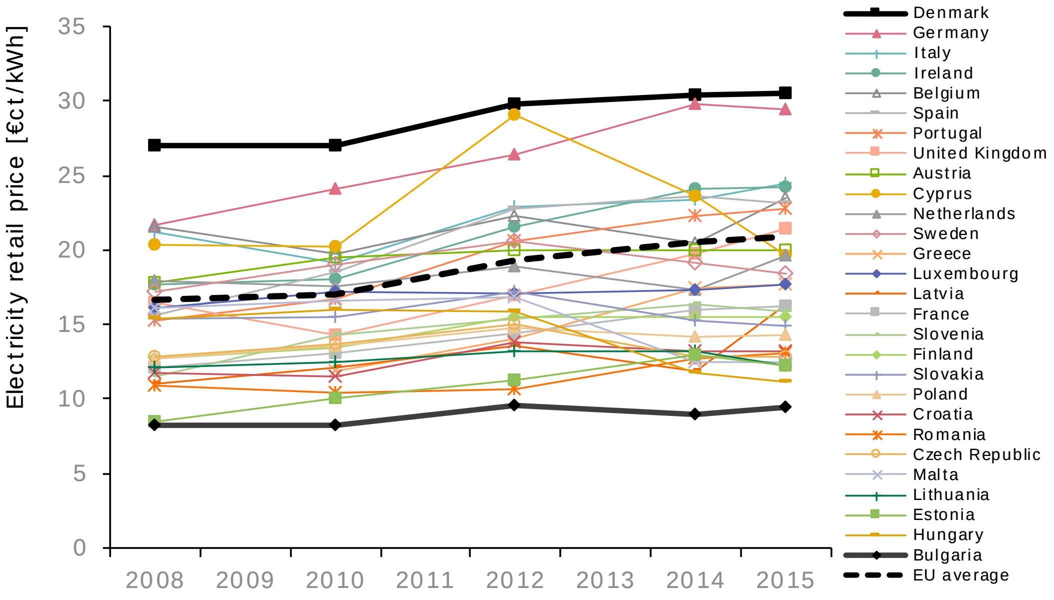

Figure 1: Total electricity price development for households (Band DC, source: European Commission)

For industrial consumers, total prices and the price spread between countries are significantly lower. Figure 2 provides a comparison for companies that consume 2 to 20 GWh/year (Band ID), excluding VAT and recoverable taxes. If numbers were missing in the ad-hoc data, Eurostat table nrg_pc_205 was used to fill the gaps. This was the case for Lithuania, and the 2008 data for Greece and Luxembourg. The island systems Cyprus and Malta have the highest prices. In Cyprus, an explosion in the Vasilikos power plant caused an additional increase in prices in 2012. For the whole period, Italy has been the country with highest prices in continental Europe. With a price of €149 /MWh (excluding VAT), it also had the overall highest price for the first semester of 2015. In 2015, the UK had the second highest price, with €139 /MWh. Lowest prices have been reported by Sweden, €54 /MWh. On average in the EU-28, the statistical retail price for industrial consumers in this consumption group increased by around 17% from €91.4 /MWh in 2008 to €107.4 /MWh in the first semester of 2015.

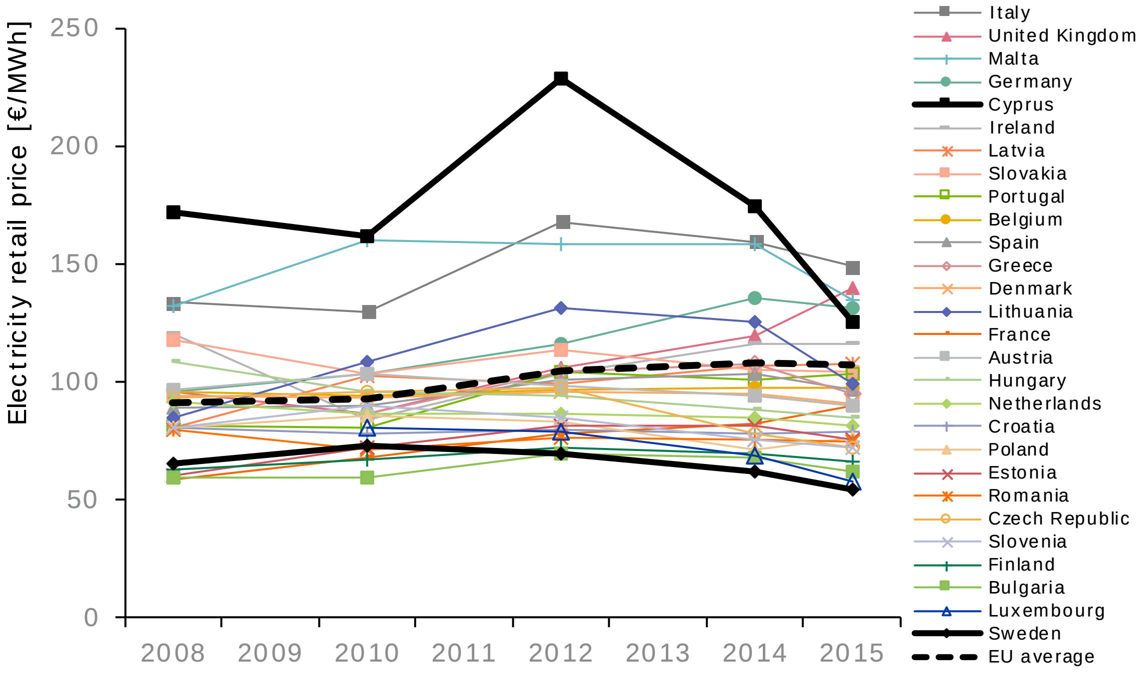

Figure 2: Total electricity price development for industrial consumers (Band ID, source: European Commission)

2.2 Natural gas

Average retail prices for natural gas in European households increased by 10% between 2008 and 2015. Nominal prices vary over time and between countries. Figure 3 shows the development for Band D2, which describes households with a consumption between 20 and 200 GJ per year. For the whole period from 2008 to 2015, the highest prices could be found in Sweden (€11.3 ct/kWh in 2015). Prices in Portugal increased significantly by 57%. In 2015 they ranked second highest with

€9.9 ct/kWh. Portugal replaced Denmark, which had the second highest prices between 2008 and 2012. In 2015, Danish prices ranked third at €8.1 ct/kWh. Lowest prices in 2015 have been reported for Romania (€3.1 ct/kWh), and Hungary (€3.5 ct/kWh). In Malta and Cyprus, natural gas is not used by households, as such there is no price information available. Data is missing for Finland, Latvia and Ireland, as well as for several countries in 2008. For Latvia and Ireland, we included information from Eurostat. For Italy, Greece, Luxembourg and Hungary, 2008 data was derived from Eurostat's table nrg_pc_202. However, Finland did not provide data to Eurostat either.

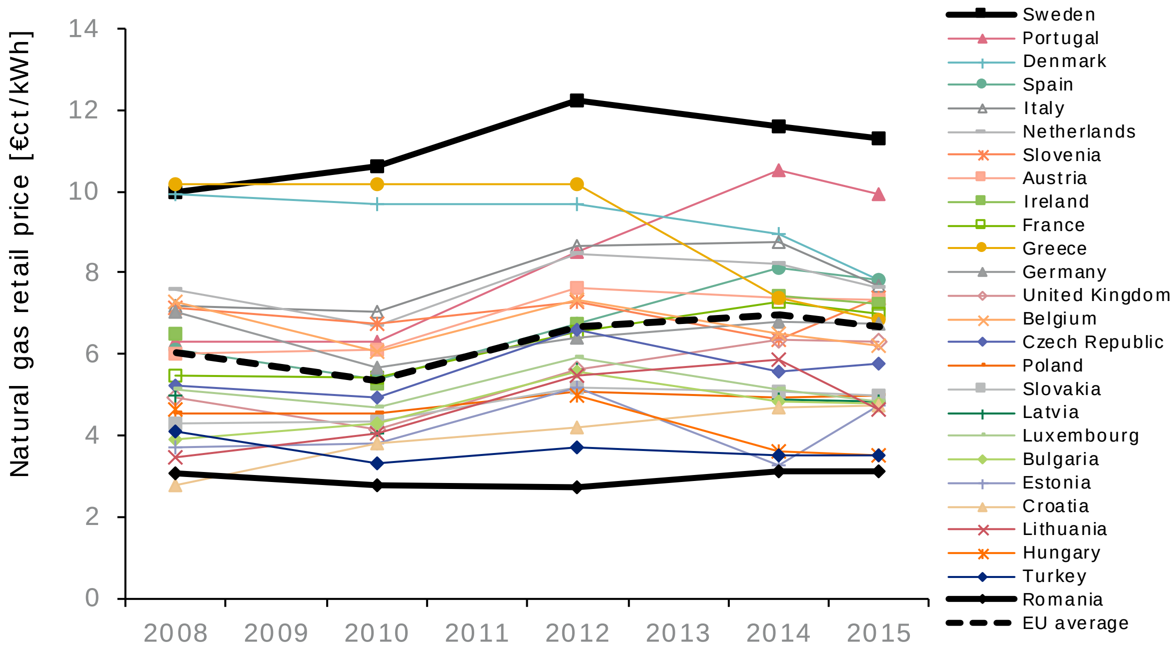

Figure 3: Total natural gas price development for households (Band D2, source: European Commission)

Industrial retail prices for natural gas in Europe decreased on average by 1% over the period. EU-28 average prices for consumers with a consumption of 10 to 100 TJ (Band I3) have decreased from €36.8 in 2008 to €36.4 /MWh (excluding VAT and recoverable taxes) in the first semester of 2015. Industrial users also paid the highest price for natural gas in Sweden, paying €53 /MWh in 2008 and €45 /MWh in 2015. Although in 2015, Finnish prices were about €1 /MWh more expensive, at €46 /MWh. Lowest prices for Band I3 in the first semester of 2015 have been reported by Turkey (€26 /MWh), while within the European Union, Belgium had the lowest prices (€29 /MWh). On average over the whole period, Romania was the European Member State with the lowest industrial retail prices for natural gas. Countries in the legend of Figure 4 are sorted in descending order by their 2015 values. For Austria, Ireland, Hungary, Luxembourg, Italy and Latvia, values are partly taken from the Eurostat data table nrg_pc_203, when it was necessary to fill data gaps, especially for the year 2008. All prices exclude VAT and recoverable taxes.

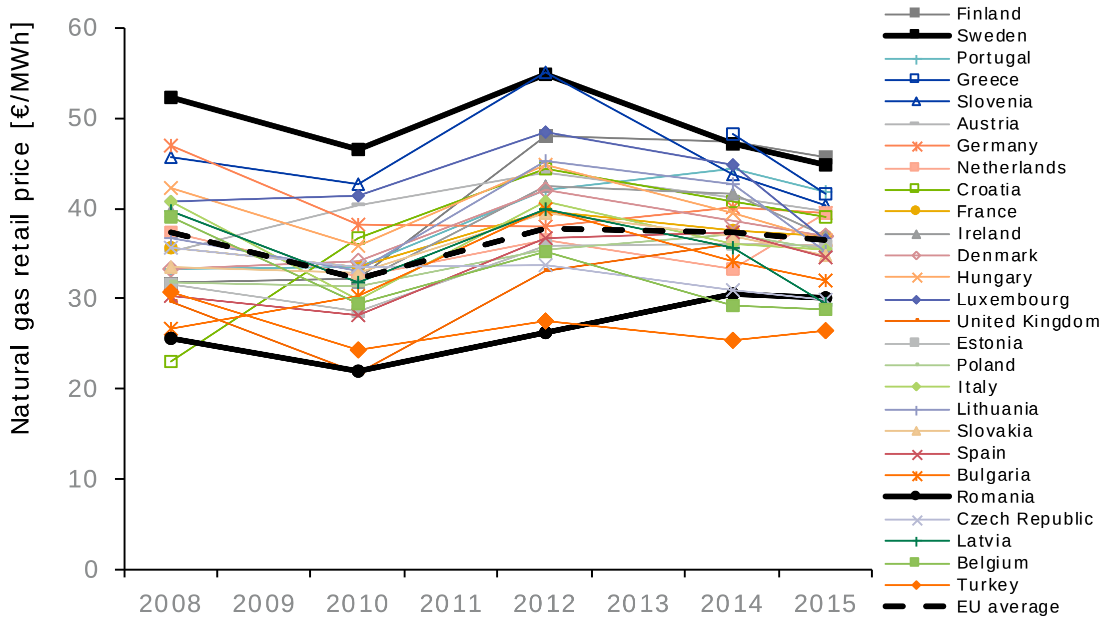

Figure 4: Total natural gas price development for industrial consumers (Band I3, source: European Commission)

2.3 Oil products

Oil product prices for end consumers in Europe can be classified into five groups: automotive diesel and gasoline, diesel for industrial use, heating oil for business and heating oil for non-business use. Price developments for all products follow the same general pattern: they start at a medium level in 2008, decline with the global oil price during the global economic crisis in 2009, then peak in 2012 and finally decline again. In 2015, average retail prices for oil products in Europe have reached a level slightly below the prices of the same product in 2008. Only gasoline prices have been higher in 2015.

European average retail prices for gasoline increased by 5% in nominal values.[1] In 2015, the statistical average price, including excise duties and VAT, was €1.4 /l for Euro Super 95. Bulgaria provided the minimum retail prices for gasoline in 2008 and 2015; It increased by 8% between 2008 and 2015 to €1.1 /l. In 2015, the highest price was to be found in the Netherlands, at €1.6 /l Euro Super 95. It increased by 1% in comparison to the Dutch price level in 2008. Figure 5 presents the values by country in the descending order of their 2015 prices.

[1] The presented price information has been extracted from the Weekly Oil Bulletin in February 2016; averages for 2015 are weighted with consumption data from 2014.

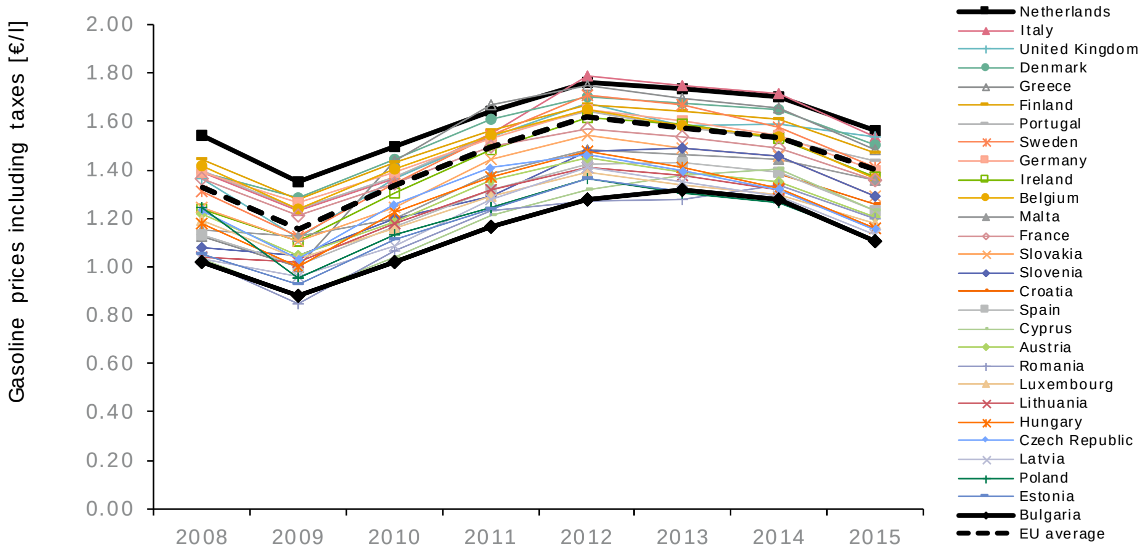

Figure 5: Development of retail prices for gasoline (2008 – 2015, data source: weekly oil bulletin)

Prices for automotive diesel varied between €1 and €1.5 per litre in 2008. In 2015, the spread increased from €1.0 to €1.6/l. After a peak of €1.5 /l in 2012, the average value returned to a value of €1.2 /l in 2015. The relative position of countries changed little. Luxembourg, Latvia and Lithuania are among countries with lowest levels of retail prices for automotive diesel in all years, while in 2008 and 2015, the Member State with highest retail prices for automotive diesel was the UK. The UK is the only Member State that applies the same excise tax to diesel and to gasoline.

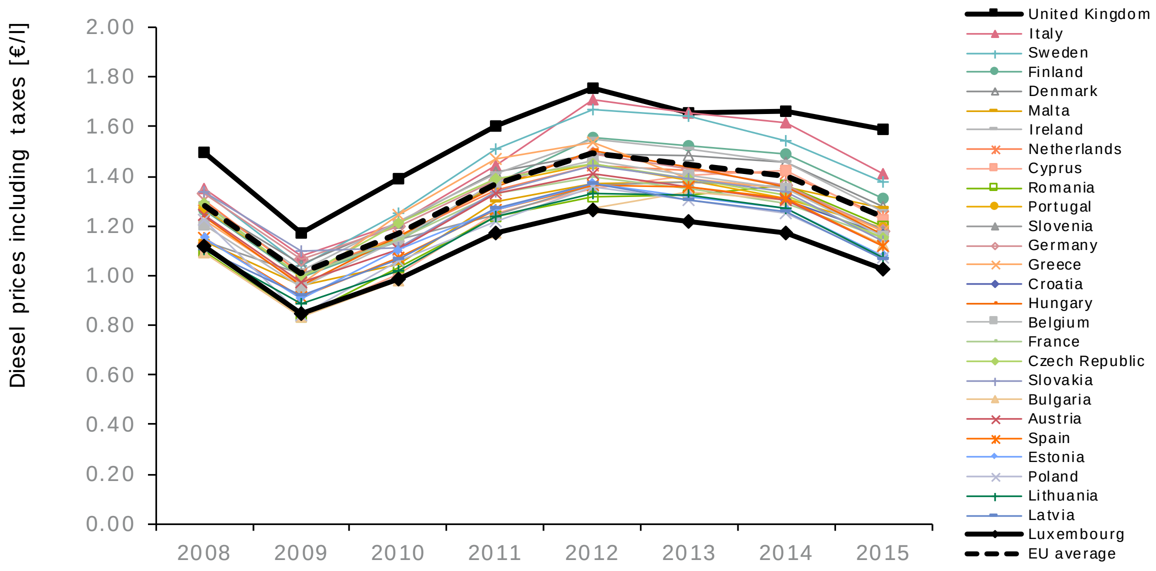

Figure 6: Development of retail prices for automotive diesel (2008 – 2015, data source: weekly oil bulletin)

Retail prices for heating oil show a broader variety of values within the Member States. Until 2012, there were two price groups of countries. In Italy, Sweden, Denmark and Hungary prices were about €200 /1000l higher than in the other European Member States. Portugal and Greece have crossed this gap between the two groups. Figure 7 illustrates this development.

In 2008, heating oil prices for non-business use ranged from €709 /1000l in Luxembourg to €1307 /1000l in Italy. This range has opened a little, with 2015 figures showing a spread from €548 /1000l in Luxembourg to €1240 /1000l in Denmark. The relative position of national prices within that range has changed little. Supply of heating oil was most expensive in Denmark, Sweden, Hungary and Italy throughout the entire period. Lowest retail prices could be found in Luxembourg, Belgium and the UK, as well as in Germany and Lithuania in 2015. The average price for heating oil decreased by 19%, from €857 /1000l in 2008 to €694 /1000l in 2015. As the average price is calculated from weighted consumption, the fact that it is at the lower end of the price spread shows that heating oil is lower priced in countries with highest consumption of heating oil.

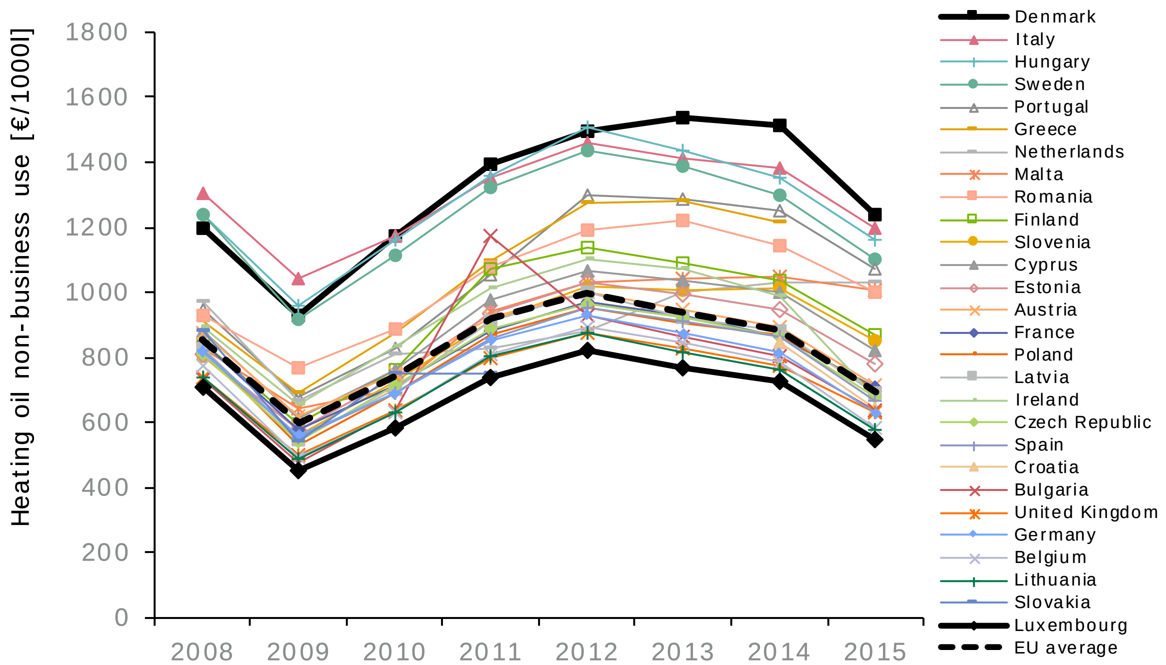

Figure 7: Development of retail prices for heating oil in non-business use (data source: weekly oil bulletin)

In 2015, business users of heating oil paid between €477 /1000l in Lithuania and €986 /1000l in Denmark. Figure 8 shows the price data including excise taxes, but excluding VAT. The European average is weighted by the diesel/gas oil use in industry (Eurostat table nrg_102a). Again, the fact that the average price is at the lower end of the price spread shows that industrial diesel is priced lower in countries that have the highest consumption.

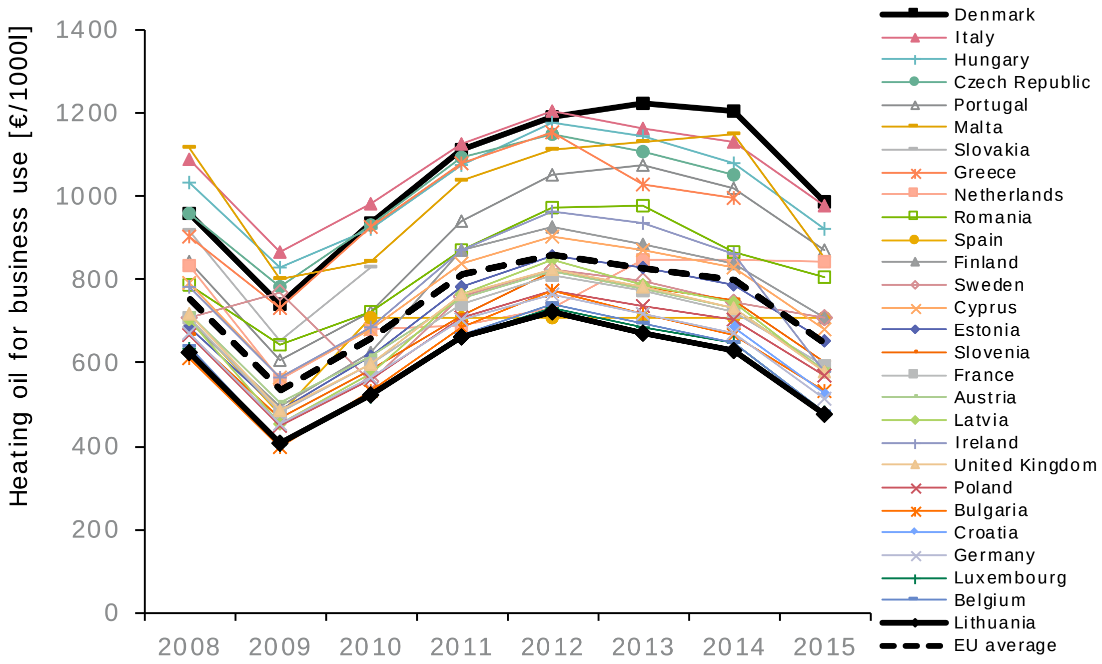

Figure 8: Development of retail prices for heating oil in business use, data sources: weekly oil bulletin, DG TAXUD, own calculations

3 Retail price components

In this section, we analyse the different components of retail prices. For each component we describe the trends and analyse the underlying drivers for those trends. Details for each Member State are described in Annex 1. The analysis of drivers is based on econometric analysis which is described in detail in Annex 2.

3.1 Components, sub-components and elements

Consumer prices for the two energy products: electricity, and natural gas consist of three components: energy, network and taxes/levies. The taxes and levies component includes all kinds of country-specific costs that are added to prices based on government decisions. These are divided into a number of sub-components, depending on the area of government policy. Each of the components is made up of several elements as illustrated in Figure 9. The energy supply component includes elements related to wholesale energy prices and costs for running an energy supply business, including margins. The network component mainly includes elements that fall under the sub-components of transmission, and distribution of electricity and gas. The elements in the taxes and levies component relate to taxes, where the revenue goes to the general state budget; and levies, where revenues are ear-marked for a particular policy and costs associated with meeting obligations, for example certificate trading.

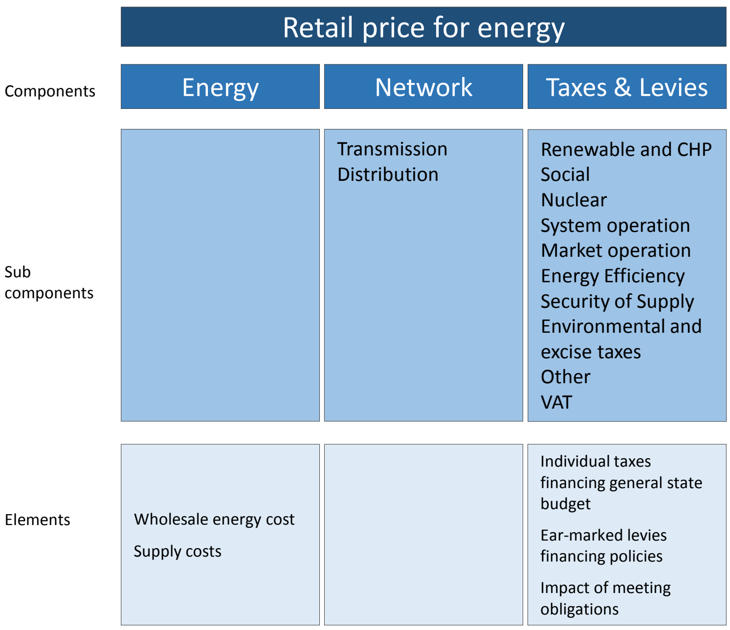

Figure 9: Components, sub-components and elements of consumer prices for energy

In this subsection, we look at the factors affecting retail prices and the energy retail price component. What ultimately matters for consumers is how much they spend on energy. Thus the retail price of energy is key when looking at impacts on the welfare of households and the competitiveness of industries. The analysis aims to describe the impacts market liberalisation and energy policies have on the retail price. While taxes and levies are price components directly set by regulation and governments, and network fees are determined mainly by infrastructure costs, the price of the energy supply component is driven by wholesale prices in combination with the competitiveness of markets.

3.1.1 Electricity

Figure 10 and Figure 11 depict the evolution of the retail price components by selected years and consumption bands DC (households), and ID (industry). The vertical lines below and above the boxes show the minimum and maximum values of the components, the boxes represent the range between the 25th - 75th percentiles, the line in the boxes show the median. The median represents the midpoint of all reported values.

The unweighted statistical values show the developments of the three price components “energy”, “network” and “taxes and levies”. For households and industries, the median energy component has decreased over the period 2008-2015, while the median for the taxes and levies component increased and the network component also saw a slight increase.

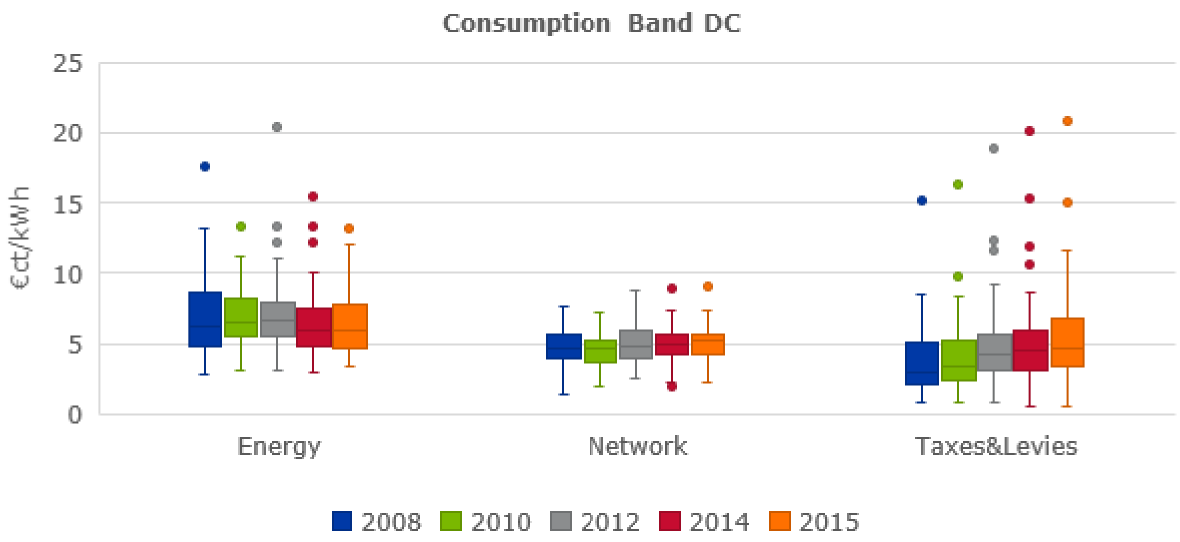

Figure 10: Evolution of retail price components between 2008 and 2015 (EU 28 plus NO, Band DC, source: European Commission)

Each price component shows outliers within the years, for extraordinary reasons, like an explosion in a power station on Cyprus (2012, energy component); but also because of very high tax levels, as in Denmark (outliers in taxes and levies component). As such, the 25th and the 75th percentile give a better overview of the general development. The bandwidth of values for the energy component in electricity prices decreases for households and industrial consumers (Figure 11). The network component shows a rather dense population of values, while the bandwidth of the taxes and levies component increases especially for industrial consumers.

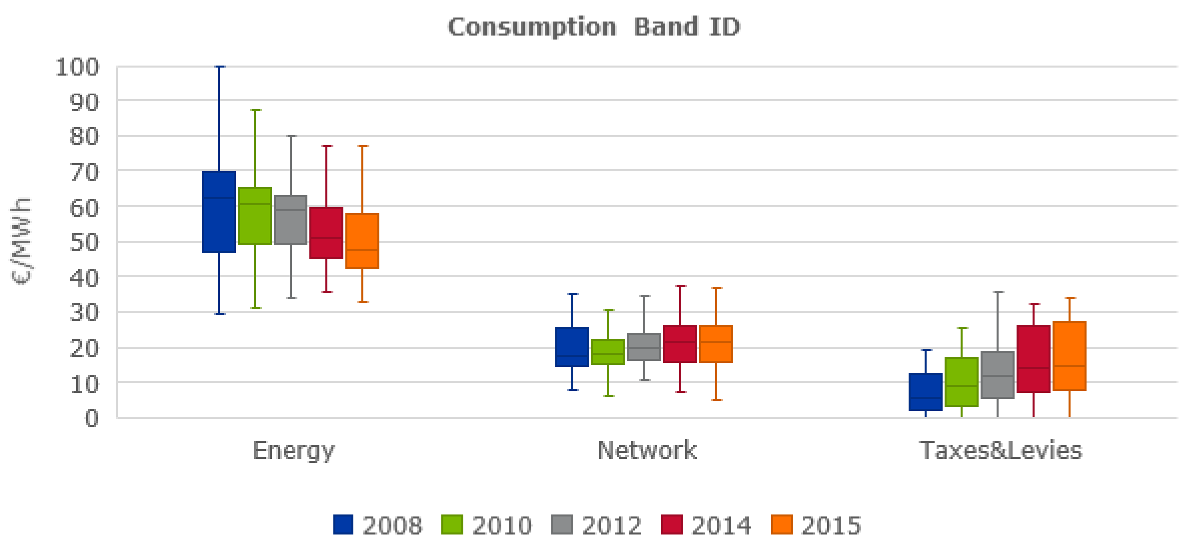

Figure 11: EU distribution and evolution of retail price components between 2008 and 2015 (EU 28 plus NO, Band DC, source: European Commission)

3.1.2 Natural gas

The evolution of gas retail price components is depicted in Figure 12 for households and in Figure 13 for industries. It shows that the energy component in gas retail prices decreased from 2012 to 2015. In contrast to the findings for electricity retail prices, the energy component in gas retail prices is clearly the highest among the three components.

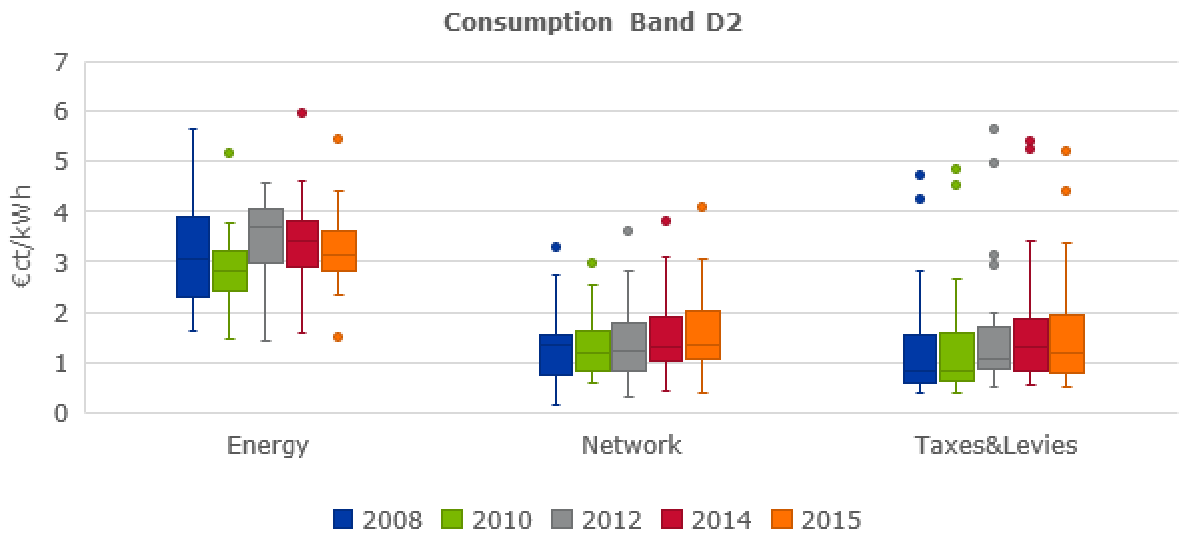

Figure 12: Annual gas retail price components for households (EU 28, Band D2, source: European Commission)

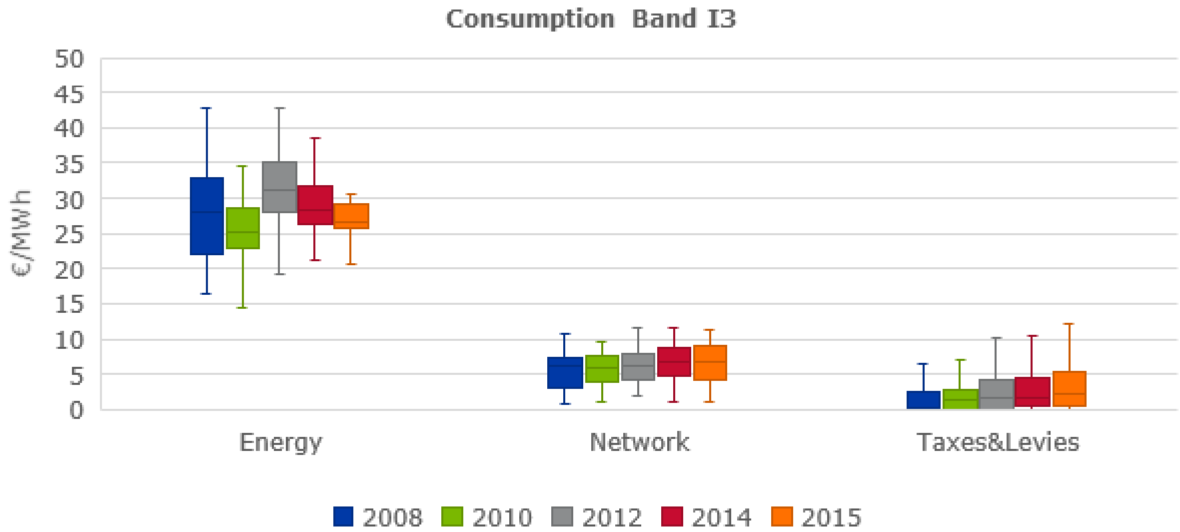

Figure 13: Annual gas retail price components for industries (EU 28, Band DC, source: European Commission)

3.1.3 Oil products

For oil products, price spreads of the energy component are lower. Figure 14 shows the development for all 28 Member States of heating oil prices, excluding taxes. Denmark shows the highest values. All values mirror the development of the Brent crude oil spot price.

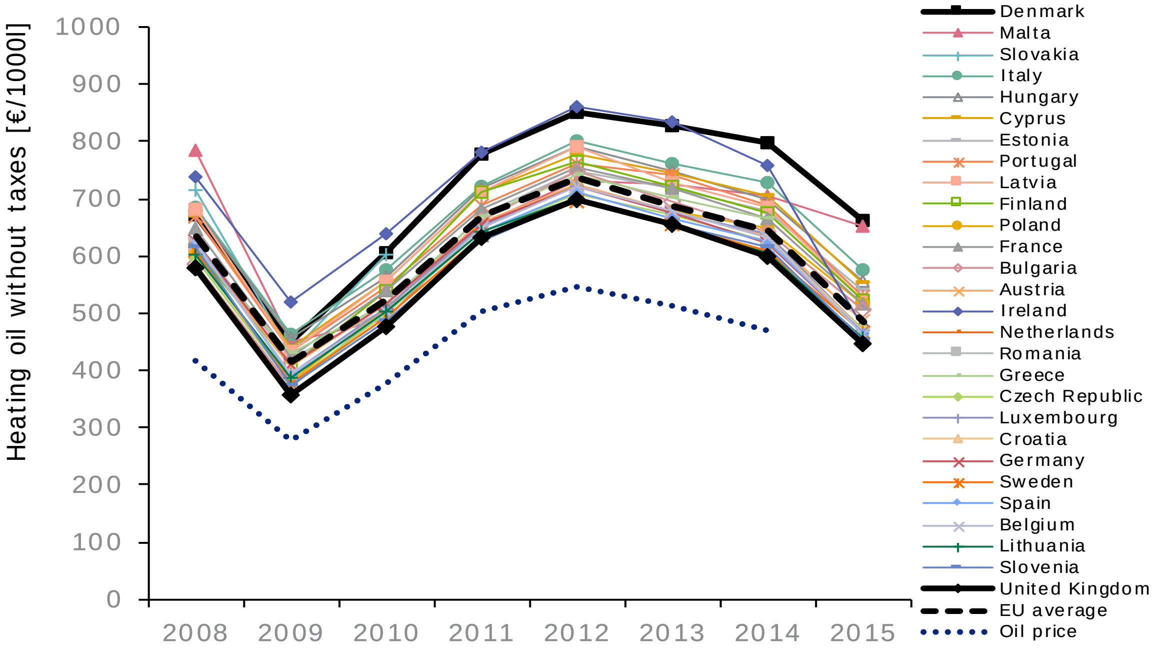

Figure 14: Prices for heating oil without taxes (source: Weekly oil bulletin, Platts)

There has been only a little change in excise duties on oil products. In general, duties have slightly increased between 2008 to 2015. Gasoline has been burdened with the highest duties, followed by automotive diesel. The outliers in diesel excise duties show the values for the UK, the only country that applies the same excise duties to gasoline and diesel. Industrial diesel is either taxed at the level of automotive diesel or heating oil in business use. The strong fluctuation of the median value for industrial diesel in 2014 is due to a change of the median country between these two options.

Excise duties on heating oil are hardly different for business and non-business users. The highest rates for non-business heating oil use can be found in the Netherlands in 2015. The Dutch tariffs have been increasing strongly in 2013. Most rates have been stable in nominal values. Yearly fluctuations in countries like the Czech Republic can be traced back to developments in exchange rates.

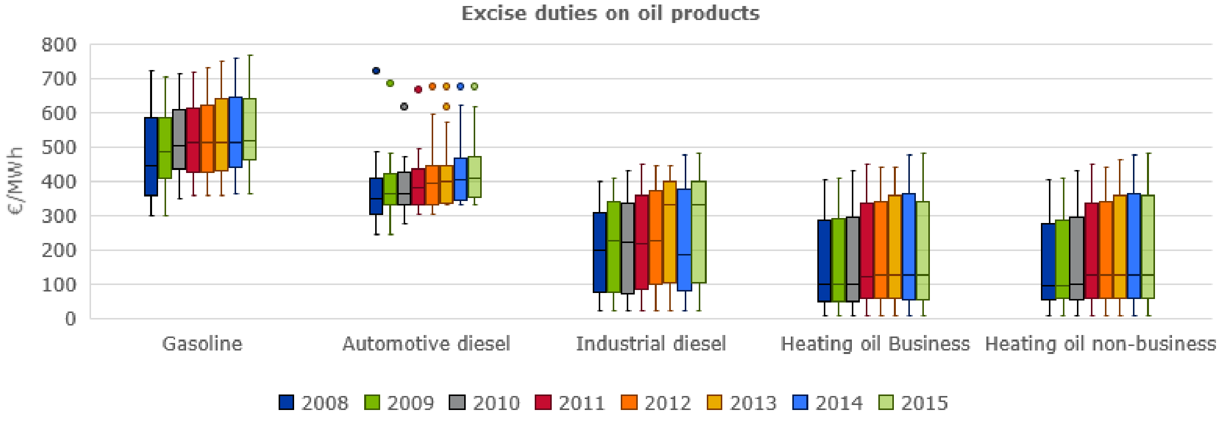

Figure 15: Excise duties on oil products (source: DG TAXUD)

Only three European countries apply different rates for heating oil in business use: in Germany and Sweden business users pay lower rates, while in Malta business users are subject to higher rates than non-business users.

3.2 Energy component

The energy price component covers elements related to the costs for purchasing energy in wholesale markets and the costs associated with supply e.g. metering, billing and margins for suppliers.

3.2.1 Energy wholesale and supply prices

The wholesale price is an important element of the energy component of retail prices and is described separately in this section.

Global developments

Historically, there have always been differences in prices of electricity and natural gas across regions worldwide. In the first decade of the new millennium, the regional differences in wholesale gas prices slowly disappeared and price volatility became even larger than the regional spread[2]. In 2009/2010, however, the price gaps reoccurred and started to widen significantly, in particular for natural gas in the US, Europe and Asia. Major drivers for this development have been the shale gas boom in the US,

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[2] compare BP Statistical Review of World Energy, June 2015. *Available at:* https://www.bp.com/content/dam/bp/pdf/energy-economics/statistical-review-2015/bp-statistical-review-of-world-energy-2015-full-report.pdf

resulting in an oversupply of markets, and a strong increase of gas demand in Japan in the aftermath of Fukushima. The changing importance of oil-indexation on gas price, and the dynamics in the EU and Asia also has an influence. As oil prices have fallen in recent years, these gaps have narrowed again. The situation for wholesale prices of electricity is much more complex, as these are also strongly influenced by different mixes of generation technologies and the impacts of climate policies. The objective of this section is to describe co-movements, correlations and convergence of prices across different markets.

Before we look at the global developments of wholesale prices of electricity and natural gas in more detail, we'll shortly focus on the recent development of the global benchmarks for crude oil and coal, as these have been major drivers for all energy markets in the past:

- The crude oil benchmarks have continuously shown high volatility since the year 2000. While the peak in 2008 was followed directly by a period of relaxation, the last peaking in 2011 ended in a three-year period of stagnation. Crude oil prices started to drop significantly again only in mid-2014, due to higher extraction rates, in particular by the OPEC countries. Until the beginning of 2011, the price spreads between the international crude oil benchmarks, in particular the West Texas Intermediate (WTI) and North Sea Brent crude oil benchmarks, had been marginal. The high level of crude oil prices allowed the US to produce an increasing share of crude oil domestically at internationally competitive prices. Most likely due to the international export ban for crude oil in the US, the WTI stagnated at a significantly lower price level than the North Sea Brent in the following years (spread up to 28 $ per Barrel). In mid-2013 the spread started to shrink and completely disappeared, and the crude oil prices severely dropped in the middle of 2014 (see Figure 16).
- In contrast to crude oil, the international trade of coal accounts only for around 20 % of the regional coal markets. The main international coal benchmarks (Amsterdam-Rotterdam-Antwerp hub, Newcastle hub, Richards Bay Port) have been continuing to show very little spread since 2000. They were also strongly correlated with the global crude oil prices until the middle of 2011. While the crude oil price stagnated at a high level for the following three years, the coal benchmarks started to relax slowly but steadily. This trend has not been broken in 2013 – 2015. However, the significant drop of the oil price since mid-2014, has re-established the former price relationship between crude oil and coal, though the price developments may nevertheless still be decoupled (see Figure 16).

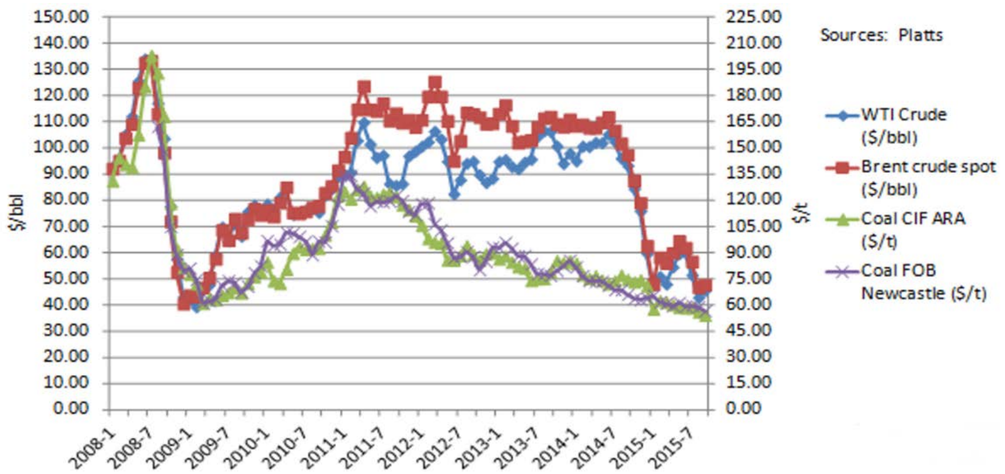

Figure 16: The monthly averages of crude oil and steam coal prices at the markets in the US and the EU (source: Platts)

Until 2010, the global development of wholesale prices for natural gas and LNG was strongly coupled to the crude oil price, mainly due to oil-indexed long-term contracts. At the beginning of 2010, natural gas prices at spot markets in the EU and the US and LNG import prices in the EU were all in the range of 5 – 6 US-$/MMBtu, showing only a marginal gap. The import prices of LNG in the Asian Pacific (in particular, Japan, South Korea and China) were approx. 40 % higher. Since 2010, the prices across the major wholesale markets have developed quite differently (see Figure 17, also compare for ACER 2015 and EC 2014[3]):

- The wholesale prices for natural gas in the US have completely decoupled from the oil price development, due to the significant increase of domestic gas production through shale gas. The prices more than halved until the beginning of 2012, which reflects the lack of opportunity to export LNG. After recovering in 2012 and 2013, the prices peaked during a cold spell at the beginning of 2014 and have halved again since.
- Reflecting the high share of oil-indexed contracts in the Asia-Pacific region, the LNG import prices in Japan, China and South Korea have stayed strongly correlated to the oil price (0.85 for the monthly averages in 2010 – 2015). Gas demand has also risen in the region, due to economic growth in China and South Korea, and the switch from nuclear to gas plants after the Fukushima incident in Japan. Hence, the LNG prices increased by more than 150 % until the beginning of 2014. There were strong fluctuations in between, partly related to the seasonal changes of demand levels. After the beginning of 2014 the prices fell to the level of 2010 within one year, again following the global crude oil price.

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[3] ACER (2015): ACER market monitoring report 2015. *Available at:* http://www.europarl.europa.eu/meetdocs/2014_2019/documents/itre/dv/acer_market_monitoring_report_2015_/acer_market_monitoring_report_2015_en.pdf,
EC (2014): Energy prices and costs report. Commission Staff Working Document. Brussels, 22 Jan 2014, SWD(2014) 20 final. *Available at:* http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52014SC0020)

- The spot market prices in the EU temporarily decoupled from the development of the crude oil price in 2011, as the shale gas boom in the US resulted in an oversupply of the LNG markets in the EU. In the following period, the prices were affected by the oil price again, although to a lesser extent. As a consequence, significant spreads with respect to the lower prices in the US and the higher prices in Asia Pacific have developed.
- While the monthly averages of LNG prices in Spain strongly correlate with those in France, and the LNG prices in Belgium strongly correlate with those in the UK in 2010 – 2015, the correlation between the former and the latter is somewhat lower. This is because, the prices in Spain and France have remained oil-indexed and thus still reacted quite sensitively to fluctuations in the crude oil price in 2011 – 2014, whereas the LNG prices in Belgium and the UK have been linked mainly to the local hub prices.

In 2014 and 2015, the wholesale prices of natural gas and LNG in the EU and the Asia-Pacific region have converged parallel to the decline of the crude oil price. The prices are still a bit higher in Asia Pacific, but the price gap between the EU and Asia Pacific is now smaller than before the beginning of the spreading in 2011. Still, the prices on the European spot markets stayed somewhat below the LNG import prices in 2015, suggesting that there is some liquidity in the markets. In contrast, the wholesale prices on the spot markets in the US have been staying at levels more than 50 % below those in the EU, indicating that the boom of shale gas production in the US is ongoing.

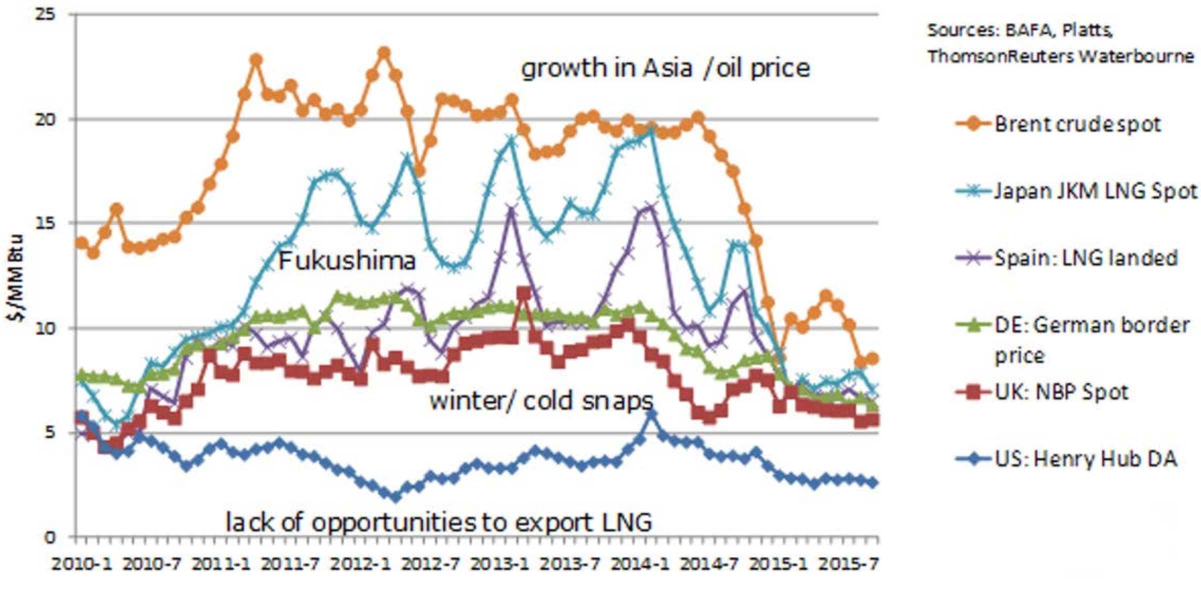

Figure 17: Monthly averages of natural gas and LNG prices on the markets in Japan, Spain, Germany, the UK and the US. Henry Hub is the most important gas hub in the US. The crude oil price of Brent is provided for orientation (Sources: Platts, Thomson Reuters Waterborne)

It is important to note that the changing price spreads are partly induced by fluctuations of the currency exchange rates. For Australia and Japan, the exchange rates with respect to the Euro have reduced by up to 30 % from 2008 to 2012, but relaxed to a level of 80 – 90 % in 2015. For the US, the fluctuations were below 15 % from 2008 to 2014. In 2015, however, the average annual exchange rate dropped by about 25 %, when compared to 2008 (see Figure 18). The role of exchange rates will also be addressed in the next subsection, which looks at the drivers of wholesale prices more closely. A detailed analysis of its relative importance can be found in Annex 2.

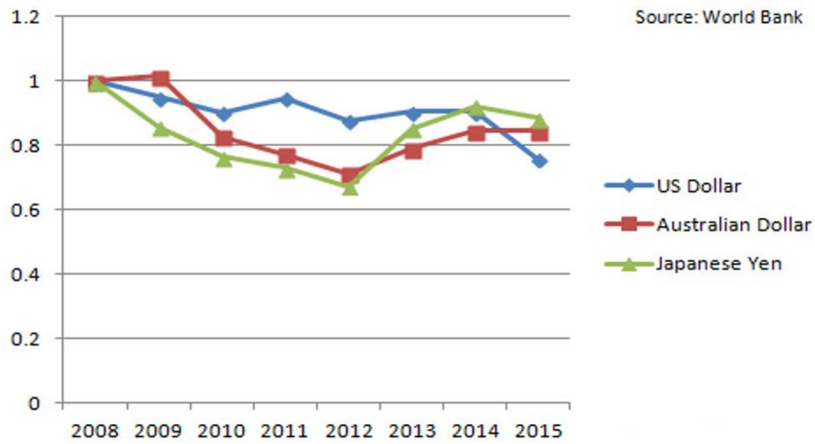

Figure 18: Indices of the currency exchange rates of Australia, Japan and the US (local currency/EUR; base year 2008, source: World Bank)

At the beginning of 2008, there was a significant spread (up to approx. €70/MWh) between average electricity prices in the wholesale markets of Japan, the EU, the US and Australia. While the prices decreased during the economic crisis in 2009 and the gap narrowed to less than €25 /MWh, the prices across the major wholesale markets developed rather differently in the years following 2009 (see Figure 19, also compare for ACER 2015, EC 2014):

- The wholesale prices in Australia showed short-time peaks in the first quarters of 2010 and 2011, coinciding with two heat waves. After the introduction of a carbon pricing mechanism by the Australian government in July 2012 the average wholesale prices more than doubled and fell only slowly afterwards. When the mechanism was abandoned in the middle of 2014, the prices returned to the level they had been before the introduction.
- In the US, the prices began to increase when the electricity demand recovered in 2010. However, the prices fell again in 2011, as the domestic shale gas boom resulted in low generation costs for gas plants. In the following period, the average wholesale prices have shown an approximately constant trend, except for strong peaks during extreme cold spells, e.g. in the first quarters of 2014 and 2015 on the East Coast.
- In the EU, the prices also slowly increased when the electricity demand recovered in 2010 and 2011. Afterwards, however, prices began to decrease again, partly in correlation with the declining prices on coal markets and with the carbon price in the EU ETS. In addition, the

rising shares of renewable energies have given rise to the so-called merit-order effect, which reduced wholesale prices thanks to the vanishing marginal costs of renewable energies.

- In Japan, wholesale prices have reached an all-time high after the Fukushima incident, as the nuclear power plants have been temporarily shut down throughout the country. Since they have been replaced mainly by gas- and oil-fired plants, the price shows a strong correlation to the global crude oil price and the oil-indexed LNG import price (0.88 for the monthly averages in 2013-2015). The recent decline of oil prices has in turn led to a significant decrease of electricity prices.

In 2014 and 2015, the wholesale prices in Japan stayed at significantly higher levels than in the EU in spite of the relaxation, though the price spread strongly reduced after the end of the complete nuclear shutdown in Japan. The average prices in the EU of approx. €40 /MWh are still 30 – 40 % higher than those in the US and Australia reflecting, among other things, the higher coal and gas prices in Europe. Moreover, there is a significant regional variation in wholesale prices in Australia and the US. In the low-price regions, the average prices are only half the EU price.

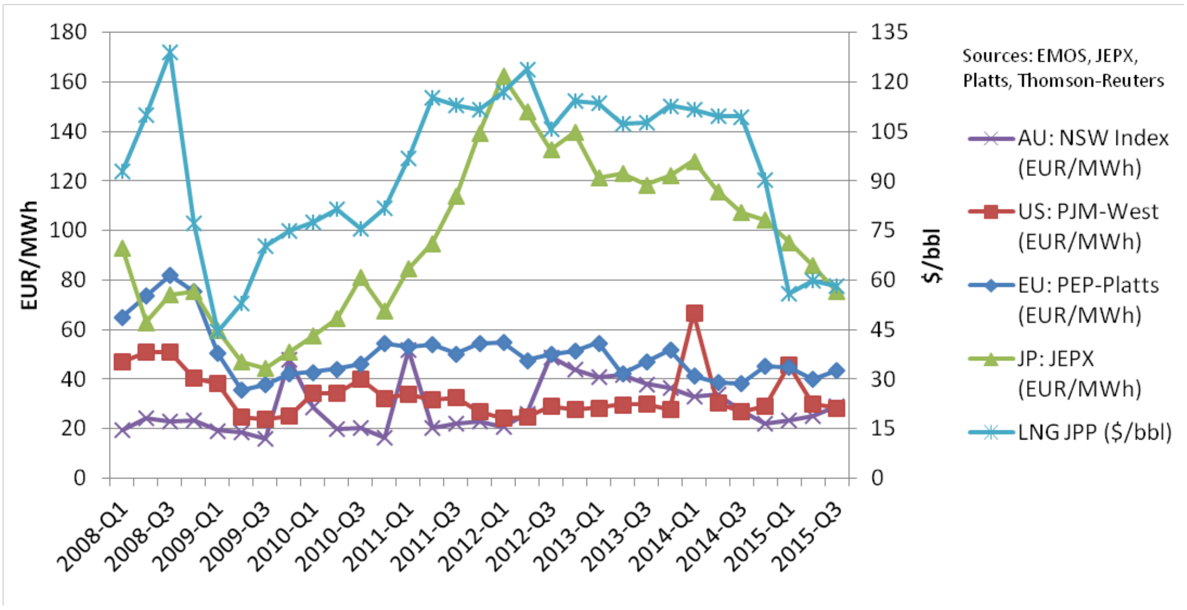

Figure 19 Quarterly averages of base load-type prices on the electricity markets in Japan, EU (Platts Pan-European wholesale electricity price index (PEP)), the US and Australia. The New South Wales (NSW) index covers the largest pricing zone in Australia. PJM-West is a large pricing zone in the US stretching out from Pennsylvania to the East Coast. The Japanese LNG import price is provided as a reference.

3.2.2 Drivers of the energy component

3.2.2.1 Electricity

The objective of this section is to show how the retail price components have evolved over time, and analyse which factors drive the energy component. This includes analysing how strongly and quickly wholesale prices affect the energy component, and what role market liberalisation and competition policies played.

The data, on which part of the analysis relies, is derived from an ad-hoc statistical data collection organised by DG ENER with the help of ESTAT and national statistical institutes. However, for the analysis using monthly data at the retail level, data is used from VaasaETT and Eurostat, because the ad-hoc database only provides information prices for every second year. The monthly Eurostat-based data is compiled by DG ENER, by applying biannual retail data and monthly electricity price indices (for more details see Annex 2) to derive monthly prices for the energy supply component. Data from Eurostat and the ad-hoc data collection is available for different electricity (and gas) consumption bands. For the analysis, DG ENER suggested applying the consumption band DC for households, and IB and ID for small and large energy consumers in industry, while data from VaasaETT depicts only the price components of households in capital cities. The econometric analyses rely on monthly data from DG ENER-data (Eurostat bands DC, IB and ID) and the VaasaETT prices for households. The correlation of the energy price component between monthly DG ENER-data (Eurostat based) and VaasaETT data for households is 0.9. For descriptive analysis, the ad-hoc data collection of the energy supply component is applied, as it provides data on prices only every two years.

This analysis focuses on the energy component, i.e. it investigates which factors drive the retail price component energy. In addition to wholesale prices, features of the energy market are taken into account. As a result, we learn to which degree wholesale prices are passed through to the retail prices, and how strongly prices are impacted by market features, such as deregulation, competition and liberalisation.

The analysis is conducted on monthly prices. The exogenous variables are listed in Table 1, the sources are depicted in Table 1 of Annex 2.

Table 1: Variables applied to analyse drivers in the retail electricity market

Variables	Description	Available Data
Retail price component energy supply	Endogenous, monthly data	Ad-hoc data collection: covering household and industrial consumer bands for electricity and natural gas in 2008, 2010, 2012, 2014, 2015. Eurostat data: monthly data derived from biannual price data and monthly electricity (gas) consumer price indices (compiled by DG ENER) VaasaETT: monthly data on prices only of households
Wholesale price	Exogenous base load prices, Monthly	Derived on daily prices of different spot markets (exchanges)
Market liberalisation Retail market regulation Competition	Logarithmic years since market opening and dummy for market opening; Dummy for regulation (<> 50% of household prices are regulated); Dummy for competition (<> 80% market share of 3 top suppliers); annual	ACER MMR 2015, 2014, 2013 CEER, DG ENER, annual basis
Heating and cooling degree days	To account for demand	
Exchange rate index	To account for changes in domestic currency to euro	
Growth rate index	To account for changes due to growth	

In economic theory a measure for competition is the closeness of realised prices to marginal costs. If we assume that the wholesale prices reflect the marginal costs and the energy price component reflects the realised price, we can see how competition has evolved over time. The difference between the energy component and the wholesale prices for households is depicted in Figure 20. Margin 1 depicts the differences between the energy supply derived from Eurostat data and wholesale prices, margin 2 from VaasaETT and wholesale prices. Both margins show slight decreases and increases over time and a rather constant spread across countries. Based on this observation, it can be stated that margins, and hence competition in the retail market, have not changed much over time. The difference between the energy component and the wholesale prices for industries is depicted in Annex 2. Overall, the margins are lower in industry, slightly decreasing and increasing over time, pointing to a stronger consumer power in the industry sector.

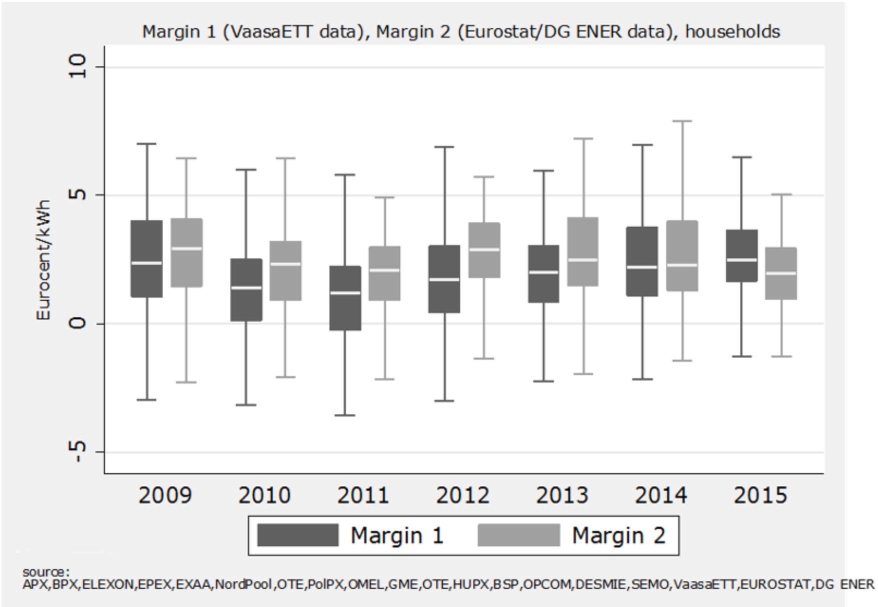

Figure 20: Margins between 2008 and 2015, electricity ID band Eurocent/kWh

To address the question of how quickly energy supply prices adjust to changes in wholesale prices, a correlation analysis between the retail price component and the wholesale price for different lags is conducted (see Annex 2). Overall, there is no clear answer to this question. Across all EU Member States, the lags with the highest correlations have a range between zero and two months. However, there are huge differences between countries. For example, in Germany and France the correlation is negative up to eight months, while it is highly positive in Norway. In a few countries the lag amounts to up to eight months (NL, IT, CZ, DE, FR), while in others it is zero (NO, SE, SE, AT, LV). Overall, it seems that in some countries, prices are passed through faster than in others. This heterogeneous picture can be explained by the fact that in some countries prices are still regulated, in others not; in some countries prices are fixed for a given time period, in others they are indexed to the wholesale market price. In the case of fixed prices, the average monthly prices rely on old and new contracts, the latter reflecting current changes on the wholesale market. Therefore, the speed of passing through depends on the very specific market and tariff design of the retail markets calling for a deepened analysis with a selected set of countries.

How strongly wholesale prices are passed through is analysed by the fixed/random effects model, comprising all EU countries and panels for subsets or regions composed of selected countries. Details of the methodology are given in Annex 2. The findings are:

- Wholesale prices have a significant impact on the retail energy component, i.e. a price drop of one Eurocent would in the short-run result in an average decrease of the energy price component by about €0.04 – 0.09 ct. The coefficient is relatively small, as wholesale costs account for a large share of the energy price component. This result points to one major challenge of the overall analysis: the diversity in pricing mechanism, competition and regulation. First, in some countries prices are still regulated for a certain share or type of customer or even for all customers, such that wholesale prices are not passed on through the market, while in other countries they are deregulated. Second, is some countries the degree of concentration is still very high, which could entail either a slow pass-through of price drops or larger margins than in more competitive markets or both. Third, in some cases - within the same country - retail prices could be fixed for one or two years, in others they are indexed to wholesale prices, or a combined mechanism is applied. Therefore, in the short-run changes in the wholesale price cannot be fully passed on to end user prices. The data used for this analysis are average retail electricity prices (Eurostat).

- Other explaining variables such as demand, measured by economic growth or heating degree days have no or minor impacts.
- In markets where the three largest electricity suppliers account for a combined market share of at least 80% the electricity supply price is significantly higher (comparison of means of both groups suggests a difference of €1ct per kWh) than in those where the market share of the top three suppliers is below 80%; in comparison, if at least 50% of the electricity market are subject to price regulations, the energy price is lower than in „unregulated“ markets (comparison of means suggests a difference of €1ct per kWh). As this are averages across countries and years, the differences in prices might differ between years. It is to note, that low retail prices in regulated markets often go hand in hand with a low level of customer satisfaction as their service and range of products is modest, as the ACER MMR 2015 report highlights.
- In a competitive and deregulated market the impact of wholesale prices on the retail energy price component is stronger (in average about €0.2 ct/kWh per one Eurocent change in DC consumption band), signalling that suppliers react to wholesale price changes in the short-run more than under regulated and less competitive markets - and given all analytical constraints listed above.
- In addition to wholesale prices further market characteristics, or different market behaviour or product designs, be it at the supply (e.g. number of suppliers, offers, price transparency) or demand side (switching behaviour) certainly exert an influence on the energy component. However there are no consistent and sufficient observations available across all Member States to capture these factors.

Overall, wholesale prices are the main drivers, given the set of variables analysed, and its impact is even stronger under competition and deregulation. Further details and results are presented in Annex 2.

As wholesale prices are drivers of the retail price, their drivers are analysed in the following. Because energy wholesale markets are not always fully liberalized, flexible and transparent, other factors, besides fuel costs, determine prices, for example, monopolistic structures, bottlenecks in infrastructure and market organisation restricting free trade. To capture all these aspects, fuel prices, generation shares, and demand accounting for the market mechanism, as well as market features, such as price coupling, interconnection capacities and cross border trade reflecting internal market/trade are included in this analysis. Furthermore, market share of the top three generators are included to account for the degree of competition. Details on data and model specifications can be found in Annex 2.

The evolution of wholesale electricity prices of base and peak load for EU countries is depicted in Figure 21. Prices are declining parallel to decreasing coal, gas and CO_2 prices and increasing RE shares. The spreads in Figure 21 also display heterogeneity in prices between countries, as there are differences in fuel shares, resources, market features, growth and demand.

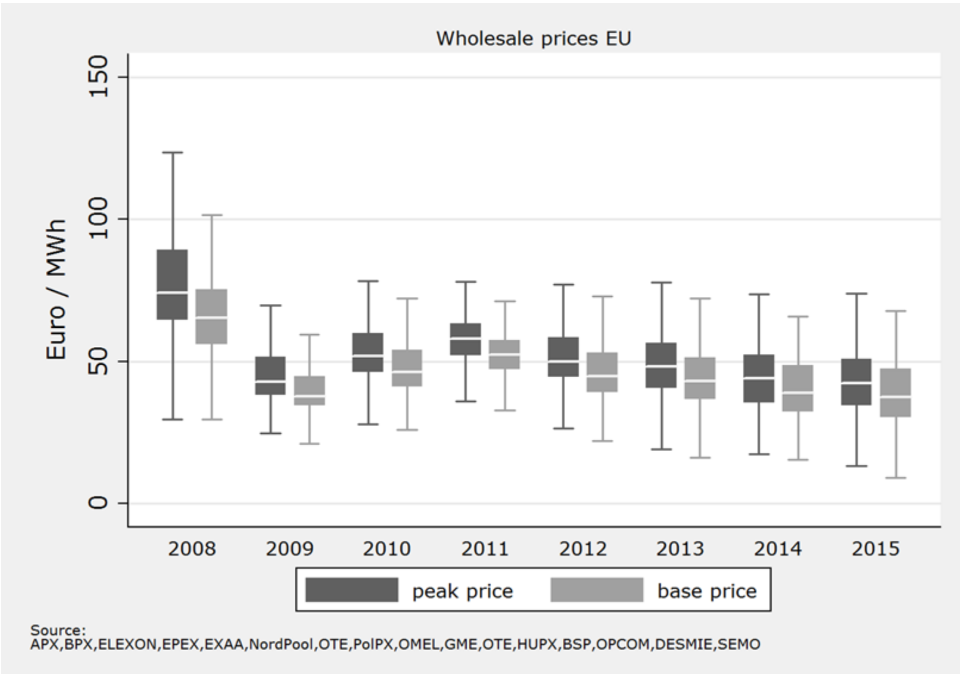

Figure 21: Annual electricity wholesale prices between 2008 and 2015 of EU Member States, (Euro/MWh)

To explain changes in wholesale prices, the fixed or random effects estimators are used to assess the respective models for the EU countries. The analysis is conducted with panel data of all EU countries to show overall effects for EU countries and with panel data of selected regions/subset of EU countries.

The EU panel data analysis shows highly significant values for all shares except for nuclear power, significant coefficients for prices, market competition and integration, as well as for demand and exchange rate. In detail, the results are:

- An increase of RES share by one percentage point reduces wholesale prices by about €0.4 /MWh at the EU level. As this result is based on monthly prices and not on hourly prices, this effect might be even more pronounced – robust - when hourly prices are applied.
- An increase in coal, gas or oil generation shares by one percentage point, could in average across all countries increase wholesale prices by €0.2 to €1.3 /MWh. However, given that

countries differ by their generation shares or pricing mechanisms the country specific effects might divert from these averages. Thus, to the extent that the marginal producer, i.e. the one setting the price in the whole sale market differs, changes in fuel shares will lead to differential effects across the hours of the day.

- Similarly, increases in coal, ETS or gas prices by €1 /MWh could lead in average across all countries to an increase of wholesale prices by €0.2 to €0.8 /MWh. As some fuel prices, e.g. for natural gas, differ between countries, country specific effect might deviate from these results.
- On the sample average, an increase of the market shares of the top 3 players by one percentage point increases prices by about €0.5 /MWh, while increasing cross border flows (by one percentage point) reduces prices by about €0.1 /MWh. The econometric analysis emphasises that especially interconnections could significantly contribute to lower prices. There is a large heterogeneity between countries regarding competition and market coupling and both could have a significant impact on wholesale prices, i.e. could lower prices.
- Overall, based on the sample, further factors, such as increasing demand or growth(scaled up by 100) leads to increasing prices.
- Price differences of day ahead prices (windows of arbitrage) between countries e.g. Germany and its neighbour countries disappeared faster in recent years (2012-2015) than earlier (before 2012), but the analysis of the variance of prices shows a different picture. After a convergence of prices around 2011, they show an increasing spread afterwards. This indicates that the development of the internal market has had an effect of equalising prices while at the same time more extreme prices occurred within countries, for example negative prices due to increasing renewable shares and different regulations regarding negative prices.

The following major regional differences to the analysis of all EU countries can be observed:

- In Northwest EU countries gas and CO_2 prices significantly drive wholesale prices, but demand is also important. Moreover, RE is reported to be an important driver, reducing electricity prices.
- Grouping the countries into different regions and estimating the respective coefficients of the fixed effect model points out regional differences (see Table 6 in Annex 2): the impact of RE share becomes even stronger in the NordPool market area. Further, among the fuels, coal (high in DK, FI and EE) and gas shares (high in LV and LT) are significant. The analysed Eastern EU countries show that the coal share (especially high share in CZ) is a very strong driver of prices, as well as gas (high share in HU). Nuclear power (high share in HU and SK) contributes to higher prices, while RE shares, although with lower significance, reduce prices. In Spain and France, the cross border flows are significant, and an increase in flows has a large negative marginal impact on prices, because especially Spain is relatively isolated regarding electricity trade. Oil and gas shares (decreasing in ES) and ETS are also significant. Further drivers are coal and oil shares. When looking at the subset of the countries with IT and SI entering price coupling in 2015, increasing coal and oil shares, as well as growing market shares (top3) increase prices, while growing cross border flows reduce them. Overall,

the different impacts of the coefficients with the same sign highlight heterogeneity of the sample.

Enlarging the analysis by Non-EU countries for a global analysis, reduces the number of explaining variables, because not all necessary data is available. However, the results when including US, Norway and Switzerland support the findings above. Again the RE share is significant, signalling a decreasing effect on wholesale prices, while coal shares and prices increases them. When including further countries, only prices (crude oil and coal) are applied as explaining variables. This reduces the explaining power of the model, and results in commodity prices being the only factors affecting wholesale prices, i.e. crude and coal prices explain changes in wholesale prices. The results are depicted in Annex 2.

Overall, in the electricity sector wholesale prices are driven by fuel shares, commodity prices and market features. The size of the impact depends on the generation structure, access to resources, the degree of competition and creation of internal markets: the more competitive a market, the lower prices; the more cross border exchange of power, the lower the prices; the higher the RE share, the lower prices. As RE deployment is financed through levies or premiums, these price component increases with increasing RE share, making power more expensive at the retail level. Furthermore, in addition to wholesale prices, retail market structures and product design influence the speed and degree of pass-through of wholesale price changes (but data to quantify this impact are still not available), while overall demand plays no role.

3.2.2.2 Natural gas

In this section, we look at the factors of the energy retail price component of gas. The value of the energy component is driven by wholesale prices, in combination with the degree of market liberalisation, competition or regulation. The objective of this section is to show how the energy retail price component has evolved over time, and analyse which factors drive the energy component. This includes an analysis of how strongly wholesale prices affect energy supply, and what the role is of market liberalisation and competition.

For a descriptive analysis, data is derived from an ad-hoc statistical data collection, designed and carried out by DG ENER, while ESTAT and national statistical institutes provided data. The data reports on gas price components every two years. For econometric analysis, data is used from VaasaETT. In addition, biannual data and monthly gas price indices are used to derive monthly data by DG ENER. However, the energy and network component are not separately depicted in this statistics, therefore, the analysis is mainly based on the VaasaETT prices.

It has been suggested to use the gas consumption bands D2 (household annual consumption) and I5 (industrial annual consumption) from the Eurostat-based monthly database, while data from VaasaETT only includes household’s prices in (capital) cities.

To assess the pass-through effect of wholesale prices on retail prices, a panel analysis, based on fixed and random effects is conducted (linear specification, selection of random vs fixed effects model via a standard Hausman test). This analysis allows for the incorporation of time variant variables and country specific characteristics. In addition, a correlation with lagged wholesale prices is conducted and the evolution of wholesale prices and energy supply prices is depicted.

To explain changes in retail prices, wholesale prices and demand are applied as exogenous variables. In addition, market characteristics, such as liberalisation and price regulation also affect prices. The exogenous and endogenous variables and the sources are depicted in Table 2.

Table 2: Variables for applied to analyse drivers in the retail gas market

Variables	Description	Available Data
Retail price component energy and supply	Endogenous energy supply, monthly data	Ad-hoc data collection, covering household and industrial consumer bands for electricity and natural gas; 2008, 2010, 2012, 2014, 2015, Eurostat data monthly data derived from biannual data (used only for analysis of the industry segment) VaasaETT data, monthly, only for households
Wholesale price	Exogenous wholesale prices, monthly	Border price or hub prices
Heating and cooling degree days	Account for demand	
Exchange rate index	To account for changes in domestic currency to euro	
Growth rate index	To account for changes due to growth	
Competition, liberalisation and regulation	Dummies competition (>< 80% market share of three top suppliers); dummy liberalisation Dummy regulation (><50% of regulated prices)	Data from diverse sources on annual basis: ACER MMR 2015, 2014, 2013, CEER, DG ENER

To identify the main drivers of the energy component a fixed/random-effect model is applied to a panel of the EU countries. Price data of VaasaETT is used for households, Eurostat data for industries (the latter includes grid fees). The detailed results are depicted in Annex 2. The central findings are:

- Wholesale gas prices drive the retail prices' energy component. Under the given variables, the impact of demand is zero and a change of one Euro per MWh of wholesale gas prices affects the retail prices' energy and supply component by about €0.4 /MWh.
- The impact of wholesale prices on energy supply price components of households seems to be slightly stronger (about €0.7 / MWh) in countries with hub markets only (NL, UK, BE).
- Countries with regulated retail markets show a lower impact of wholesale prices (about €0.2 /MWh).
- Markets with higher level of competition (CR3 equal or below 80%) show a slightly stronger impact of wholesale prices on the energy supply component.
- Countries with liberalized markets seem to have lower prices, but limited data availability allows no further analysis.
- Impact of other factors (demand) is insignificant or very marginal.

There are regional differences in prices, which could be explained by different market characteristics, such as retailer concentration, number of suppliers, number of households switching, etc. However, sufficient time series data for market characteristics have not been identified to carry out a detailed analysis.

However, the difference between the wholesale price and the energy component (margin) reflects the degree of market competition in the retail sector. The regional or country specific differences in the margins reflect different markets characteristics:

- There are huge differences between countries (households): e.g. high margins in household segment in UK, low prices in NL, HU, CZ.
- There are differences across time in all EU countries and within one country (households): e.g. UK, DE.
- Margins in the industry segment (including network fees) are slightly lower than in the household segment pointing to market power of larger consumers.

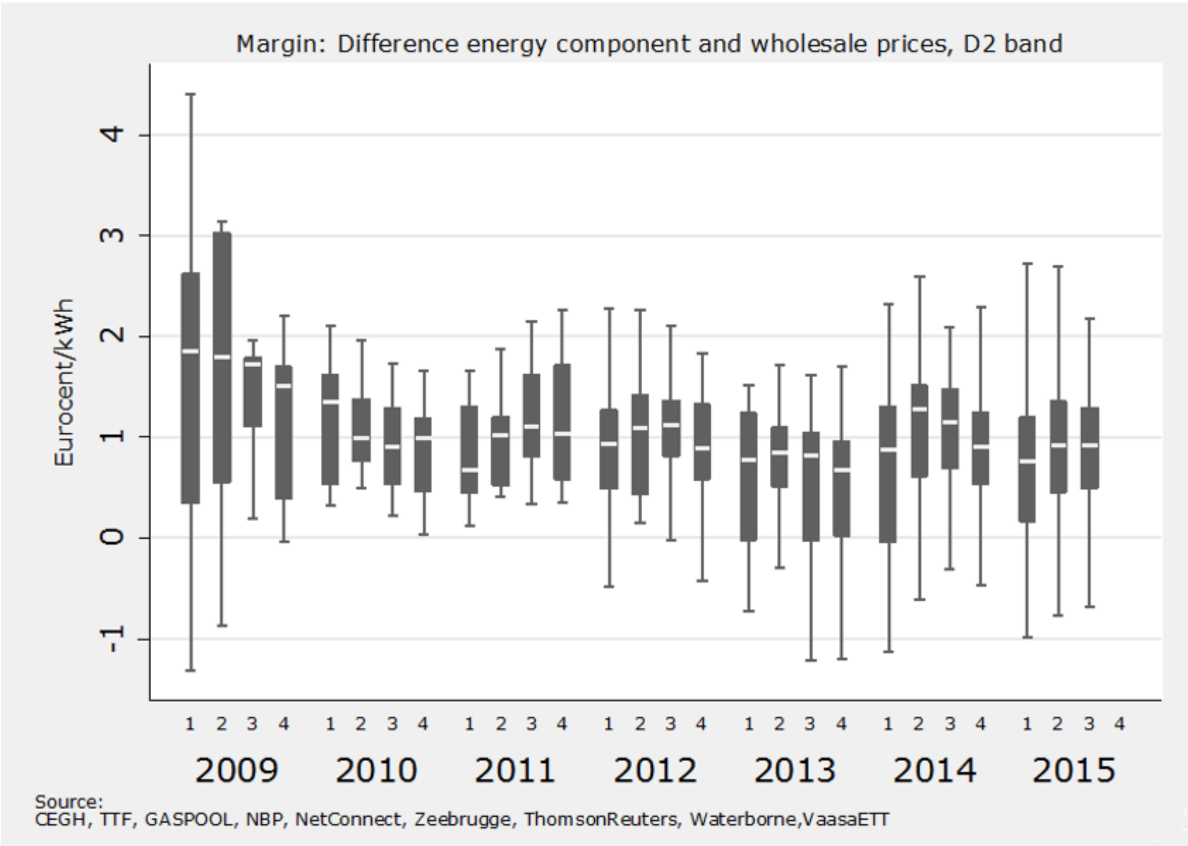

Figure 22: Quarterly margins in household segment: difference between gas retail price and wholesale price, 2009 and 2015 of EU Member States, (Eurocent/kWh)

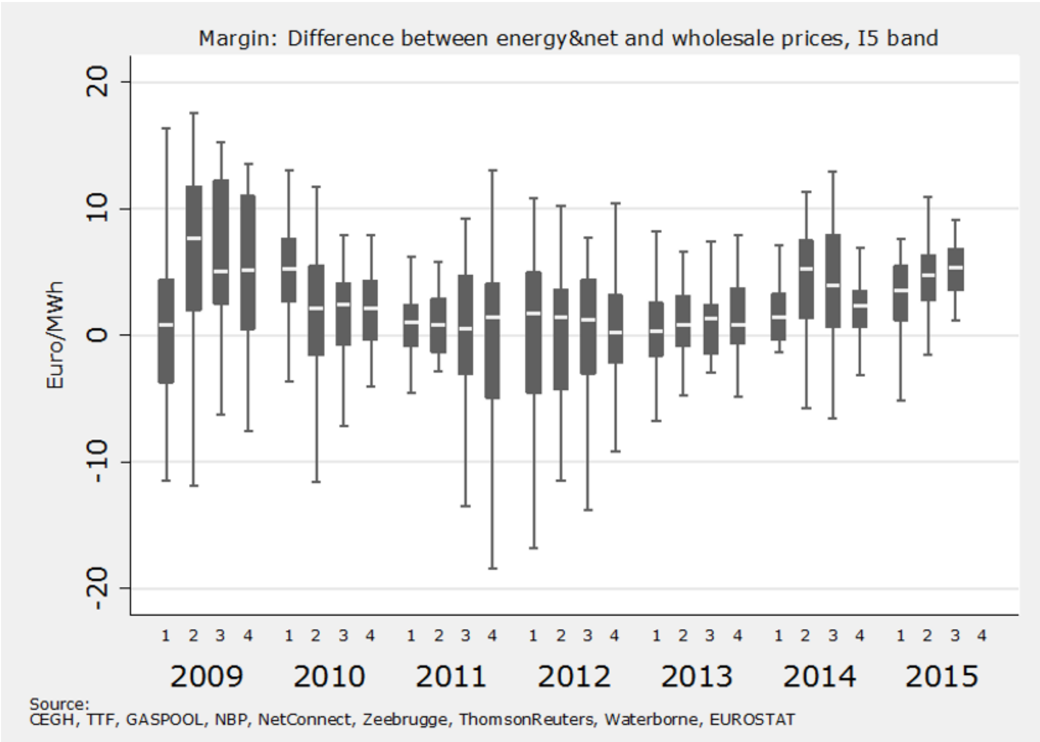

Figure 23: Quarterly margins in industry segment: difference between gas retail price and network components and wholesale price, 2009 and 2015 of EU Member States, (Euro/kWh)

Overall, wholesale prices affect retail prices, but how strongly and quickly wholesale prices are passed through to retail prices (supply component) depends on retail market structures, of which no appropriate data has been available yet to fully explain price developments.

With regard to wholesale trading of natural gas, the market structures and pricing mechanisms are quite diverse around the globe but also within the EU. There are three main different pricing mechanisms that coexist on the global scale, sometimes even within the same region, namely

- government regulated prices (GRP),
- oil-price escalation (OPE) and
- spot market pricing in competitive gas markets (GOG).

Natural gas is traded partly via bilateral agreements and partly at hubs with shares differing dependent on the region. While OPE is mainly based on long-term contracts (LTC), spot markets with various kinds of time frames (in particular day-ahead, month-ahead, one-year-ahead) exist at trading hubs. The hubs may be physical hubs representing the exchange of gas at network interconnectors or virtual trading points.

Hubs usually provide a regional marker price. There are regions without such marker prices though. In this case, border prices have to be used as proxy data for estimating the wholesale prices, as the prices of LTCs are not known to the public. The border price of a country is defined the weighted average price of imported piped natural gas within one month. It can be derived from customs data on total imported volumes and total costs. Thereby a border price reflects both pricing mechanisms GOG and OPE. However, it is not take into account domestic production and liquefied natural gas (LNG) imports.

While the EU is slowly but steadily shifting from a dominance of OPE to more GOG (GOG's share increased from 15% in 2005 to 61% in 2014, while OPE declined from 78% to 32%[4], the latter clearly dominates the North American market with fully liquid trading markets in the USA and Canada and the wholesale price in Mexico being referenced to prices in the USA. The markets in Asia Pacific (Japan, Korea) have a dominant share of OPE-traded LNG, but also some GOG. Russia and Central Asia have a diverse mixture of markets with highest share of GRP (see IGU 2015).

In the EU, the North-western Member States were the first to shift to GOG, both for piped natural gas and LNG. In 2008, hub prices existed in the UK, the Netherlands, Belgium and Germany. In the meantime, also Austria, Denmark, France, and rather recently Finland and Poland have established national hubs and corresponding marker prices. While the transition to GOG is ongoing in central European states, the Baltic and the South-eastern European states are just starting to make use of spot trading. A few of those countries still even have a share of GRP like Romania for its domestic production. The Southern European countries (most importantly Spain, France, Greece, and Portugal) have dominant import shares of LNG that is still mainly purchased via long-term contracts (IGU 2015).

In general, wholesale gas prices at spot markets can be affected by the following drivers:

- Fundamentally, markets are expected to be driven by the relation between supply and demand, both on the regional and on the global level.
- Moreover, the spot price is influenced by the oil-indexed prices of long-term contracts and should thus show a positive correlation with the global crude oil price lagged in time.
- Local gas storage capacities allow reduced price peaks and should therefore, help to avoid peak prices.
- Due to the trade of commodities in fixed currencies, exchange rates can also be of importance.
- There are drivers linked to the market structure, such as the shares of GOG in the consumption, as well as the share of domestically produced natural gas in total consumption. Here the hypothesis is that a higher share of GOG results in lower prices, due to the higher level of completion and a high share of domestic production in lower ones.
- The demand for gas shows strong seasonal variations with low demand in summer and peak-demand times in winter. An important factor is therefore, the monthly level of consumption.

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[4] see IGU (2015): IGU Wholesale Gas price survey – 2015 Edition. *Available at:* https://www.neb-one.gc.ca/nrg/sttstc/ntrlgs/index-eng.html)

However, the supply-side is well adapted to the seasonal pattern of demand, in particular by filling up gas storages in summer, and emptying them in winter.

- There may still be deviations from the usual seasonal pattern, e.g. during warm winters or severe cold spells, consumption peaks may result in price peaks. These kind of impacts may be reflected by heating degree days per month on the one hand and a monthly consumption index that measures deviations from the usual seasonal pattern on the other hand. Deviations from the seasonal pattern can have different kinds of impacts, in particular because LTCs commonly include take-or-pay clauses that may result in penalties in case of a demand below the lower limit of expectations.

During the period 2008 – 2015, wholesale pricing of natural gas in the EU has undergone large changes. At the beginning of 2008, the shares of GOG and OPE were already quite diverse across the Member States with close to 100% of GOG in the UK and a vanishingly small share in the Baltic and South-eastern European Member States. The level of prices, however, was not so different, due to the persistence of a strong coupling to the oil price dynamics. In 2009/10, the gas price dynamics at the European hubs decoupled driven by an oversupply of international markets. The oversupply was a consequence of the low international demand for energy induced by the economic crisis and the particularly lower gas imports to the US because of the shale gas boom. In the following years, more and more Member States were trying to profit from the low hub prices by both increasing the share of GOG and renegotiating the existing oil-indexed LTCs. The interplay of this development with the hub price dynamics itself has led to a diversification of gas price dynamics throughout the EU. Figure 24 shows the price development for selected Member States, which roughly represent the whole spectrum of spot and border price dynamics in the period 2008 – 2015. For a discussion of price dynamics in all Member States with sufficient data available see Annex 2.

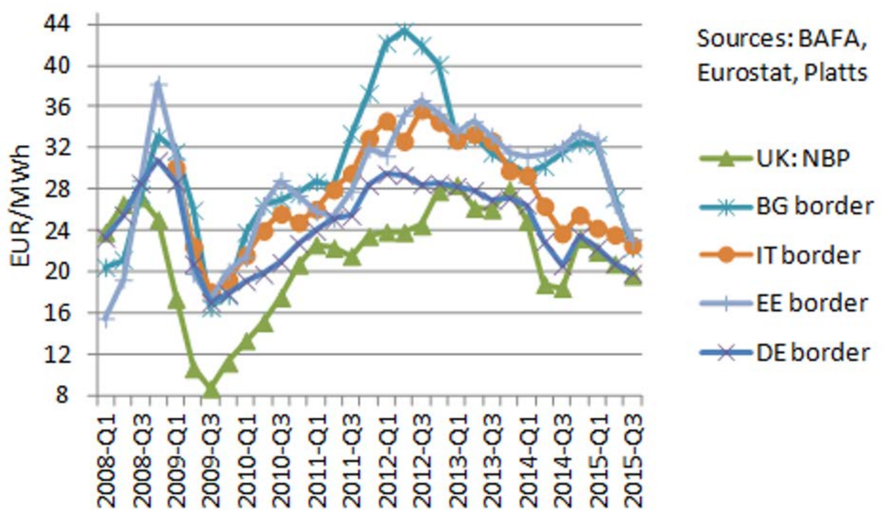


Figure 24 Development of hub and border prices of natural gas in selected Member States of the EU in 2008 – 2015 (UK United Kingdom, BG Bulgaria, IT Italy, EE Estonia, DE Germany). Border prices are the country-specific average import prices reflecting imports from Algeria, the Netherlands, Norway and Russia.

Based partly on publically available and proprietary data (sources: BAFA, EIA, Eurostat, IEA, JRC, Platts, ThomsonReuters Waterborne and the Worldbank), an econometric analysis of the drivers has been carried out for the monthly averages of

- spot prices in Western Europe (Belgium, Germany, Italy, the Netherlands, United Kingdom; Ireland and Luxemburg linked closely; insufficient data for Denmark, France and Sweden) and North America (US; Canada and Mexico linked closely),
- border prices of piped natural gas in Central European Member States (Czech Republic, Germany, Hungary, Italy, Slovakia; insufficient data for Austria and Poland), as well as Baltic and South-eastern European Member States (Bulgaria, Estonia, Finland, Greece, Latvia, Lithuania, Romania, Slovenia; insufficient data for Croatia; no imports by Cyprus and Malta) and
- LNG landed prices in the EU (Belgium, France, Spain, UK; insufficient data for Greece, Italy, Lithuania, Portugal) and East Asia (China, Japan, Republic of Korea).

The corresponding prices were considered as the endogenous variable to be explained by the models and a set of exogenous variables was chosen as the possible drivers according to the discussion of gas-price dynamics above. While the hub prices in Western Europa are strongly correlated, the major US hub price at Henry Hub shows a completely different behaviour. Similarly, the LNG landed prices within Asia are strongly correlated, but significantly differ from the hub prices in the EU and the US. For these reasons, time-series analyses were carried out for the individual hub prices and LNG landed prices. With regard to the border prices of piped natural gas within the EU, there are groups of countries with similar developments as explained above, but the individual properties of the countries (e.g. share of GOG and domestic production) result in a diversification of price dynamics. Hence, a panel approach was pursued for two groups of EU Member States: the Central European states being in transition to GOG and the Baltic and South-eastern European states still being dominated by OPE.

For the hub prices in North-western Europe, represented by the British NBP hub in Figure 24, the econometric analysis has found a weakly to moderately significant impact[5] of the non-lagged crude oil price and a moderately significant impact of the European import price of oil-indexed LNG (both non-lagged and with a lag of two months). While the former reflects the impact of oil-indexed LTCs on the spot markets, the latter is an indication of the indirect interconnection of markets via the trade of LNG. The impact of the crude oil price (with an increase by one unit raising the hub price by €0.13 - 0.17 /MWh on average) is only half as big as the total impact of the LNG import price (€0.23 - 0.27). This suggests a persisting decoupling of the hub prices from the crude oil price, as the impact of the crude oil price is significantly higher for oil-indexed prices (see below). In addition, the analysis provided evidence for a strongly significant impact of deviations from the usual seasonal patterns of demand on the European hub prices.

[5] Throughout this subsection we use the following wording: "strongly significant" for a p-value < 0.01, "moderately significant" for a p-value < 0.05, "weakly significant" for a p-value < 0.1.

The development of border prices in central European Member States, was more diverse, as can be seen from the comparison of the German and the Italian border price in Figure 24. There is, however, clear evidence from the econometric analysis that the rising share of GOG in central European Member States has significantly decreased the impact of oil price on the border prices for natural gas: while the average impact of an increase of the US hub price by €1 on the border prices of €0.33 in 2009 – 2012 more than doubled in 2013 – 2015, the impact of the crude oil price has reduced from €0.42 to €0.34 in the same period. As a consequence, central European Member States were able to profit from the drop of hub prices in 2014.

For the Baltic and south-eastern European states – represented by the Estonian and the Bulgarian border price in Figure 24 – the main drivers are less clear. Given the still high share of OPE, it is not surprising that the analysis indicates the still high importance of the crude oil price (average impact of €0.44 in 2013 – 2015). On the contrary, there is also moderate evidence that the impact is decreasing and that also hub price dynamics have been affecting the border prices, which might be explained by the introduction of gas components in oil-indexed LTCs and the installation of a LNG terminal in Lithuania in 2014. Moreover, other factors like the share of domestically produced gas turned out to have had notable impact in the econometric analysis. All in all, this has led to diverse price developments in the recent years.

Very recently, the strong drop of crude oil prices in 2015, however, has reduced the price spreads not only among the Baltic and south-eastern European Member States but throughout the EU in general. In the context of the seemingly persisting low level of the crude oil prices, hence, the question arises whether the diversity of gas price dynamics is replaced by a situation similar to 2008 again, with a very low spread of wholesale gas prices that are mainly driven by the oil price development.

LNG landed prices in north-western Europe are strongly correlated to the hub prices. LNG prices in southwestern Europe and in Eastern Asia are highly correlated with each other and both are still strongly driven by the oil price development, but our analyses indicate that the price development at European hubs has gained an impact of regionally varying significance, too. With regard to the impact of the US hub price at Henry Hub, the time period covered for LNG prices (2010 – 2015) did not provide evidence for a significant impact on the LTC-based LNG prices. Furthermore, the econometric analysis suggests that the seasonal change of demand persists to be an important driver of LNG prices in Europe.

The development of wholesale gas prices in North America has been quite different from the one in the EU. This is commonly attributed to the rising share of domestically produced natural gas in combination with the existing export restrictions for natural gas that allow exports to countries without a free-trade agreement with the US only with a special permission. The econometric analysis could provide indirect evidence for the impact of the rising domestic production by indicating that the impact of the crude oil price is insignificant and the impact of the European LNG prices is weak (€0.14 /MWh with a lag of one month). On the contrary, it clearly indicated an impact of international LNG prices on the US market itself. Finally, there is some evidence of the impact of the exchange rate between the US Dollar and the Euro, as well as of deviations from the usual seasonal pattern of demand, which may result in high peak prices during periods with extraordinary high demand. The latter suggests that a complete shift to GOG as in the US that on the one hand allows to reduce the risk of price volatility, due to the oil-price volatility may on the other hand also partly increase volatility, due to the lower importance of LTCs. Here, it should be noted that the general level of hub prices is only half as big as in the EU though.

Further details of the methodology and the results of the econometric analysis of wholesale gas prices can be found in Annex 2.

3.3 Network component

The network component covers costs for transportation of electricity and natural gas. Major sub-components of this component are costs for transmission and distribution. Beside costs of capital and operation of grid, this component includes compensations for grid losses, and costs back-up systems to ensure system security. Some countries also report costs of metering services under this headline.

3.3.1 Electricity

The unweighted average of statistical values for the network component in electricity prices has been increasing for households between 2008 and 2015 (Figure 10). In 2008, values ranged from €1.43 ct/kWh in Turkey and €7.66 ct/kWh in Luxembourg. In 2015, Bulgaria reported the lowest network costs for households: €2.2 ct/kWh.

In general, households are connected to the distribution grid level. Several countries reported the share of distribution and transmission costs in their network component. This shares are displayed in Figure 25. In general, the distribution grid share was above 70 %, the only exemption being Italy, where transmission grid costs have been reported to be close to 87 %. France is the other extreme that reported 100% of the grid costs in for households to be distribution grid related. There is no harmonised definition for transmission and distribution grid, therefore, cross country comparisons should be treated with caution.

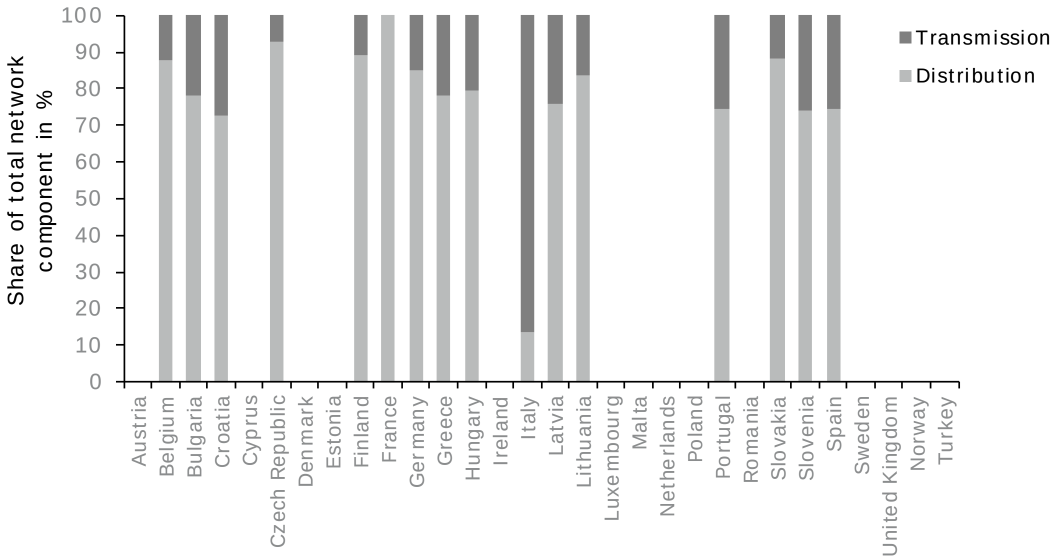


Figure 25: Share of distribution and transmission grid costs in network component for the year 2015 (Band DC, source: European Commission)

Industrial consumers are more often connected to the medium voltage level or even directly to the transmission grid. For this reason, they pay lower prices for grid usage on average, and a higher share for transmission grids. Consequently, statistical values for industrial consumers that require 2 to 20 GWh of electricity per year are much lower (Figure 11), but also slightly increasing between 2008 and 2015. The lowest value for 2015 can be found in Bulgaria: €4.96 /MWh. The highest statistical value for network costs is reported by Slovakia: €36.7 /MWh. With higher consumption, these values decrease further. In consumption band IF (consumption of 70 to 150 GWh/year), the highest value reported was €30.2 /MWh in the UK.

The share of transmission grid costs in the network component for industrial consumers is higher than in households, assumed that industrial consumers in this consumption band are mainly connected at the HV level, but the main cost share is still with distribution grids in consumption band ID (Figure 26). For consumption band IF, the share of reported transmission grid costs is up to 80% higher (e.g. in France).

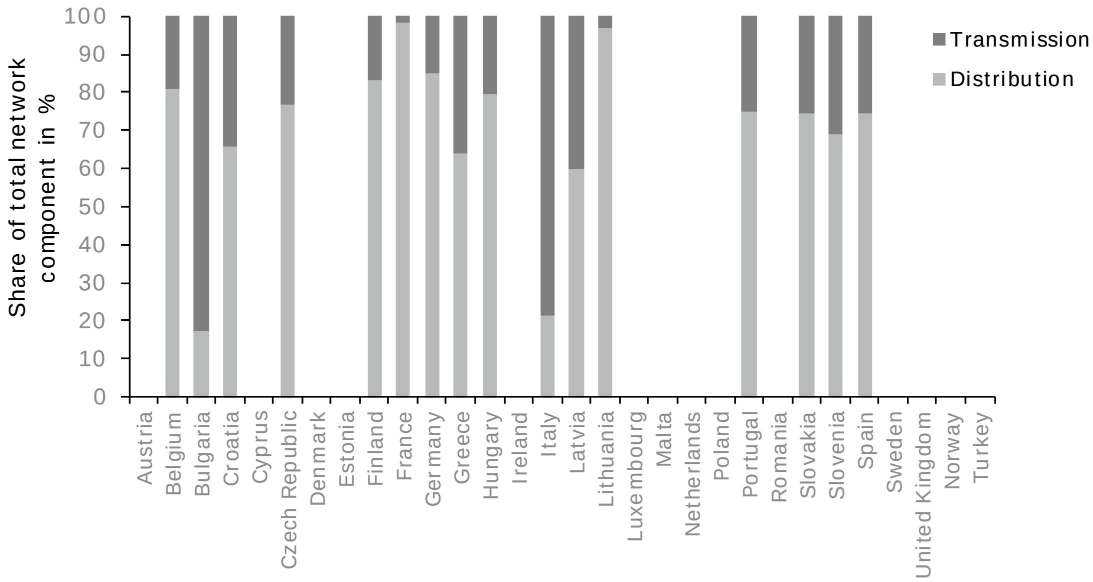


Figure 26: Share of distribution and transmission grid costs in network component for the year 2015 (Band ID, source: European Commission)

3.3.2 Natural gas

For natural gas, there is less data available. Countries like Malta, Cyprus and Finland, in which natural gas is hardly used, are not obliged to report natural gas prices. For other countries, the network price component could not be separated from the energy price component. Network components in natural gas prices for households are missing for nine countries. The spread of network costs in total value increased in the countries that reported network costs separately. In 2008, the lowest value in retail prices for households was found in Estonia (€0.17 ct/kWh). In 2015, Hungary reported the lowest value of €0.38 ct/kWh in household prices. Highest network costs have been accounted in Portugal. Figure 12 in section 3.1.2 shows the development of minimum and maximum values, as well as the median for the years 2008 to 2015 for Band D2.

Figure 27 provides available information about the share of transmission and distribution costs in the network component of gas prices for households. The share of transmission costs in general does not exceed 50% of the network component.

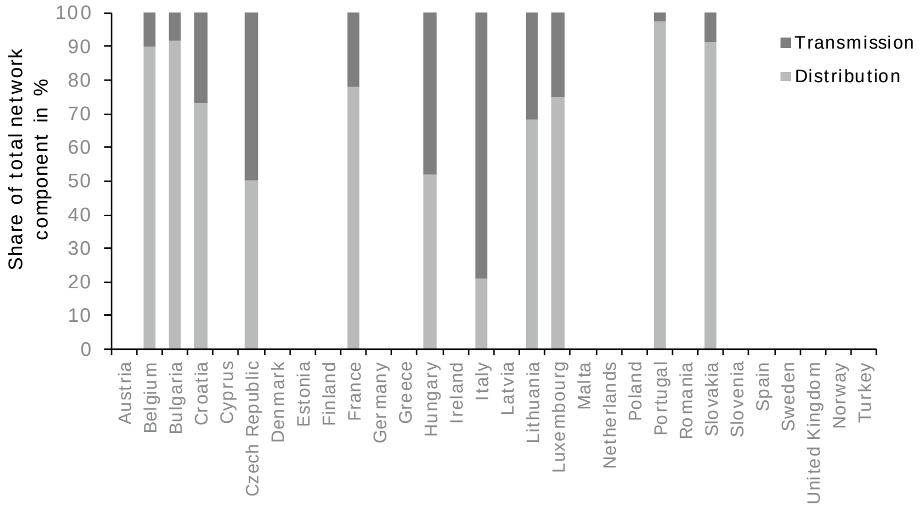


Figure 27: Share of distribution and transmission grid costs in network component for the year 2015 (Band D2, source: European Commission)

For industrial consumers of consumption Band I3, the Netherlands delivers the lowest value in 2015: €1.0 /MWh, the maximum of €11.2 /MWh can be found in Portugal. The un- weighted average is €6.6 /MWh (Figure 13).

In general, the share of distribution costs in the network component for industrial gas consumers is lower than for household consumers. Figure 28 gives an overview for the information provided by the statistical offices from each Member State.

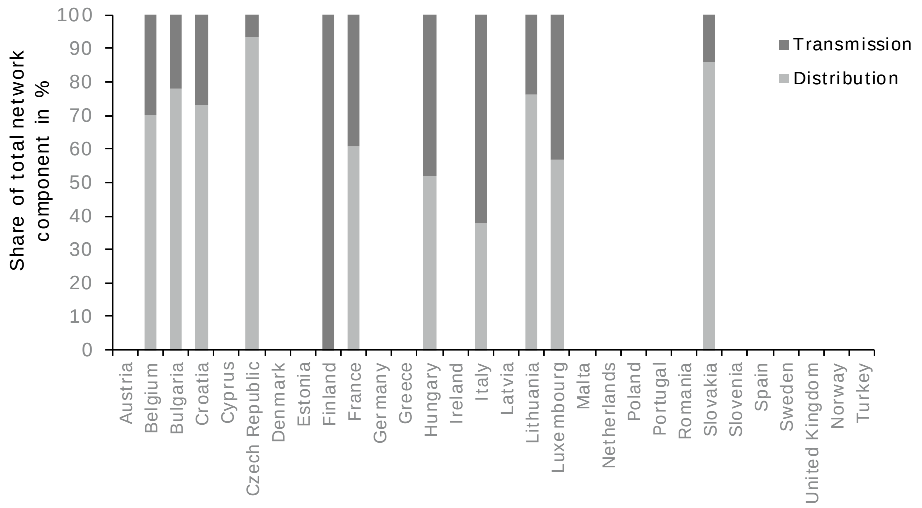


Figure 28: Share of distribution and transmission grid costs in network component for the year 2015 (Band I3, source: European Commission)

3.3.3 Drivers of the network component

As shown in section 3.1, the spread of network fees is small for all consumption levels, suggesting that infrastructure costs are more homogenous within Europe than the other two components.

There are three potential factors to calculate network costs: a lump sum for the connection of an installation, a capacity fee for the connected capacity (kW) and a consumption fee based on the usage of the network. In most countries, households only pay a consumption fee, sometimes there is a lump sum fee for the connection. For industries, the capacity fee for the connected capacity (or peak load) often is more important. By basing the network costs on capacity, the network operators provide an incentive for "flat" consumption, a low peak load in comparison to the total consumption, or – described from a different perspective – high full load hours of consumption. In some countries, these incentives are provided by grid operators to maximise the usage of existing (transmission) grid capacity, in some countries, there are additional regulatory measures to reduce network costs for large energy-intensive industries with high full load hours. In general, network fees are lower for industrial consumers with large consumption, they are more often connected to medium and high voltage levels and therefore, do not need to pay fees to use distribution grids.

Increasing fees for transmission and distribution over time mainly depend on the expected long-term development of grids. Transmission and distribution system operators plan investments in long periods, based on the information about future developments in their covered region. Transmission grid operators are encouraged to increase capacity for international exchange of electricity and gas. The European association of transmission system operators for electricity (ENTSO-E) and gas (ENTSO-G) provide lists of projects of common interest for European grid extension. These projects are generally aimed at increasing the capacity of interconnectors or facilitating transport via longer distances. Often, the increasing and intermittent share of renewable energies is also mentioned as drivers for the projects of common interest for electricity. Centres of wind and solar generation capacity need to be connected to other regions in Europe to supply in times of strong wind and sun and to back up local demand in times of low in-feed.

Similarly, distribution grid operators have to justify their more local investments. In the electricity grid in particular, increasing costs for distribution grid operation are assigned to distributed generation of electricity, mainly by wind power plants and solar photovoltaic.

In the following, the impact of the penetration of RES on the network component of retail prices of electricity is analysed for the EU member states. As a measure for the penetration of RES, we use the annual share of electricity generation from RE sources per country. The level of electricity grid fees in the years 2008, 2010, 2012, 2014 and 2015 is available for households and industrial consumers in all EU member states from the ad-hoc data collection. The annual share of electricity generation from RE sources per country is available for all EU member states for 2008 – 2015. The latter allows for a quantitative assessment of the impact of RE penetration based on the panel of all EU member states. The parameters used in the analyses are listed in Table 3.

Table 3: Variables applied to analyse drivers of the network component of retail electricity prices in the EU

Variables	Description	Available Data
Retail price component network	Endogenous component, annual data for 2008, 2010, 2012, 2014, 2015	Ad-hoc data collection, covering household and industrial consumer bands for electricity (DC, IB, ID), 2008, 2010, 2012, 2014, 2015 in all 28 EU member states
Share of electricity generation from renewable sources	%, electricity generation from renewable sources is divided by the total generation	ENTSO-E: Total generation and per technology for 2008 – 2015 in all 28 EU member states

We have divided the network fees into two groups according to different levels of RE penetration. The levels of grid fees are depicted for RES generation shares above and below 15% for the DC band (Figure 29). The number of 136 observations allows the application of standard statistical tests, which indicate that the grid fees are significantly lower for an RES generation share below 15 %. The statistical significance remains for a split at 10 %, but disappears at 20 %. The significant differences suggest that in average across all countries and years higher RES penetration goes hand in hand with higher grid fees in the past. When looking at annual grid fees, the relation between grid fees and RES generation shares becomes less evident. The results also suggest that the increase of grid fees does not continue in a linear fashion for higher shares. Overall, grid fees can be driven by several factors, such as replacements (investments) of existing equipment, substitution or new infrastructures, number of connections, and by RES generation shares.

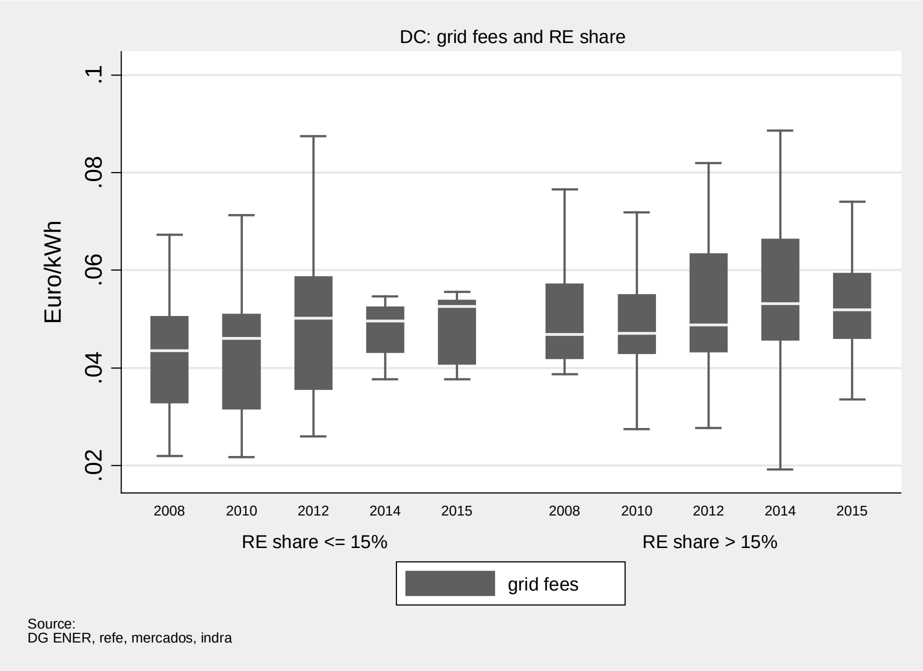


Figure 29: The level of electricity grid fees for households (DC band) in EU member states depending on the current share of RE electricity generation.

3.4 Taxes and levies component

Government policies affect energy prices in multiple ways. Taxes and levies that are explicitly mentioned on energy bills have the most transparent impact on energy prices. There are also indirect ways of policies affecting energy prices, especially electricity prices. The EU ETS scheme and the influence of renewable energy sources on electricity prices have been analysed in the drivers' discussion above (section 3.2). Figure 30 illustrates the range of potential effects of government policies discussed in this section for a hypothetical case in the electricity sector.

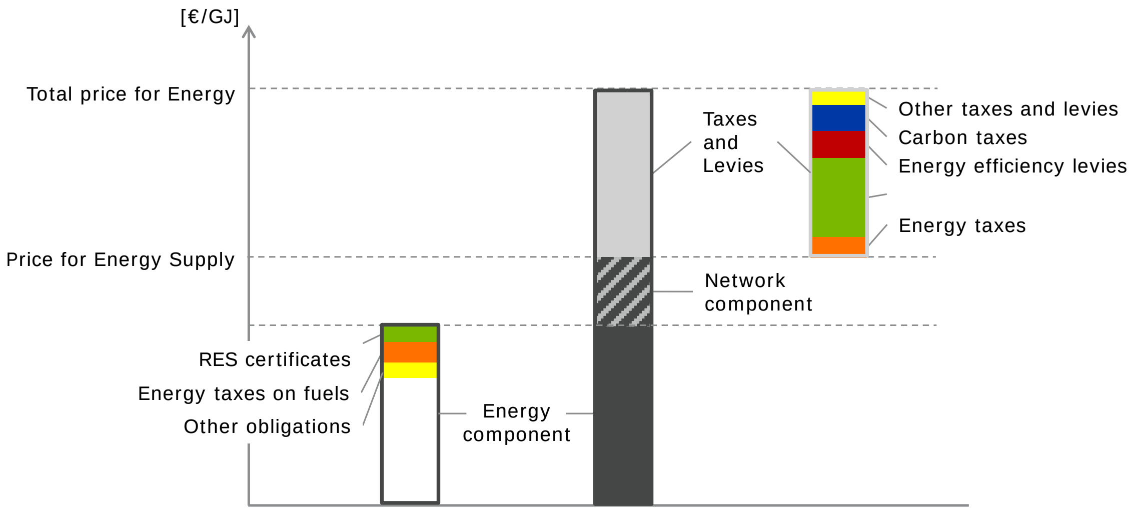


Figure 30: Government policies are influencing energy prices in several ways. Illustrative example for electricity prices (source: Ecofys)

Electricity wholesale prices are determined by the (marginal) costs of electricity generation. Regulations set by governments can change these costs of electricity generation, e.g. by adding energy and/or environmental taxes on fuels or by setting emissions standard for power plants. Governments can also affect the costs of energy supply by setting targets or quotas for energy suppliers. They can require suppliers to include a certain share of renewable energies in their portfolio or obligate them to meet energy efficiency targets. The costs of meeting these obligations are ultimately passed on to the bills of end consumers, often in a less transparent way than taxes and levies, without a clear line on the bill.

For further analysis, the impact of government policies on energy prices has been summarised in several sub-components:

- Renewable Energy Support and Support to Combined Heat and Power (RES & CHP)
- Social (tariffs to support particular consumer groups (e.g. low income or island population))
- Payments for decommissioning of nuclear power stations
- System operation
- Market operation
- Support for Energy Efficiency
- Security of Supply
- Environmental taxes and excise duties
- Other
- VAT

The number and size of elements summarised under these headlines vary broadly across European countries. In this section, we give values in the Member States for the different elements of the taxes and levies components for electricity, gas and oil and describe how they have changed in the period 2008-2012.

Differences between taxes and levies

There are two kinds of elements directly added on energy bills: taxes and levies. From a consumer's point of view, both measures increase the bill in the same way. From a political point of view, they are very different.

The Energy Taxation Directive sets minimum tax levels for energy products and electricity used as motor fuel or heating. Above these levels the Member States define the levels as they see fit. The tax rates are often used to direct behaviour. High excise duties on energy consumption are used to raise awareness and to increase energy savings, sometimes referred to as "eco taxes". Some Member States apply "carbon taxation", the tax rate is based on the carbon content of the energy carrier and raises the cost of carbon intensive products. The income from excise duties and some environmental taxes feeds directly into the general state budget. If a certain group of energy consumers is eligible for tax exemptions, tax refunds or reduced tariffs, the state can either decide to reduce its spending or increase taxes on other products. High and low taxes for energy normally comply with the general targets of the government and can be changed accordingly.

In contrast, levies are distributed costs of specific policies. The dedicated budget is accounted outside of the state budget. In European energy systems, renewable energy support is the most common policy to be financed by a levy. Political institutions set the framework for the levy, but in general, they do not directly determine the tariffs. Levies are directly linked to the policy purpose. They grow (and shrink) with the costs of the specific policy. If a policy is very successful and there is no limit for expenditures, the tariff of the levy can grow very fast. The government has limited options to steer this development. If it reduces the tariff rates for specific consumers, other energy consumers have to pay higher tariffs.

3.4.1 Electricity

The taxes and levies component in electricity has been growing both for domestic and industrial consumers of electricity. The spread for households with a consumption of 2500 to 5000 kWh/year has been growing from €0.8 ct/kWh to €14.9 ct/kWh in 2008 to a spread of €0.6 ct/kWh to €20.8 ct/kWh in 2015 (see Figure 10 in section 3.1.1). Countries with very high impact of the taxes and levies component are Denmark, Germany, Portugal, Spain and Italy. The lowest impact was observed in Malta and Hungary, Bulgaria and Croatia.

The taxes and levies component can be broken down into sub-components. For households, the value-added tax is the single biggest sub-component in electricity retail prices in almost all countries. The split for 2015 numbers (Figure 31) reveals the high impact of excise duties and environmental taxes on household retail prices in Denmark, the Netherlands, Sweden and Finland. In Germany, Italy, Portugal and Spain, support payments for renewable energies and combined heat and power production exceed the effect of VAT on electricity retail prices for households.

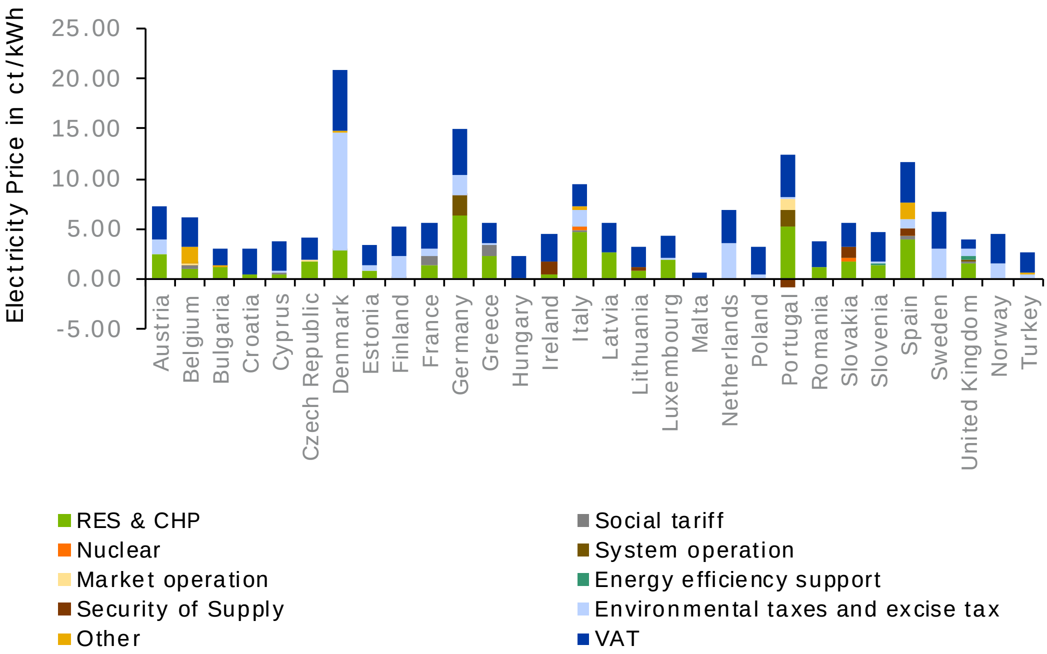


Figure 31: Taxes and levies sub-components in European electricity prices for households in 2015 (Band DC, source: European Commission)

The European Energy Tax Directive 2003/96/EC provides minimum levels of taxation for energy products used as motor fuel and heating fuel and for electricity. There are no maximum limits for taxes. The implementation varies broadly: In Denmark households with a consumption of 2500 to 5000 kWh per year (Band DC) paid €11.8 ct/kWh in 2015, while countries like Bulgaria, Croatia, Ireland, Malta, Slovakia, Lithuania, Latvia, Hungary and the UK exempt households from paying excise duties on electricity. The basis for excise duties is also different. In the Netherlands, the excise tax rate on electricity consumption was €11.96 ct/kWh in 2015 for the first 10 000 kWh of yearly consumption, the highest in all European Member States. The reported average payment for 2015, €3.5 ct/kWh is much lower because each household gets a lump sum refund of excise duties of €311.84. Due to this regulation, the value of excise duty per unit of electricity depends on the total consumption of the entity. Households with high yearly electricity consumption pay a higher tax rate per unit of consumption, households with little consumption pay less.

Figure 32 shows the development of average excise duties and environmental taxes for household consumption Band DC for 2008 until 2015. Due to the high value for Denmark, values of €0.001 EUR/kWh as seen in Romania, Cyprus, Czech Republic or Greece are nearly invisible in this graph. There have been few changes in this price sub-component, fluctuations are often due to developments in exchange rates (e.g. for Sweden). Values for the sub-component increased significantly in Denmark and in the Netherlands. Small increases have been reported by Slovenia, Romania, and Finland.

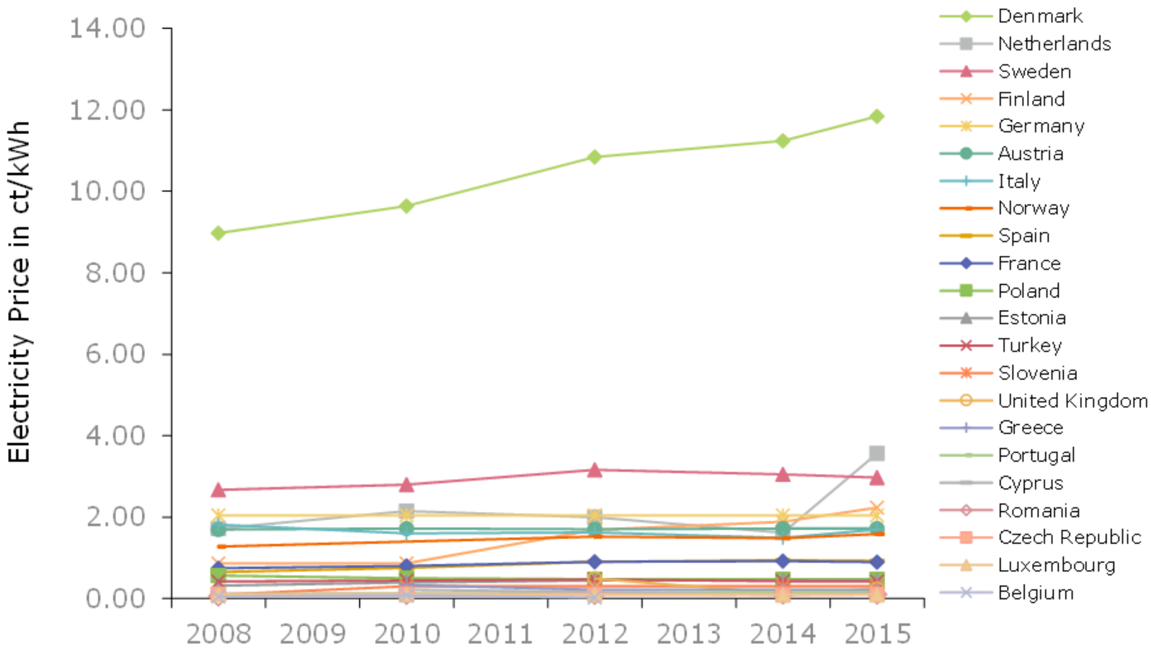


Figure 32: Development of excise duties and environmental taxes on electricity prices for European households for the period 2008 to 2015 (Band DC, source: European Commission)

All households in Europe pay value added tax on their electricity bill. Rates vary between 5 % in the UK and 27 % in Hungary. The tax is applied to the total electricity price, including energy and network component and taxes and levies. The VAT is summed under the headline taxes and levies, but the nominal value depends on the total price development. Figure 33 presents the nominal values for VAT per unit of electricity. In clear correlation to the total electricity price, the average payment of VAT on electricity in Denmark is the highest in Europe. In 2015, consumers paid about €6.2 ct/kWh, the applied rate is 25%. The second highest value, €4.7 ct/kWh is paid in Germany for a VAT rate of 19%. Portugal increased the VAT rate from 6% to 23% in 2011[6] causing a strong increase in absolute numbers. In Belgium, the VAT rate was reduced to 6% in 2014, but was then returned to 21% again in 2015.

[6] DG TAXUD: Excise Duty Tables, Part II – Energy products and Electricity

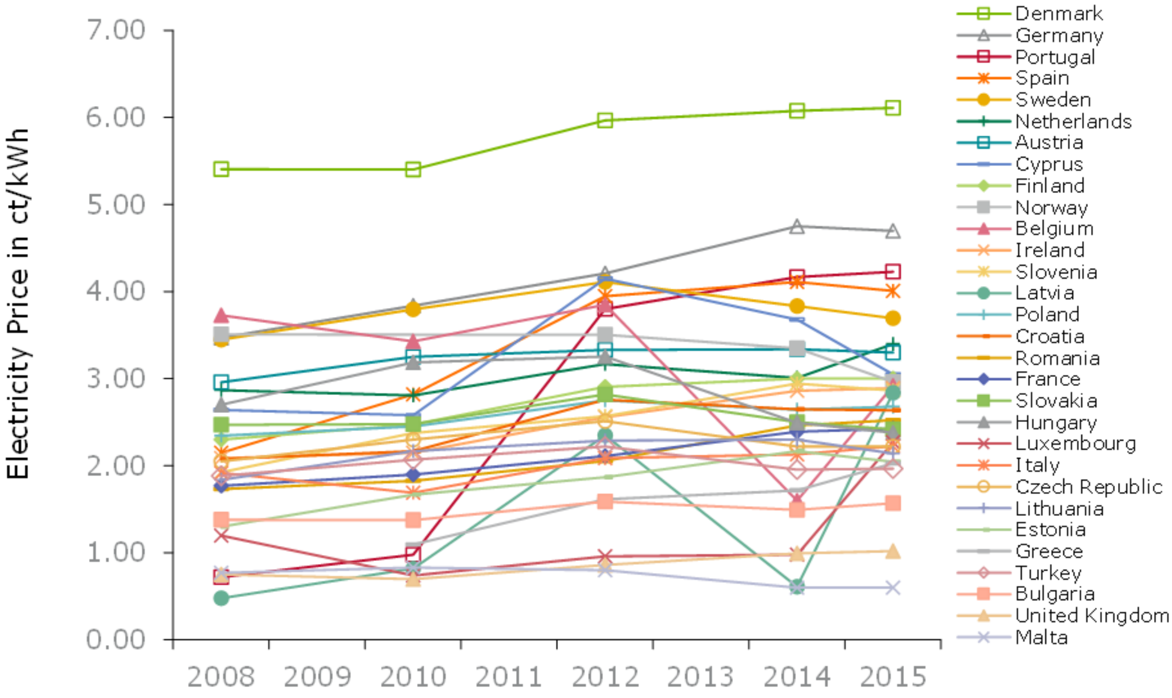


Figure 33: Development of VAT payments per unit of electricity, Band DC, 2008 to 2015 (source: European Commission)

Support payments for renewable energy sources and combined heat and power generation facilities sum up to a third price sub-component that has significant impact on electricity retail prices in Europe. In Germany, three policies are summed under this headline and resulted in a price sub-component of €6.4 ct/kWh in 2015. In Portugal, Italy and Spain, a large share of the electricity retail price is also used to support generation from renewable energy sources and combined heat and power. Malta, Norway, Poland, Finland and Turkey do not directly add costs of RES and CHP support to electricity prices of households (Figure 34). In most Member States, this sub-component of taxes and levies has grown over the period 2008-2012, in some cases quite significantly. In Sweden and Norway, the payments for a joint renewable energy certificate scheme have not been estimated, they are reported as part of the energy component.

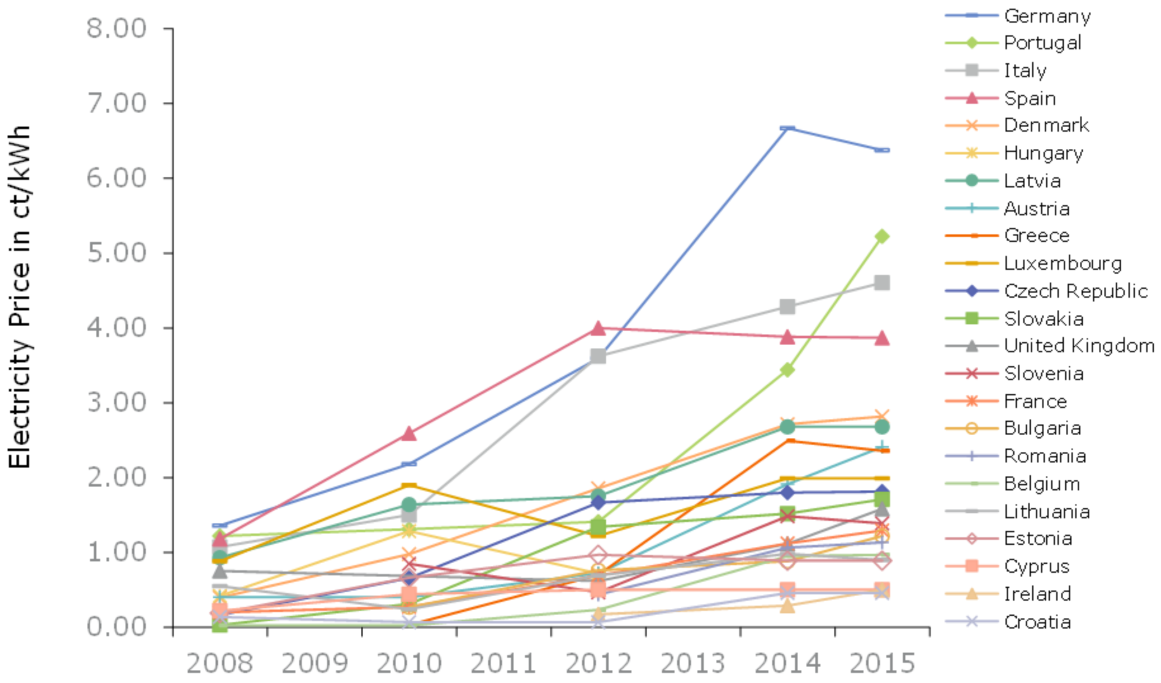
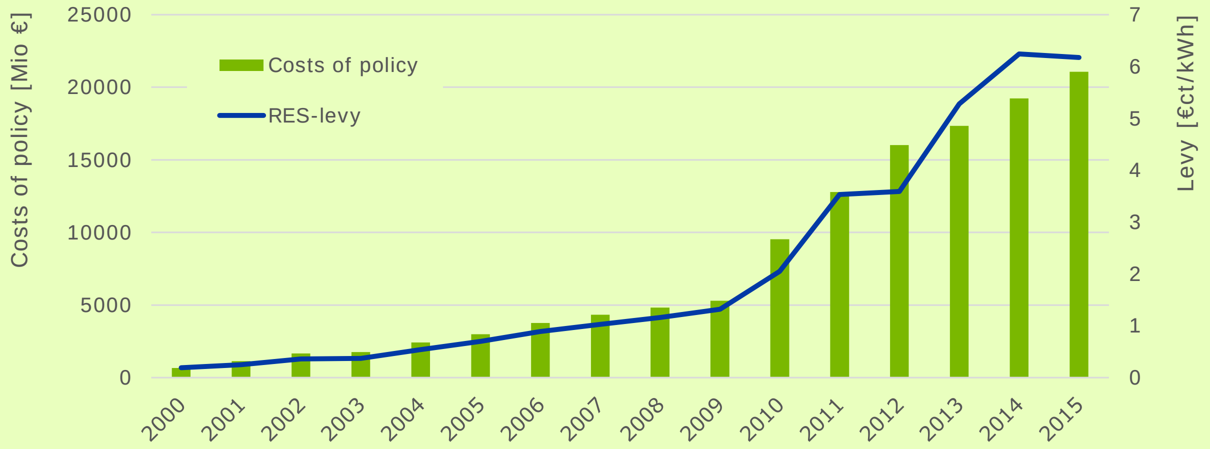


Figure 34: Values for price sub-component "RES & CHP" in European electricity retail prices for households (band DC, source: DG ENER)

Costs of political interventions in electricity markets: Using levies to estimate the development

Levies finance a dedicated budget that is set aside to reach defined policy targets. Political institutions set the framework for the levy. If they do not directly determine the tariffs, levies grow (and shrink) with the costs of the specific policy. If the tariff of a levy is pre-defined, the available funding for the policy grows and shrinks with the levy. This makes them good indicators for following the total cost development of a specific political intervention.

If a policy is very successful, the tariff of the levy can grow very fast. The development of the largest levy in Europe, the German renewable energy levy (EEG-Umlage) provides an example. Starting in the year 2000, the renewable energy law guaranteed a defined feed-in tariff for electricity generated from renewable energy sources. A payment period of 20 years provided a stable income for investors. Every year's costs of the policies were to be covered by the yearly income from a dedicated levy. The law was in place for several years, and the levy slowly grew with the growing number of installations to generate electricity from RES. The technology progressed and costs for installations decreased. The fixed feed-in tariff in combination with decreasing cost and difficult investment climate elsewhere in times of financial crisis made investments increasingly interesting. The number of installations grew rapidly and with it the levy.



Based on data from the German Federal Ministry of Economic Affairs and Energy

The German RES-levy is also a good example of the difficulty of governmental intervention in the mechanism of a levy. In 2011, the German government promised the levy would not exceed a threshold of €3.5 ct/kWh. The consequence was a financial gap between the revenues collected with the levy and the payments needed to cover the guaranteed feed-in-tariff and a stronger increase in the following years to cover the deficit.

VAT has been omitted in the analysis for industrial consumers as it is refunded. The median for the taxes and levies component in industrial electricity retail prices is nonetheless increasing (Figure 11 in section 3.1.1). Government policies for industrial electricity consumers are less targeted at behavioural changes, instead there are exemptions and reduced rates in taxes and levies for consumers with limited potential for demand reduction. There are several types of compensation and tariff reductions granted by governments and details of these are given in the country profiles in Annex 1. Eligibility for this compensation or reduction depends on a number of factors for example energy cost intensity, sector affiliation, procured processes or grid connection. Often, regulation requires proof of energy efficiency efforts to grant reduced payments, e.g. for usage in metallurgical or mineralogical processes.

In 2015, Germany and Italy by far reported the highest values for the (non-recoverable) taxes and levies component in industrial electricity retail prices. Industrial consumers on average paid €63 /MWh and €62 /MWh for taxes and levies. Sweden, Malta and Croatia reported the lowest effects of the taxes and levies components on industrial electricity bills.

Figure 35 shows the reported values for customers demanding between 2 and 20 GWh per year (Band ID) excluding recoverable taxes and value added taxes. Excise and environmental taxes are reduced for large electricity consumers in many countries. In most of the countries, the sub-component that finances support payments to renewable energy sources and combined heat and power installations has the highest impact on industrial electricity prices. The highest value of this sub-component on electricity prices in 2015 is in Germany (€61 /MWh), the next highest is in Italy with €48 /MWh, followed by Denmark and Latvia (€27 /MWh). Data for Lithuania and Norway is missing, Malta reported zero impact of taxes and levies on industrial electricity prices.

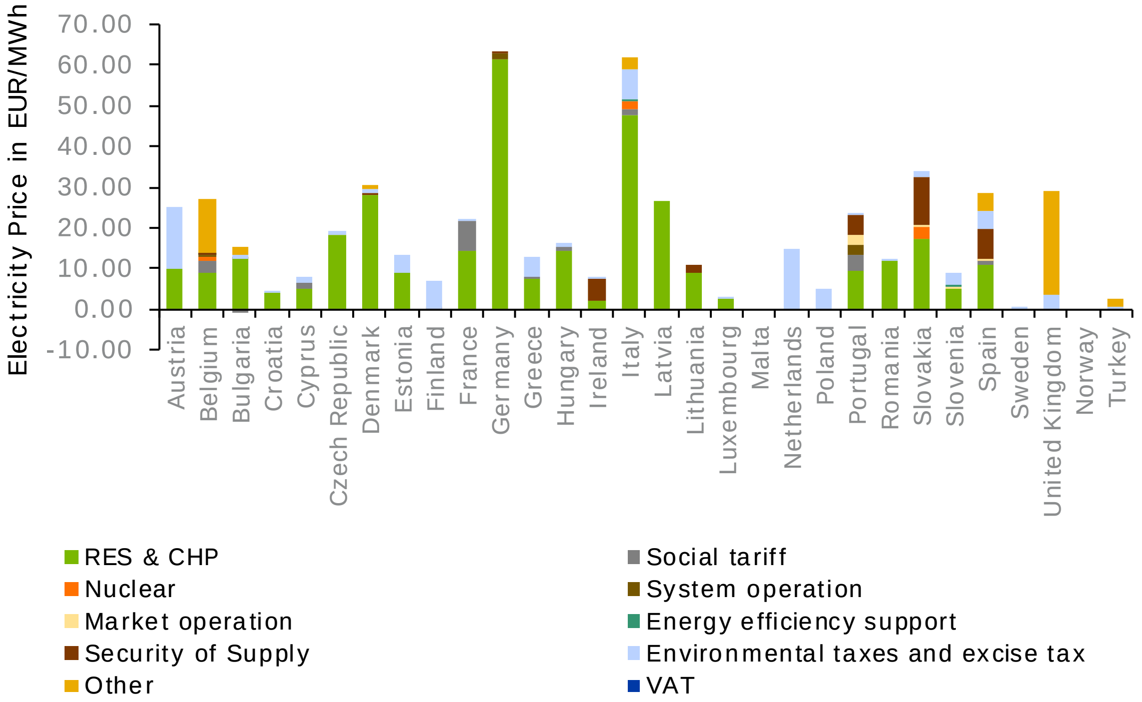


Figure 35: Taxes and levies sub-components in European electricity prices for industrial customers in 2015 (Band ID, source: European Commission)

In many countries, the impact of the taxes and levies component strongly depends on the characteristics of individual companies. A more detailed analysis for specific energy-intensive sectors is presented in section 5.1.

3.4.2 Natural gas

National retail prices for natural gas are less impacted by elements in the taxes and levies component. The development over time is not steady, neither for minimum and maximum, nor for median values in household retail prices (Figure 12 in section 3.1.2).

Most European countries only apply excise duties to natural gas. Italy, the Netherlands and Slovenia additionally raise financing for RES and CHP policies via natural gas bills. Belgium and the UK add cost for social policies. Tariffs related to system and market operation are applied in Belgium, Czech

Republic, Germany and Portugal. Security of Supply contribution is applied in Greece and Hungary. Households again pay value added tax. Figure 36 shows the impact of government policies on natural gas retail prices for households (Band D2) in 2015. The highest impact can be found in Sweden (€5.2 ct/kWh) and in Denmark (€4.4 ct/kWh). Cyprus, Finland, Ireland, Latvia, Malta and Norway did not report domestic retail prices for natural gas. In these countries, natural gas is hardly used for heating or cooking in households.

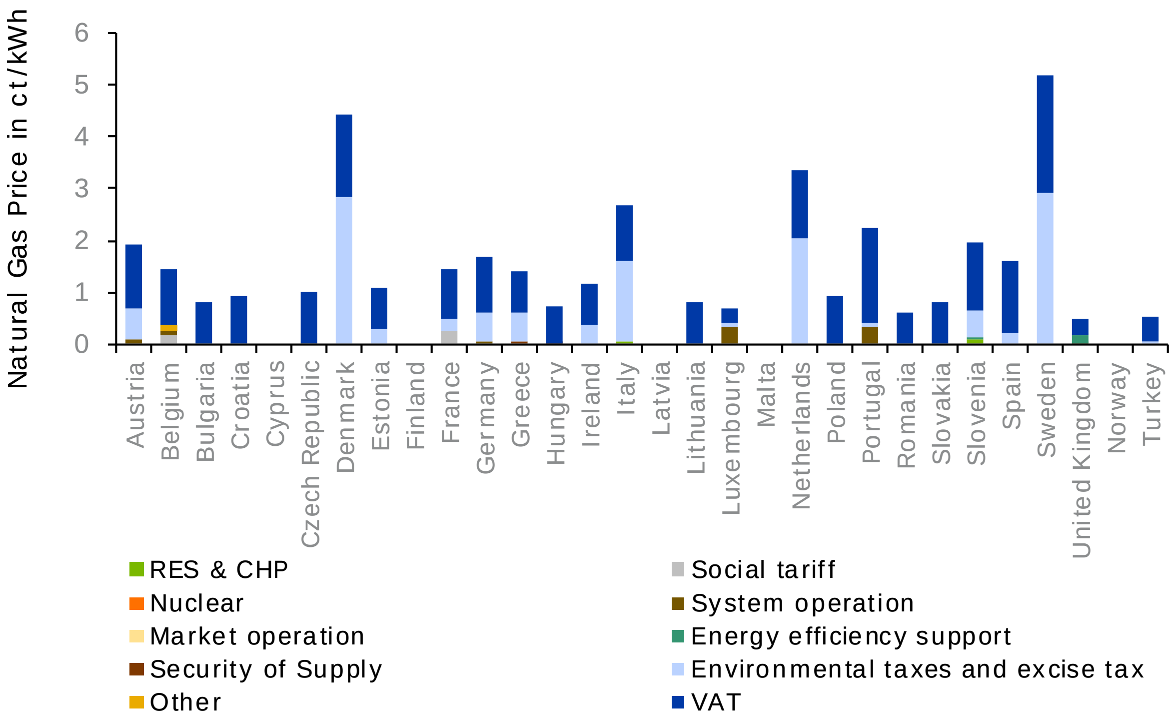


Figure 36: Taxes and levies sub-components in European natural gas prices for households in 2015 (Band D2, source: European Commission)

For industrial customers, excise duties show the highest impact on their natural gas bills, although most countries levy low tariffs on customers exceeding a demand of 1000 TJ/year (Band I3). In absolute terms for the taxes and levies component, Finland ranks highest with €14.6 /MWh. The Netherlands (€12.2 /MWh) overtakes Denmark (€9.2 /MWh), Austria (€9 /MWh), and Sweden (€8.8 /MWh) in 2015. Figure 37 shows the direct impact of sub-components in the taxes and levies category on natural gas bills of industrial natural gas consumers (band I3) in 2015.

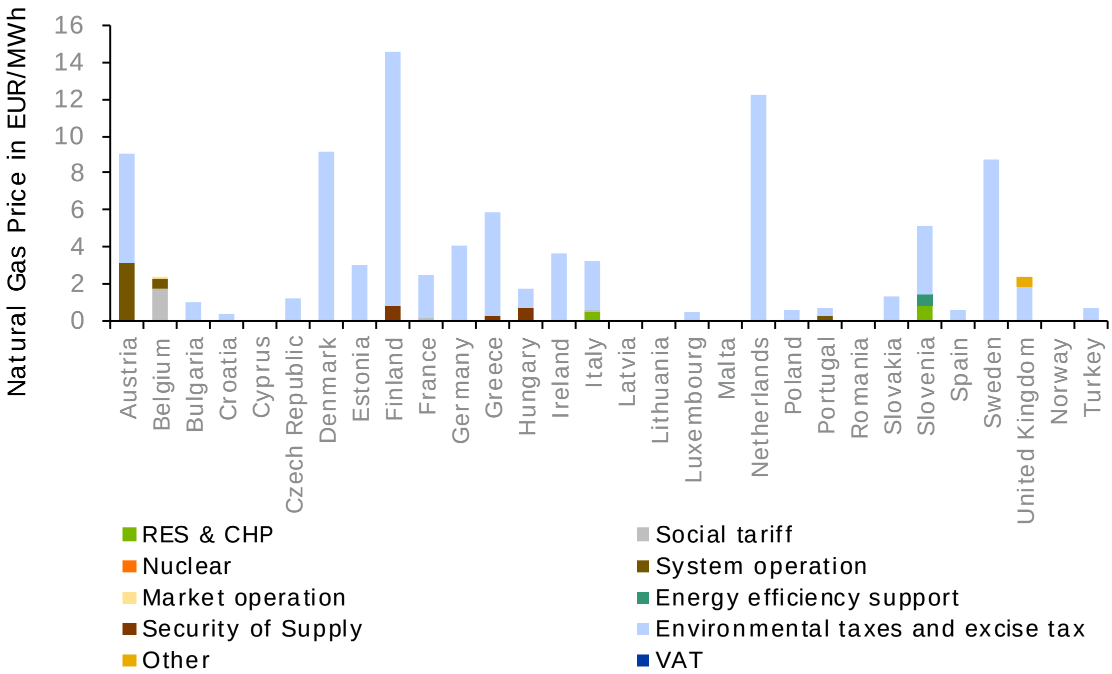


Figure 37: Taxes and levies sub-components in European natural gas prices for industrial customers in 2015 (Band I3, source: European Commission)

The impact of the taxes and levies component often depends on the characteristics of individual companies. A more detailed analysis for specific energy-intensive sectors is presented in section 5.1.

3.4.3 Oil products

Taxes and levies on automotive diesel and gasoline are high, but varied little over time. The minimum tax rate set in the Energy Taxation Directive of €0.33 /l has been exceeded in all Member States. In 2015, the highest tax rates have been applied in the UK, totalling €1.1 /l of gasoline. Bulgarian taxes on gasoline have been €0.4 /l, in Spain the total value was €0.5 /l. Figure 38 provides an overview for all European Member States.

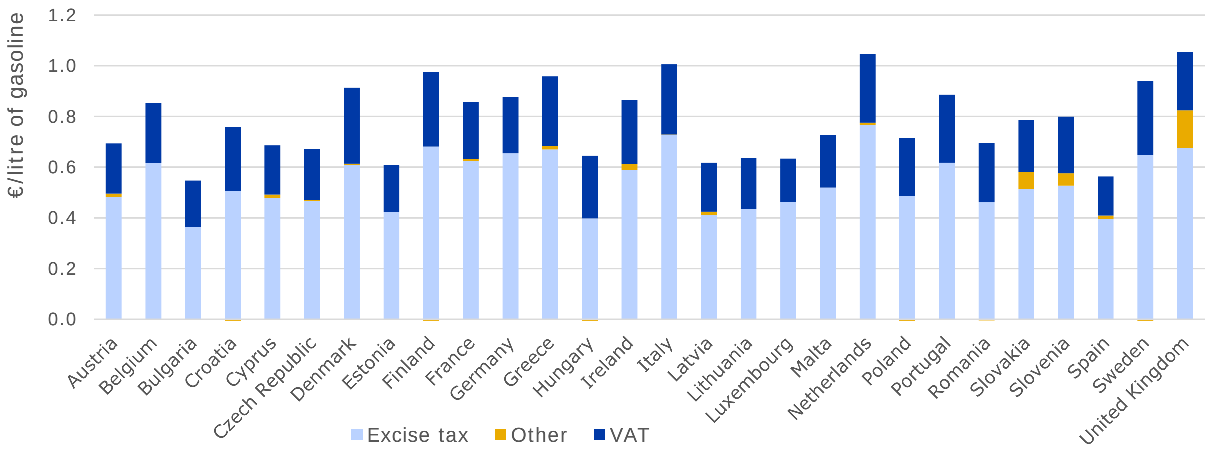


Figure 38: Taxes on gasoline in 2015 (source: own calculations based on weekly oil bulletin)

With rates above €0.7 /l, excise duties are especially high in the Netherlands and Italy. In Bulgaria and Cyprus, there was a transition period that allowed lower taxes than the minimum tax rate of 0.36€/l for unleaded petrol in 2008 and 2009. In Greece, an exemption ended in June 2009, when the excise duty increased from €0.35 /l to €0.41 /l and then to €0.67 /l in 2010. Figure 39 shows that there have been only small changes in tax levels on gasoline between 2008 and 2015.

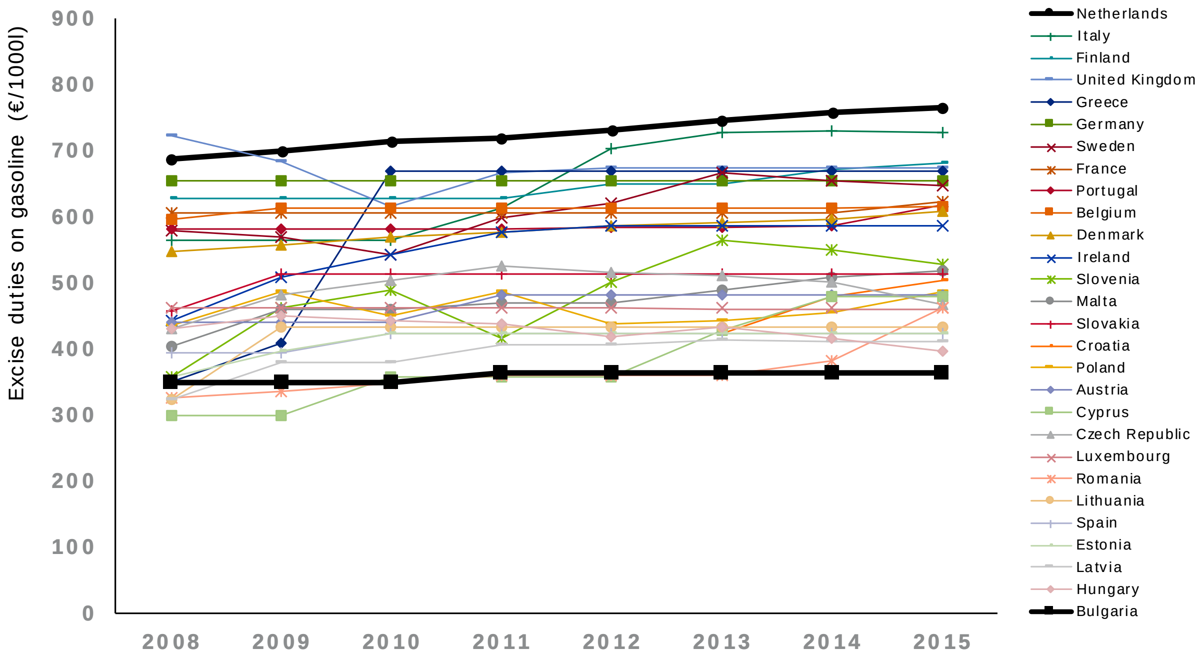


Figure 39: Development of excise duties on gasoline, 2008 to 2015 (source: DG TAXUD)

Some countries provide different tax rates for unleaded petrol. In Belgium, Greece and Spain, the tax rate depends on the octane rate. In Belgium, the threshold is 98 oct, in Spain it is 97 oct, in Greece 96.5 oct. Tax rates for gasoline are higher for fuels with octane rates above these thresholds. For the analysis, we assumed that the fuel did not cross this threshold.

The minimum tax rate and national taxes in general are significantly higher for leaded petrol, which is, however, banned from the market in Bulgaria, Czech Republic, Latvia, Luxembourg, Malta, Poland, Portugal, Slovenia, Slovakia, Finland and Hungary.

In general, taxes on diesel have been lower than taxes on gasoline in 2015. They ranged from €0.5 /l in Spain, Latvia and Lithuania to €1.1 /l in the UK. The UK is the only Member State in Europe that applies the same excise tax to gasoline and diesel.

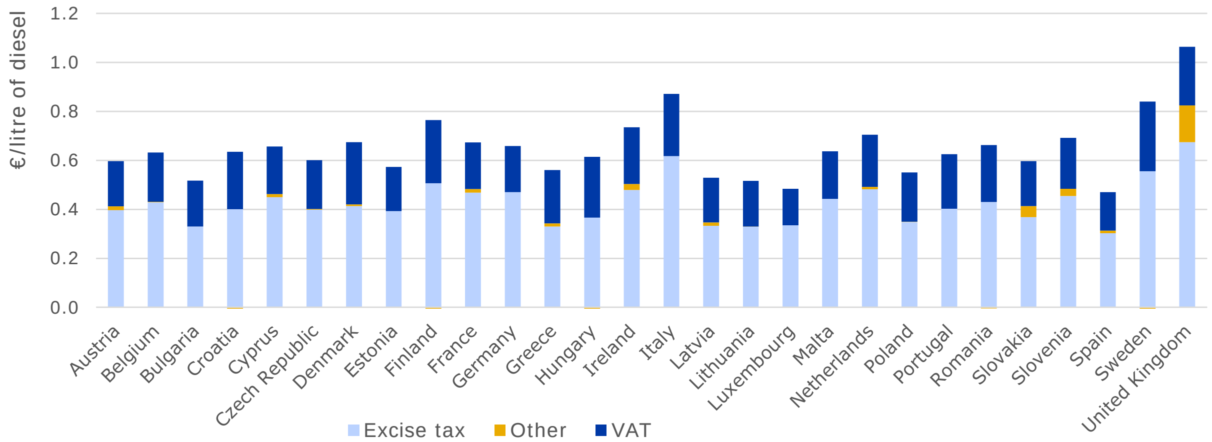


Figure 40: Taxes on automotive diesel in 2015 (source: own calculations based on weekly oil bulletin)

Again, excise duties changed little over time. Figure 41 shows the development from 2008 to 2015. While UK has applied the highest rates in every year, excise duties in Italy and Sweden increased recently.

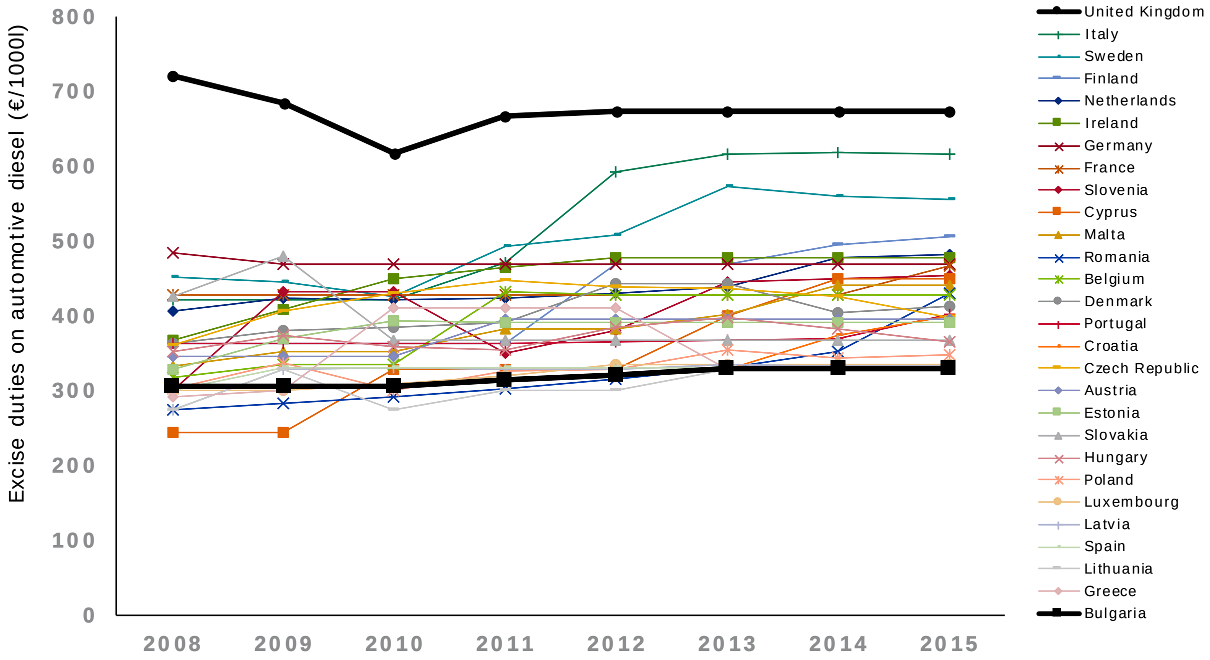


Figure 41: Development of excise duties on gasoline, 2008 to 2015 (source: DG TAXUD)

For heating oil, taxes and levies differ broadly. Two countries, Belgium and Luxembourg, have special regimes and apply excise duties below the minimum excise duty rate set in the Energy Taxation Directive of €0.021 /l heating oil. Tax rates in Lithuania and Bulgaria are close to this threshold. The highest excise duty rate is applied in the Netherlands: €0.5 /l of heating oil in non-business use. However, as section 4 will show, Dutch households rarely use heating oil, they use natural gas. In general, there is a clear dependency of excise duties on heating oil and the usage of heating oil in private households. In countries, where households mainly use natural gas or other energy carriers for heating, the tax rate is high in comparison the tax rate in countries, where households broadly heat with oil.

Comparing the information for 2008 and 2015, the Greek government nearly doubled the excise duty on heating oil from €168 /1000l to €330 /1000l. In every year, there is an exemption for the winter period from 15 October to 30 April. In this period, heating oil is delivered at a strongly reduced rate. Consumers in Czech Republic can get a refund of €0.4 /l if they can prove that the marked diesel has been used for heating. Slovakia does not provide data about the energy component in heating oil.

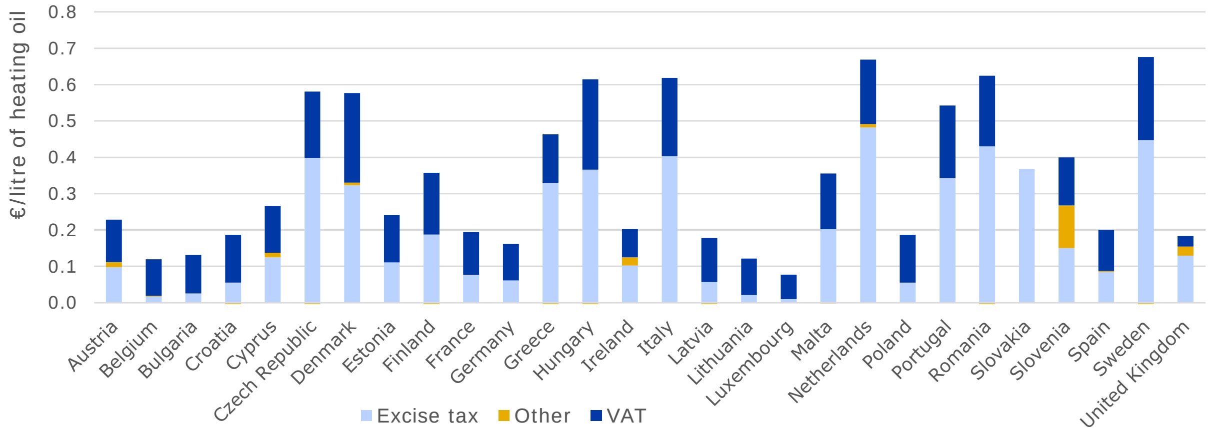


Figure 42: Taxes on heating oil in non-business use in 2015 (source: own calculations based on weekly oil bulletin and DG TAXUD)

Excise taxes for heating oil in business and non-business are often identical. In Germany, households pay about €0.015 /l more than business users. In Sweden, there is no difference in tax rate of industrial diesel and heating oil – business users pay about €0.2 /l less for diesel than non-business users. In Malta, the difference is the other way around: non-business users pay €0.26 /l less than business users for heating oil. Figure 43 provides an overview of excise tax rates for business users in 2015.

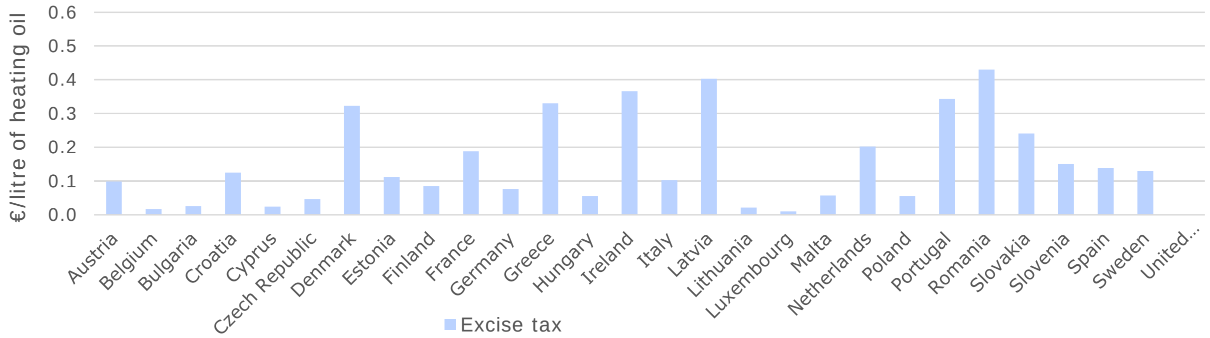


Figure 43: Excise duties on heating oil in business use in 2015 (source: DG TAXUD)

There are two different regimes to treat industrial diesel in taxation. Several countries apply the same tax rate on industrial diesel and on automotive diesel: Austria, Bulgaria, Cyprus, Greece, Hungary, Lithuania, Malta, the Netherlands, Slovakia and Poland. Alternatively, industrial diesel is treated in the same way as heating oil for business users, of which there are only three examples:

Italy, Denmark and Portugal apply a lower tax rate only to industrial diesel. Denmark started to privilege industrial consumers of diesel for commercial use only in 2014. French and Slovenian excise taxes for industrial diesel are between the rates for automotive diesel and the rates for heating oil. Belgium and Luxembourg apply the minimum tax rate on industrial diesel. Germany does not provide information. Figure 44 provides all available excise tax rates for industrial diesel.

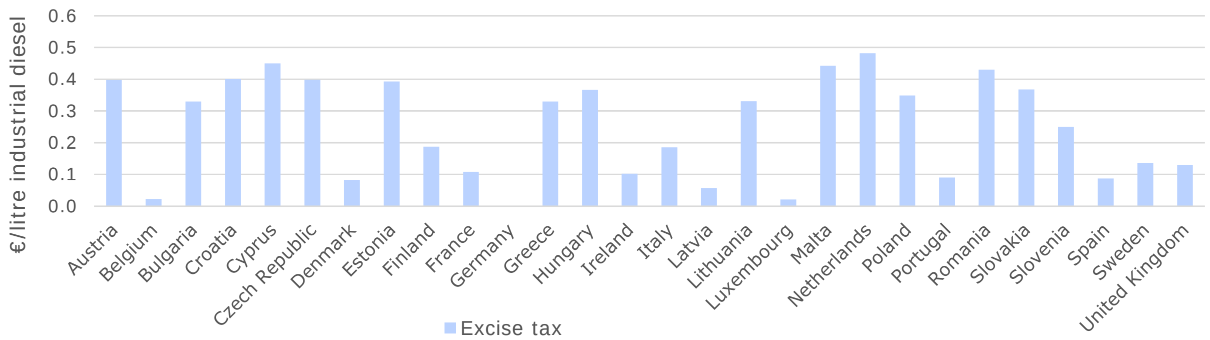


Figure 44: Excise duties on diesel for industrial use in 2015 (source: DG TAXUD)

In Luxembourg, the excise tax includes a climate changing tax of €20/1000l, starting in 2007. In Poland, the rate includes a fuel tax. In Denmark, Sweden and Finland, the excise tax includes a CO_2-tax for the whole period 2008 to 2015. Ireland introduced a CO_2 charge on gasoline end of 2009. In 2015 the rate was €45.87 /1000l. Biofuel or the biofuel proportion is not subject to this charge. In Finland, the excise tax includes a strategic stockpile fee.

Several countries have implemented minimum content of biofuels to be eligible for lower excise taxes. In Austria, Czech Republic Latvia, Lithuania, Slovakia and France, there is a threshold for biofuel and ethanol content that determines the applicable tax rate.

In Austria, Germany, and in Luxembourg, the tax rate depends on the sulphur content, with a threshold of 10 mg sulfur per kilogramme. In Hungary, this differentiation ended in 2008, in Finland it was in place until 2010. For the analysis, we assumed that the fuel did not cross this threshold.

France is the only European country in which excise tax shows regional differences, ranging from €589.20 to 606.90 /1000l for unleaded petrol and €428.40 to 416.90 /1000l for diesel for the years 2008 to 2014. In 2015, the rate has been increased by about €17 /1000l for gasoline and €40 /1000l for diesel.

Many countries apply special rates for diesel used in the agricultural, horticulture, pisciculture, and forestry sector. Also railway operators are often eligible for special rates.

4 Impact of energy prices on household budgets

Energy prices affect the disposable income of households. In this section, we analyse the evolution of household energy consumption, the resulting expenditure, and the impact of energy prices on household budgets. As expenditure is determined by the consumption of energy and the price, we analyse these separately.

The analysis relies mainly on data from the ODYSEE-MURE database, as data from Eurostat is only available for 2005 and 2010, while the ODYSEE-MURE database has an almost complete dataset on residential consumption for 2008-2013[7]. Data on household income and price data is taken from Eurostat with the latter being from when the data was available (Electricity and Gas). The consumption band was chosen based on the average consumption of households for each fuel in each country. Oil prices are taken from the Weekly Oil Bulletin, coal prices stem from the BP statistical review, and wood prices stem from the PIX Pellet Continental Europe Index by FOEX. Prices for heat stem from Euroheat. The data on household expenditure, differentiated by household income (Annex 3), stems from an ad-hoc data collection.

4.1 Evolution of household consumption

The analysis starts on an aggregated level, including energy consumption in households[8]. Spending on energy for transportation[9] is treated separately. Household consumption includes, among other things, energy for heating, cooking, lighting, as well as the operation of small and large appliances.

The absolute total energy consumption per year of the residential sector was relatively constant at levels fluctuating around 12000 PJ (Figure 45)[10] with an overall decreasing trend (from 2008 to 2013). Energy consumption in 2010 was exceptionally high, mainly due to a cold winter.

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[7] There are missing data points for Malta (2013), Romania (2012 and 2013). The data-availability for appliance-specific energy consumption and for energy-efficiency in ODYSEE-MURE is limited and incomplete.
[8] COICOP 4.5
[9] COICOP 07.2.2
[10] These numbers do not include energy consumption through individual transport.

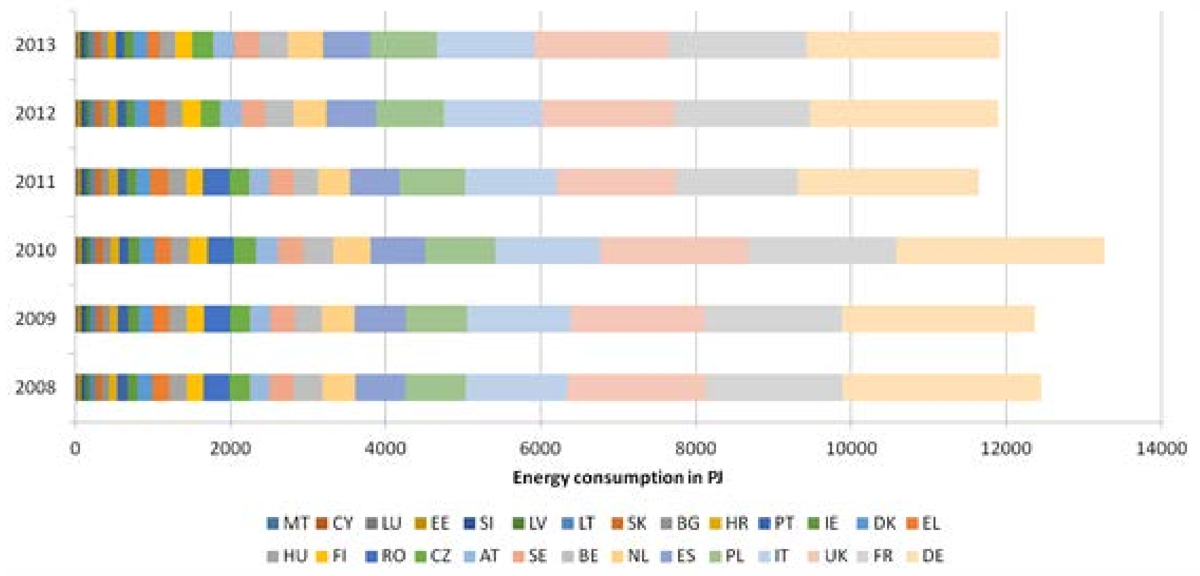

Figure 45: Development of the total energy consumption of the residential sector (excluding transport, in PJ) (Data: ODYSEE-MURE database)[11]

In 21 out of 28 Member States, 2010 was the year with the highest energy consumption of the residential sector[12] in the time-frame considered. The influence of cold weather is confirmed by looking at the aggregated number of heating degree days, which are at much higher levels in 2010 than in the other years considered here (Table 4).

	Heating degree days	% of mean
2008	93251	95%
2009	95888	98%
2010	107480	110%
2011	92643	95%
2012	99865	102%
2013	97943	100%
mean	*97845*	

Table 4: Heating degree days between 2008 and 2013 (Data: European Commission, JRC, MARS Unit)

The energy consumption shown in Figure 45 are totals per Member State and therefore, relate strongly to the national population. Figure 46 shows the development of energy consumption per household for each of the 28 EU Member States from 2008 to 2013.

[11] The bars are in the order of the key in all figures in this report.

[12] Exceptions are Cyprus, Latvia, Bulgaria, Portugal, Greece and Romania. In all these countries energy consumption was not at a maximum level, still it was at quite high levels. In Luxembourg consumption in 2010 is at almost the same level like in 2009 where their consumption was at a maximum.

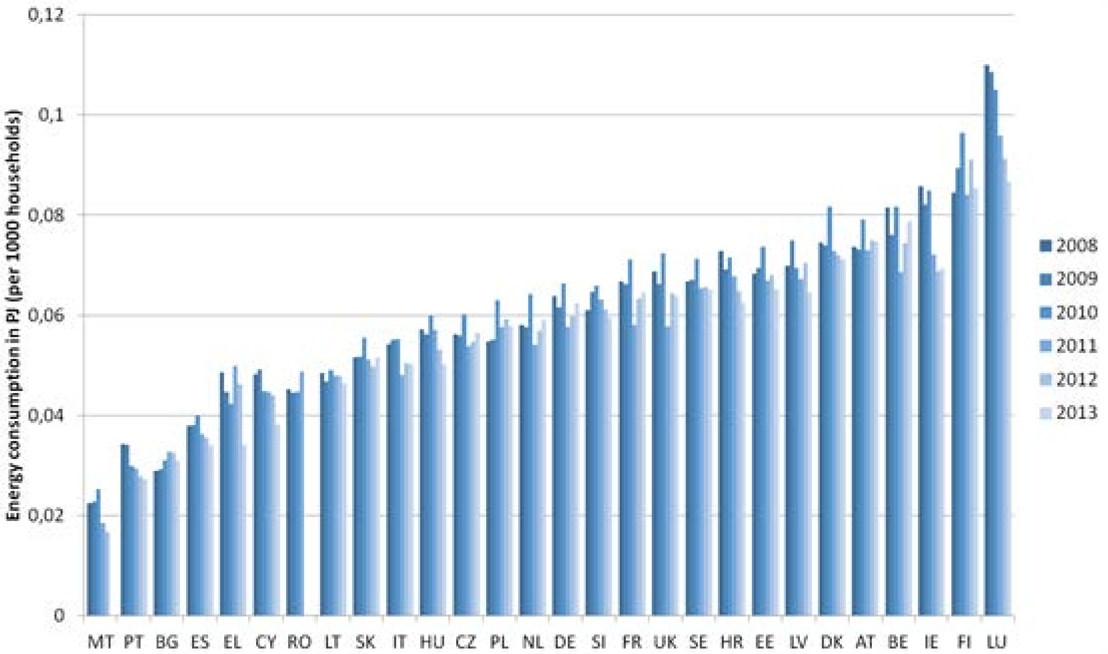

Figure 46: Total energy consumption of the residential sector (in PJ) per 1000 households (Data: ODYSEE-MURE database)

When accounting for the number of households, Luxembourg and Finland display the highest energy consumption per household. Malta's energy consumption is at the lower end. The exact rank order depends on which reference unit (households or persons) is used. Differences are due to different household sizes across the Member States. The mean household size ranges from about two (Germany) to slightly above three (Slovakia). The correlation between the ranks of the countries in these two measures is very high (0.93). In the following, we will therefore, focus on the analysis at household level, which also helps to keep it comparable to the policy-discussions which usually centre on households. The household energy consumption also depends on the size of the dwelling that the residents live in, in particular through the consumed heating energy. We observe that the size of the dwelling (as reported in the Eurostat dataset "ilc_hcmh01") ranges from 44.6 m^2 in Romania to 141.4 m^2 in Cyprus. The household energy consumption is positively correlated with the size of the dwelling, being slightly less than 0.25. No correlation is found between the size of the household and the size of the dwelling.

Energy consumption decreases not only in total, but also at the household level. Figure 47 shows the relative change, comparing consumption per household for 2008 and 2013. In Bulgaria, Romania and Poland, energy consumption increased, but was still below 10%. In the Czech Republic, the Netherlands, Austria and Finland energy consumption slightly increased. In the majority of countries, however, energy consumption at the household level decreased. Decreases of more than 20% are observed in Malta, Portugal, Greece, Cyprus and Luxembourg. The large decrease in Cyprus should be interpreted with care, however, since for Cyprus we consider the development between 2008 and

2011, due to limited data availability. Knowing from the analysis of total consumption (Figure 45) that overall energy consumption was lowest in 2011, this might also hold for Cyprus and explain why the observed decrease is of such high magnitude.

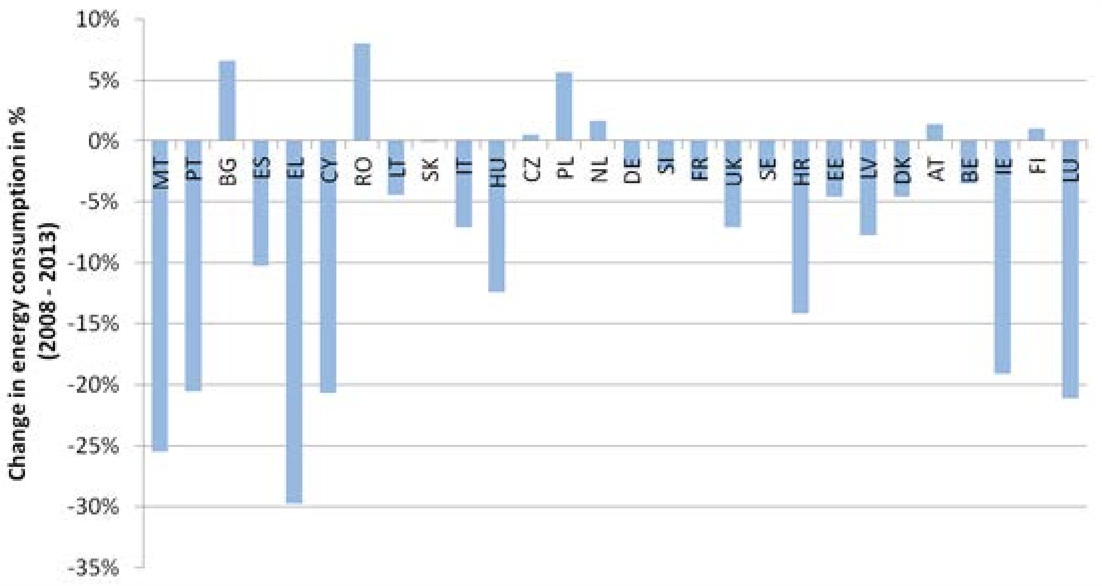

Figure 47: Change in energy consumption per household in % (2008-2013*) (Data: ODYSEE-MURE) [13]

4.2 Evolution of total energy expenditure of the residential sector

Total household expenditure on energy (COICOP 4.5) is estimated from the sum of the products of the prices of the different energy carriers and their reported consumption. All calculations are performed per household, making the analysis comparable across countries of different size.

$$Household\ expenditure\ on\ Energy\ (excl.transport) = \sum p_{energy\ carrier} * q_{energy\ carrier}$$

The energy carriers included are electricity, gas, heating oil, wood, heat[14] and coal. Figure 48 displays household expenditure in Euro, ordered by the mean expenditure over all years that are

[13] *Due to limited data availability, consumption in Malta is compared between 2008 and 2012 and in Cyprus between 2008 and 2011, respectively.

[14] Prices for heat are only available for a selected number of countries. No price data was available for Belgium, Cyprus, Greece, Spain, Ireland, Italy, Luxembourg, the Netherlands, Portugal and the UK. In most of these countries heat consumption per household was rather low, an exception being the Netherlands where it is between 330 and 425 kWh/household. For most countries prices are public available for 2009 and 2011. Prices for all other years have been estimated based on growth rates of the other energy carriers. Moreover, based on the

available. Household expenditures vary considerably across Member States. The overall expenditures on energy products (without fuel for personal transport) per household are highest in Ireland, Sweden and Denmark. The lowest expenditures are observed in Bulgaria, Romania and Lithuania. These orderings do not correspond directly to the consumption displayed in Figure 46.

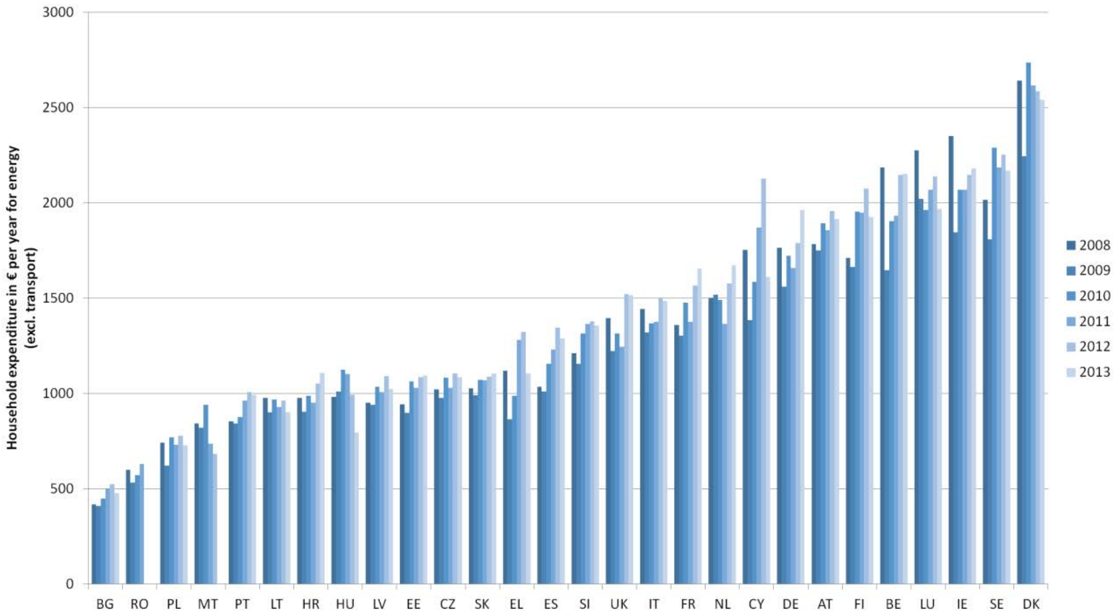

Figure 48: Household expenditure in € per year for energy (excl. transport energy) (Data: ODYSEE-MURE, Eurostat, BP, FOEX, Euroheat, Weekly Oil Bulletin)

Except for a few countries, energy expenditures have increased between 2008 and 2013, in many countries, this increase has been substantial. Figure 49 displays the percentage change over the same time horizon, comparing the energy expenditure per household in the latest observation in 2013 and the observation in the base year 2008.

Countries in which energy expenditure have decreased are notably those countries in which the highest average expenditure was observed over the considered time horizon. Exceptions are Malta, Lithuania, Hungary and Sweden. In ten Member States, household energy expenditures have increased by 10% or more from 2008 to 2013. In Spain and France, the expenditures have increased by more than 20%.

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data from Euroheat it is not clear for which data the reported prices are including taxes. We will treat the reported and estimated prices as if they were including taxes.

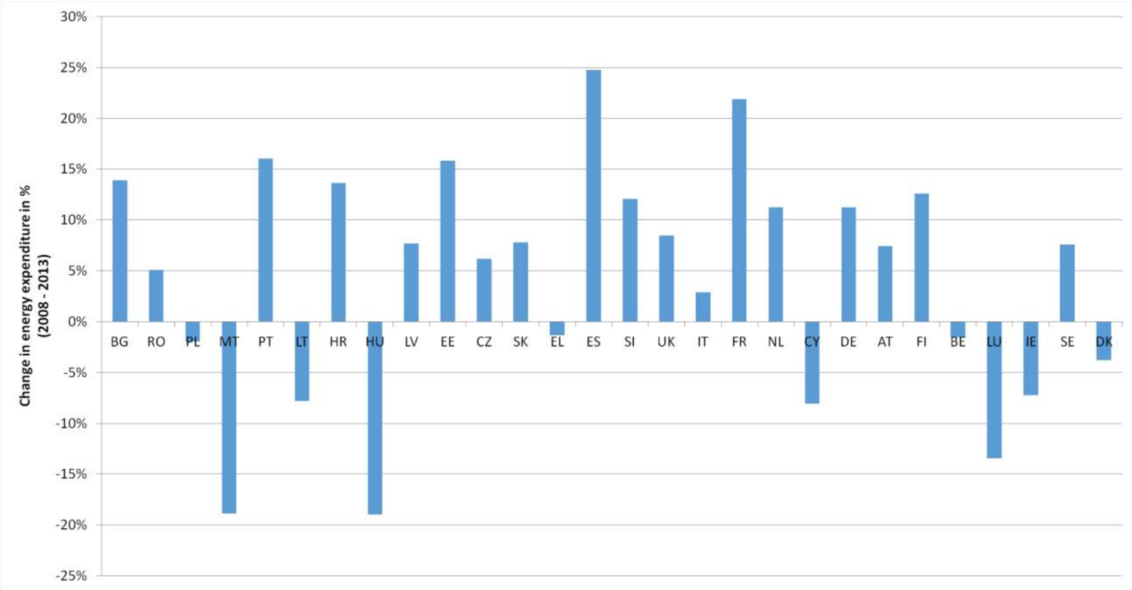

Figure 49: Change in energy expenditure in %, 2008-2013 (Data: ODYSEE-MURE, Eurostat, BP, FOEX, Euroheat, Weekly Oil Bulletin)

4.3 Evolution of expenditures per energy carrier

The numbers for total energy expenditures include values for different energy carriers. Energy consumption structures differ considerably across Member States. Figure 50 shows the different importance of energy carriers in the consumption structure across all Member States. The numbers for Malta, Cyprus and Portugal have to be interpreted with care, as there is a lack of data on consumption of specific energy carriers.

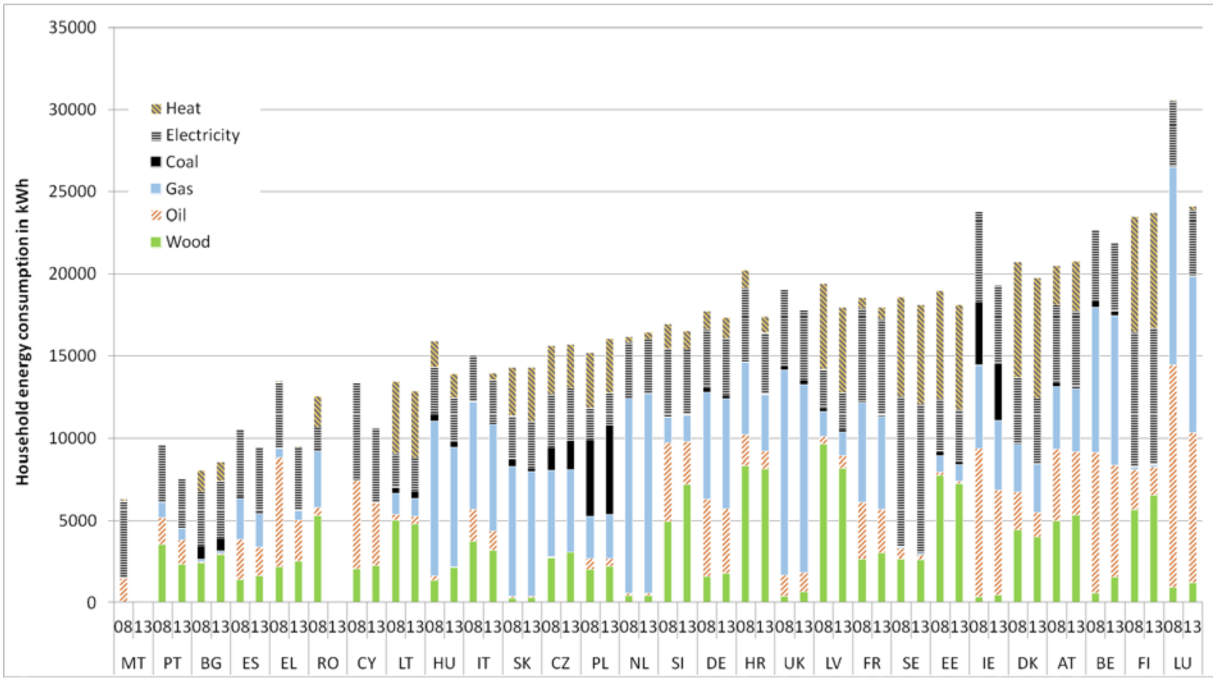

Figure 50: Energy consumption per household by energy carrier in kWh in 2008 and 2013[15] (data: ODYSEE-MURE)

There are no fundamental changes in the structure of energy consumption observable when comparing consumption in 2013 to consumption in 2008. This observation is not surprising, considering that the structure is largely determined by the stock of energy-using appliances and heating technologies, which have long lifetimes.

The corresponding expenditures vary widely across Member States. The non-weighted (simple) average share of energy expenditure on electricity (out of overall spending on household energy), over the time from 2008 to 2013, as well as over all Member States is 49%, whereas its minimum share is 32% (in Romania). The average is probably biased upwards by the countries where we have a lack of data (in particular Finland, Malta and Cyprus) on gas expenditures. Figure 51 shows the average expenditure per energy carrier and household for all 28 EU-Member States, comparing 2008 with 2013.

[15] There are missing data on consumption as listed in Annex 3.

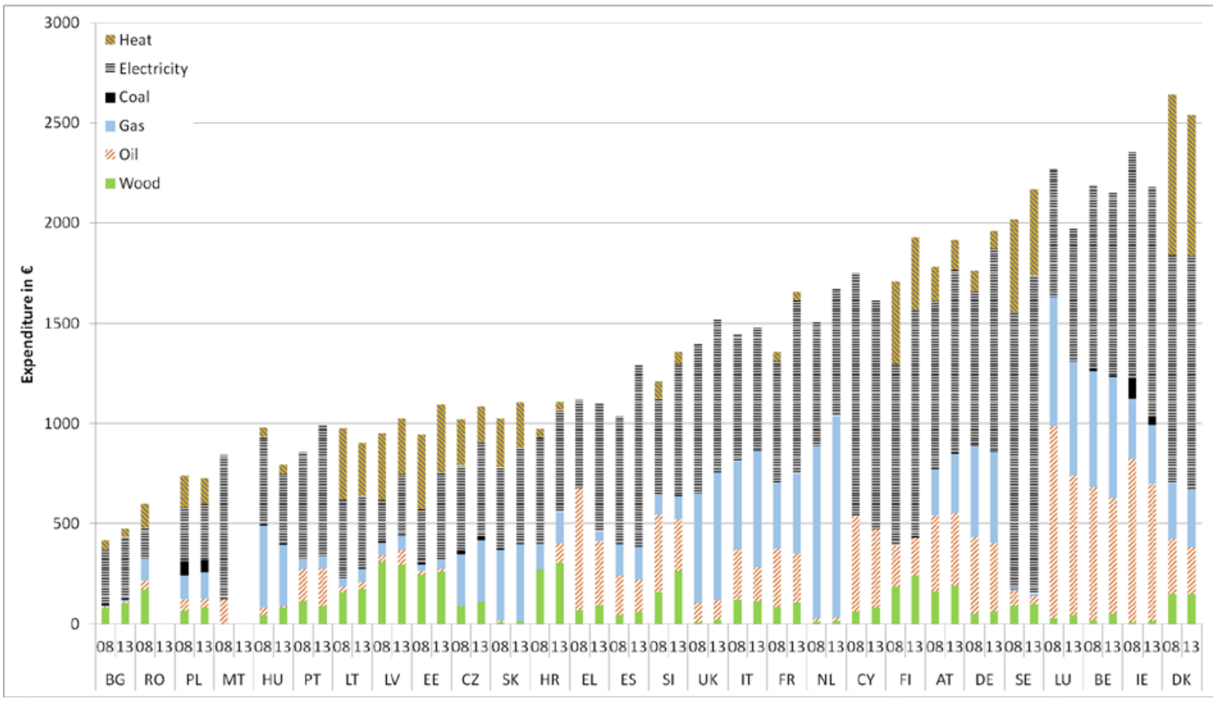

Figure 51: Energy expenditure by energy carrier, in 2008 and 2013 (Data: ODYSEE-MURE, Eurostat, BP, FOEX, Euroheat, Weekly Oil Bulletin)

The example of Luxembourg shows that households with a high total energy consumption are not necessarily showing the highest energy expenditure. There are two important additional factors: the structure of consumption and the price per energy carrier. Figure 52 combines information about the patterns in energy consumption and energy expenditures.

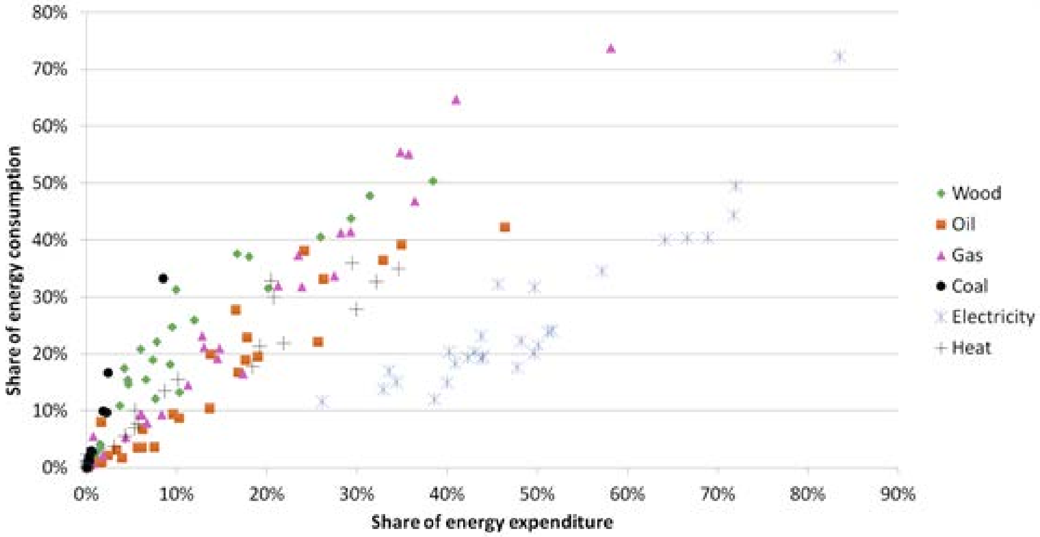

Figure 52: Share of energy consumption and energy expenditure of the different energy carriers (average over 2008-2013), (Data: ODYSEE-MURE, Eurostat, BP, FOEX, Euroheat, Weekly Oil Bulletin) [16]

Data points are not scattered around the 45-degree line, which would indicate that the share in expenditure is mainly determined by the share of consumption. It appears that electricity is the most expensive form of energy, as lower consumption shares are associated with a higher share of the overall energy expenditure. This is, however, not surprising, as electricity is a secondary energy carrier and therefore, a higher form of energy, thus we cannot easily compare kWh of oil, wood, or gas with kWh of electricity. Still, this shows that – at current prices – private households would typically benefit relatively more from efficiency gains in electricity use (e.g. from adopting energy efficient appliances) than from the same percentage of savings in the use of other fuels. In addition, households may gain from substituting electricity with relatively cheaper energy carriers.

4.4 Consumption and expenditure on transport energy

The availability of data regarding households' energy consumption for transportation and the associated expenditures varies considerably between the Member States. To ensure a consistent approach, the expenditures on energy for transport are estimated for this project. To this end, data from the harmonized index of consumer prices (HICP) is used[17]. From the HICP we can obtain the share of expenditures (an index out of 100) that is devoted to, among other things, electricity and energy for transport (COICOP 07.2.2.) Thus, first the ratio of expenditure on transport related energy to the expenditure on electricity (COICOP 04.5.1) is calculated from the HICP. This ratio is multiplied

[16] Since there are some missing data points might be over-/underestimated.

[17] The Eurostat data-set "prc_hicp_inw" includes a COICOP category "Fuels and lubricants for personal transport equipment, which was used for the purpose of this study.

with the estimated household expenditure on electricity to obtain an estimation of the household expenditure on transport energy.

$$Expenditure\ transport\ energy \approx \frac{\frac{expenditure\ on\ transport\ energy}{total\ expenditures}}{\frac{expenditure\ on\ electricity}{total\ expenditures}} * p_{electricity} * q_{electricity}$$

Figure 53 displays the estimated expenditures. According to these estimations, expenditures on fuels and lubricants for personal transportation are highest in Luxembourg[18] and lowest in Romania. From these figures, it is not clear whether it is price differences or consumption differences which drive the differences in expenditures. Therefore, Figure 54 displays an estimation of the household consumption. The yearly mean of gasoline prices including taxes are used to estimate energy prices here. The correlation between the prices of gasoline and diesel is approximately 87%.

$$Consumption\ of\ transport\ energy \approx \frac{Expenditure\ transport\ energy}{p_{Gasoline}}$$

18 The high per household consumption levels for Luxemburg are striking. To a large extent, this is the result of the relatively low fuel costs at the pump, because taxation of gasoline is relatively low in Luxemburg compared to its neighbouring countries. Thus, owners of commercial, as well as private vehicles from neighbouring countries (or through traffic) find it worthwhile to fill their tanks in Luxemburg. In addition, more than 150.000 people work (and fill their tank) in Luxemburg but live elsewhere. Both effects lead to a statistical increase in transport fuel consumption per household in Luxemburg.

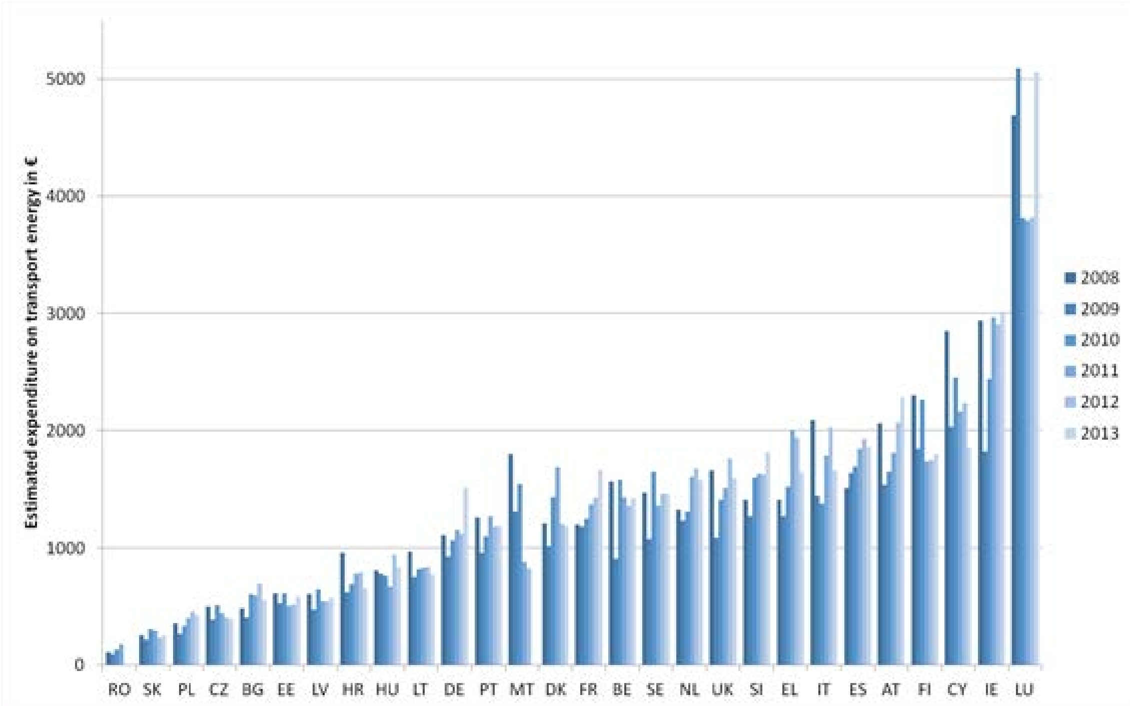

Figure 53: Estimated yearly expenditure in Euro on transport energy per household (Data: ODYSEE-MURE, Eurostat)

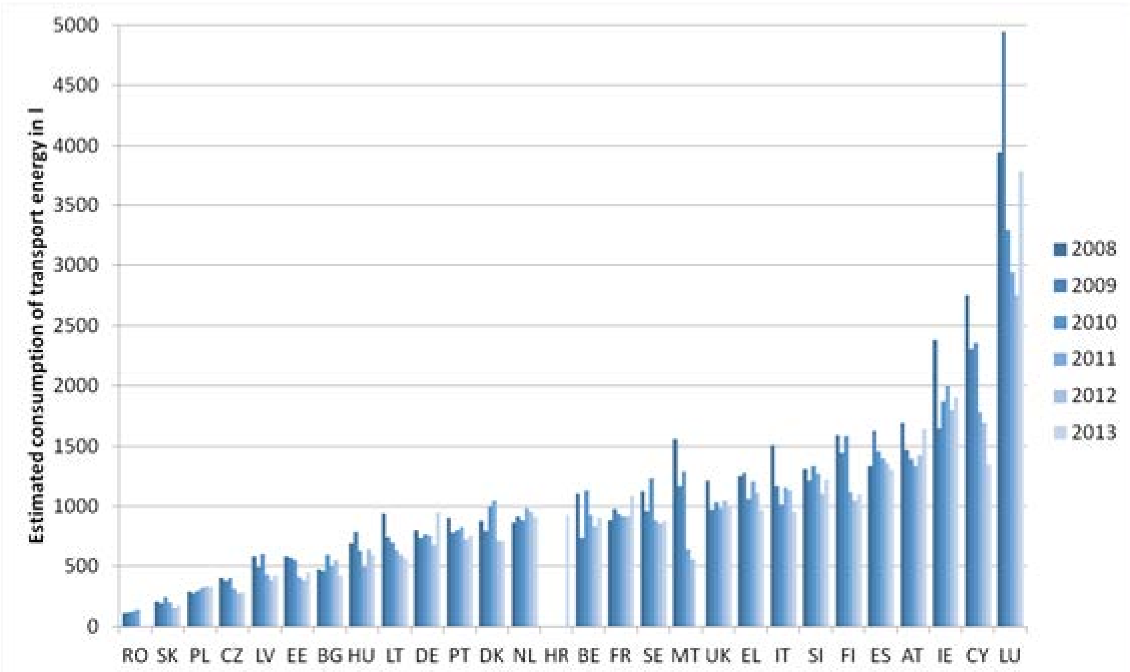

Figure 54: Estimated yearly consumption of transport fuel in l per household (Data: ODYSEE-MURE, Eurostat, Weekly Oil Bulletin)

Combining Figure 53 and Figure 54 suggests that the differences in estimated expenditures on transport fuels and lubricants stem from differences in consumption patterns across the Member States. These can stem from differences in driven kilometres, as well as differences in the energy efficiency of the cars. The development over time is displayed in Figure 55. No clear trends in relation to the level of expenditure or geographical location are observed. Since gasoline prices have increased from 2008 to 2013, these could correspond to the change in the estimated expenditures. However, there are a few countries in which estimated expenditures decreased, while gasoline price increased. There are various reasons, which we cannot distinguish here; the two most important ones are changed consumption pattern and changed efficiency of cars.

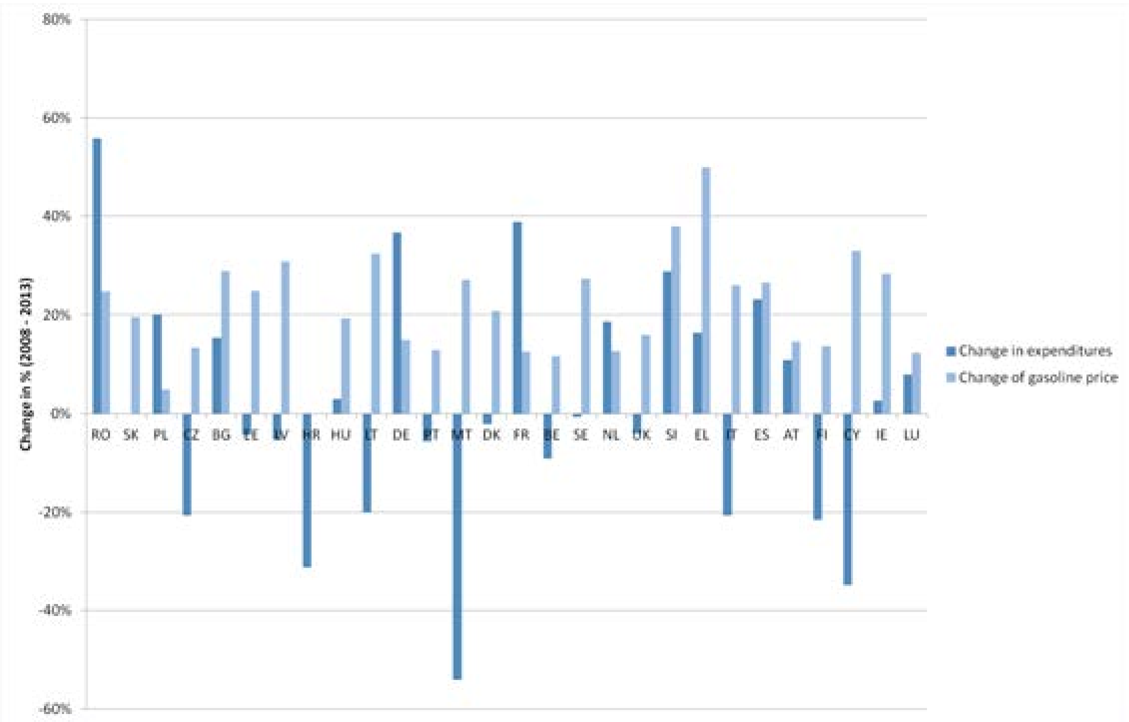

Figure 55: Change in estimated expenditure on transport energy and change of gasoline prices in % (2013-2008), (Data: ODYSEE-MURE, Eurostat, Weekly Oil Bulletin)

4.5 Drivers of energy expenditures

To separate the contribution of price and quantity changes on the observed changes in total energy expenditures over time, decomposition analysis is employed, which isolates the effects of the individual components of energy expenditures, i.e. changes in the prices of the energy carriers (or fuels) and quantities consumed. To this end, following Ang (2005), the (additive) Logarithmic Mean Divisia index is employed. Unlike other decomposition methods, the LMDI provides a perfect decomposition, i.e. the results do not contain an unexplained residual term. To allow for detailed insights, this decomposition analysis is carried out for each energy carrier (or fuel) separately. A short introduction to the method is provided in the following box, a detailed, more formal, description is provided in the second chapter of Annex 3.

Example: Decomposition analysis

*Decomposition is a method of breaking up a variable of interest (e.g. total expenditure E in Section 4.5.) into constituent elements (e.g. fuel price P and fuel consumption C), where the variable of interest is the mathematical product of these components (e.g. Expenditure = Price * Consumption). Decomposition analysis then "explains" the change in the variable of interest over time ($\Delta E = E(1) - E(0)$) as the changes on the components over time, i.e. ΔP and ΔC).*

*Suppose the price P increase from P(0) = 10 to P(1) = 15 and consumption C increases from C(0) = 30 to C(1) = 40. Expenditure E then increases from E(0) = 300 to E(1)= 600, i.e. by 300. But what is the contribution of the change in the price and the change in consumption to this change in expenditures? To explore the effect of the price change, let us hold consumption constant at the initial level of C(0). In this case, expenditures would increase by (15-10)*30 = 150. Similarly, to explore the effect of the consumption change, we hold the price level at P(0). In this case, expenditures would increase by (40-30)*10 = 100. The change in the price then explains half the change in expenditures, and the change in the consumption level explains one third of the change in expenditures.*

However, this composition fails to account for a rest term of 50, i.e. one sixth of the change in expenditure. Most decomposition methods involve such a rest term. The Logarithmic Mean Divisia Index decomposition, which is used in this project, however, does not lead to a rest term and is therefore, preferable to other types of decomposition methods.

4.5.1 Decomposition of expenditures for electricity

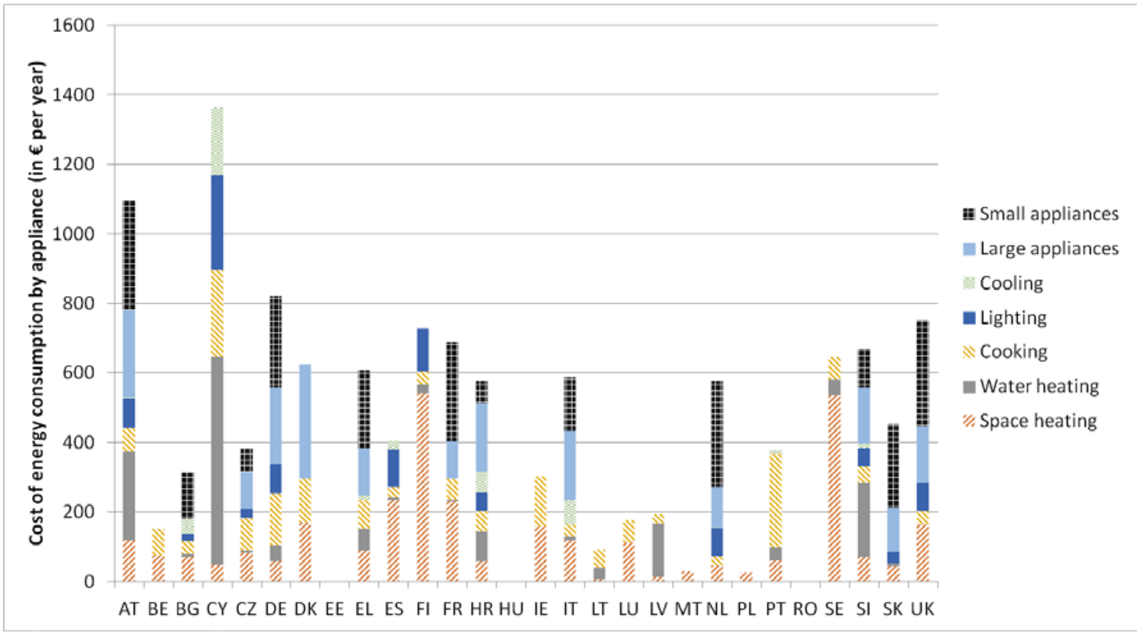

Figure 56: Household spending for electricity, by purpose, year: 2012[19] (Data: ODYSEE-MURE, Eurostat)

Electricity consumption has, in general, a higher share in the household expenditures. Figure 56 shows the shares of the different appliances in those member countries for which the respective information is available in the ODYSEE-MURE database, i.e. zero values have to be interpreted as missing values and not as "no consumption". From this figure, it appears that space heating based on electricity is very common in Finland, Sweden, France, Denmark and the UK. Using electricity to heat water seems to be particular common in Cyprus, Austria, Latvia and Slovenia. Using electricity for cooking appears to be particular pronounced in Cyprus and Portugal. Data on small and large appliances is too limited to detect trends. Moving to the LMDI decomposition of expenditures on electricity, Figure 57 shows the decomposition of the changes in expenditures for electricity for 2013 compared to the base-year 2008 for the EU Member States. For example, an increase in the price of electricity (holding electricity consumption constant) increases the electricity expenditure share, as reflected by a positive bar in Figure 57.

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[19] The year was chosen to find a good balance between recency and completeness of data.

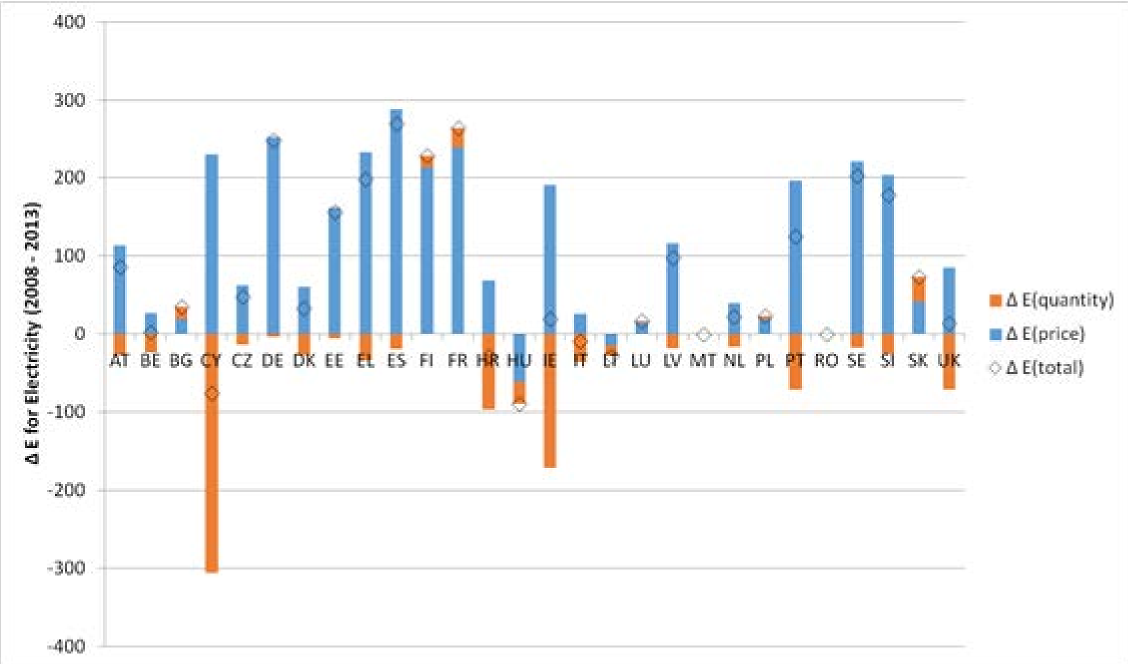

Figure 57: ΔE(price, quantity, total) for electricity, comparison of 2013 with 2008 (Data: ODYSEE-MURE, Eurostat)

The net effect on total energy expenditures is the sum of both bars. For example, if a positive price effect exceeds a negative quantity effect, total expenditures increase. Key insights from the decomposition are:

- *Price effect*: for almost all countries, the electricity price increased between 2008 and 2013, thus leading to an increase in the electricity expenditures. The magnitude of the price effects differs across countries. It was particularly strong (in absolute terms) in Cyprus, Germany, Spain, Finland, France, Greece and Sweden. Only minor price effects could be observed for Belgium, Bulgaria, Italy, Luxembourg, or Poland, for example.
- *Demand effect*: this effect is displayed as ΔE(quantity). The direction of effect is more heterogeneous than for the price effect; for most countries this effect is somewhat smaller in magnitude than the price effect; in most countries the demand effect is negative, i.e. electricity consumption has decreased after 2008. The largest decreases, in absolute terms, are observed in Cyprus, Ireland and Croatia. In Ireland this large decrease seems to be linked to an increase in energy efficiency, which will be briefly discussed in Section 4.9. For Cyprus and Croatia, we lack the respective information from ODYSEE-MURE.

The net effect in most countries is positive, i.e. total expenditures increased over time. The numbers can be interpreted, as real average changes in the household expenditures on electricity. Exceptions in which expenditures decreased, in absolute terms, substantially, are Cyprus, where the negative demand effect was stronger than the positive price effect, and Hungary, where price and quantity effects were negative.

4.5.2 Decomposition of expenditures for gas

Figure 58 shows the decomposition of the changes in expenditures for natural gas for 2013 compared to 2008 for those EU Member States where data was available. Key insights are:

- *Price effect*: in all countries with the exception of Germany and Hungary, the gas price increased between 2008 and 2013. This lead to an increase in the expenditures for gas consumption, but the magnitude of the price effects differs across countries. The increase was strongest (in absolute values) in the United Kingdom, Italy, and the Netherlands, reflecting the relatively large share of natural gas in total household energy consumption in these countries (see Figure 50). Relatively small price effects could be observed for Belgium, Bulgaria, Slovenia, Sweden or Denmark.
- *Demand effect*: the direction of the demand effect is more heterogeneous than for the price effect; a few countries – including Austria, Belgium, Germany, the Netherlands or Poland - exhibit small positive effects, i.e. increases in gas consumption; but most countries saw gas consumption decline, with the strongest negative effects occurring in Hungary, Ireland, Luxembourg and the UK.
- Since the positive price effect tends to dominate in countries where the quantity effect was negative, expenditures for gas increased in most countries. In Luxembourg, the negative quantity effect dominated the positive price effect, leading to lower gas expenditures. Conversely, in Germany, the negative price effect dominated the positive demand effect, thus leading to lower gas expenditures in 2013 compared to the base year. In Hungary both effects were negative and consequently, the total effect was highly negative, i.e. spending on gas decreased a lot from 2008 to 2013.

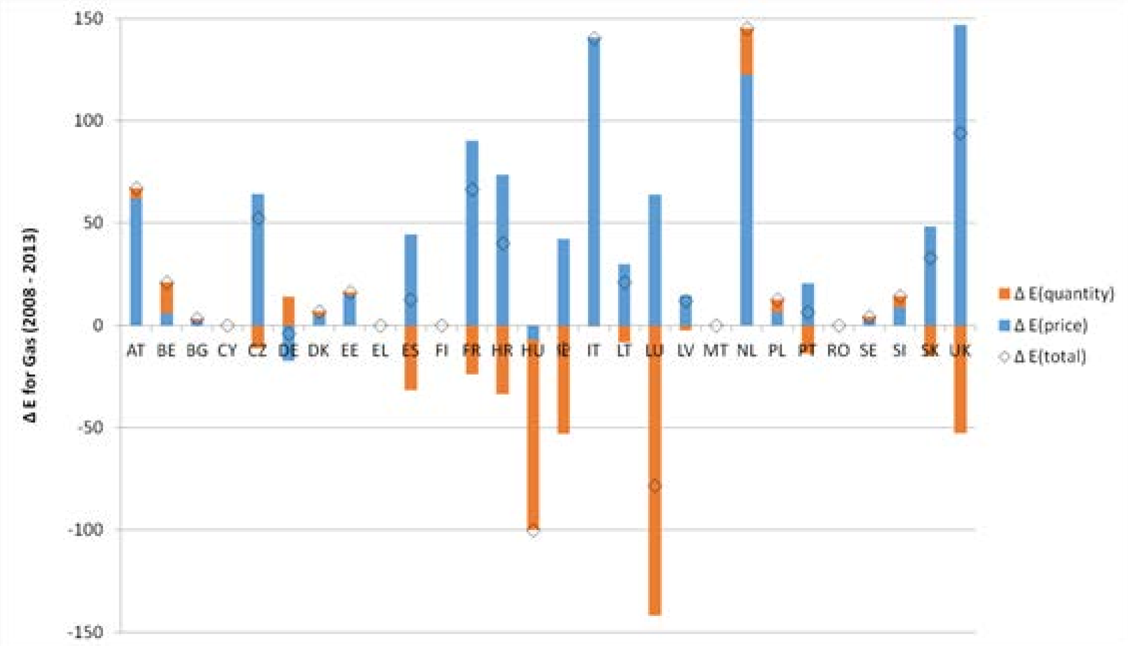

Figure 58: ΔE(price, quantity, total) for gas, comparison of 2013 with 2008 (Data: ODYSEE-MURE, Eurostat)

4.5.3 Decomposition of expenditures for heating oil

Figure 59 shows the decomposition of the changes in expenditures for heating oil, comparing the expenditures in 2013 to those in 2008 for those EU Member States where the data was available. Key insights are:

- *Price effect*: the price effect is positive in all countries; however it is smaller in magnitude than the demand effect, except for Portugal. This indicates that prices for heating oil increased in all countries.
- *Demand effect*: except for Latvia and Lithuania, the demand for heating oil decreased from 2008 to 2013. The demand effect is particularly highly negative in Greece, Ireland, Luxembourg and Slovenia.
- *Net effect: t*he negative demand effect dominates the positive price effect; consequently the overall effect is negative in all countries except for Latvia and Portugal. The remarkably high negative demand effects in Greece, Ireland, Luxembourg and Slovenia lead also to remarkably highly negative net effects.

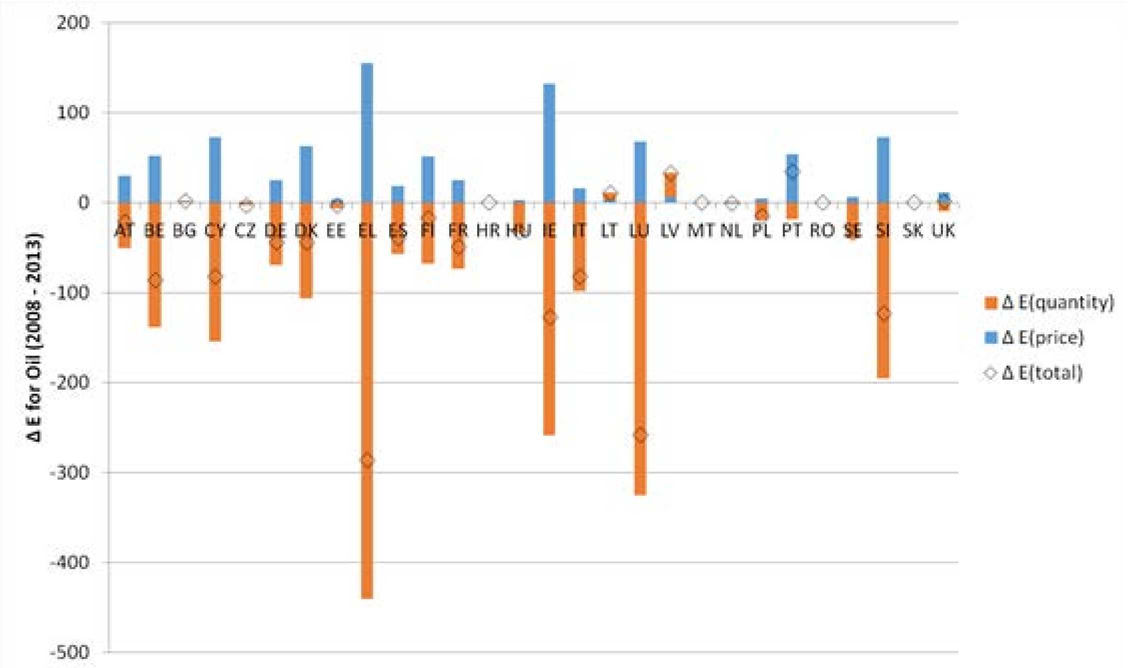

Figure 59: ΔE(price, quantity, total) for heating oil, comparison of 2013 with 2008 (Data: ODYSEE-MURE, Eurostat, Weekly Oil Bulletin)

4.5.4 Decomposition of expenditures for coal

Figure 60 shows the decomposition of the changes in expenditures for coal, comparing the expenditures in 2013 to those in 2008 for EU Member States where the data was available. Note that the pre-tax prices for coal are assumed to be the same for all Member States, differing over time. VAT and excise taxes differ across countries. Key insights are:

- *Price effect*: the price effect is negative in all countries. It corresponds to the decrease in the pre-tax price of coal from 2008 to 2013. In general, the price effect is rather low; exceptions are Ireland and Poland, as coal is an important energy carrier in the respective consumption structures (see also Figure 50).
- *Demand effect:* except for Poland, Lithuania and the Czech Republic, the demand effect is negative, differing in size between the Member States.
- *Net effect*: the expenditures on coal decreased in all Member States, the absolute size of the effect differs across countries. Large decreases can be observed in Ireland and Poland. In Ireland the negative price effect and the negative demand effect lead to a significant negative net effect. The average yearly household spending on coal decreased by almost €60 from 2008 to 2013. In Poland, even though the demand effect is positive, the net effect is negative and slightly more than €10.

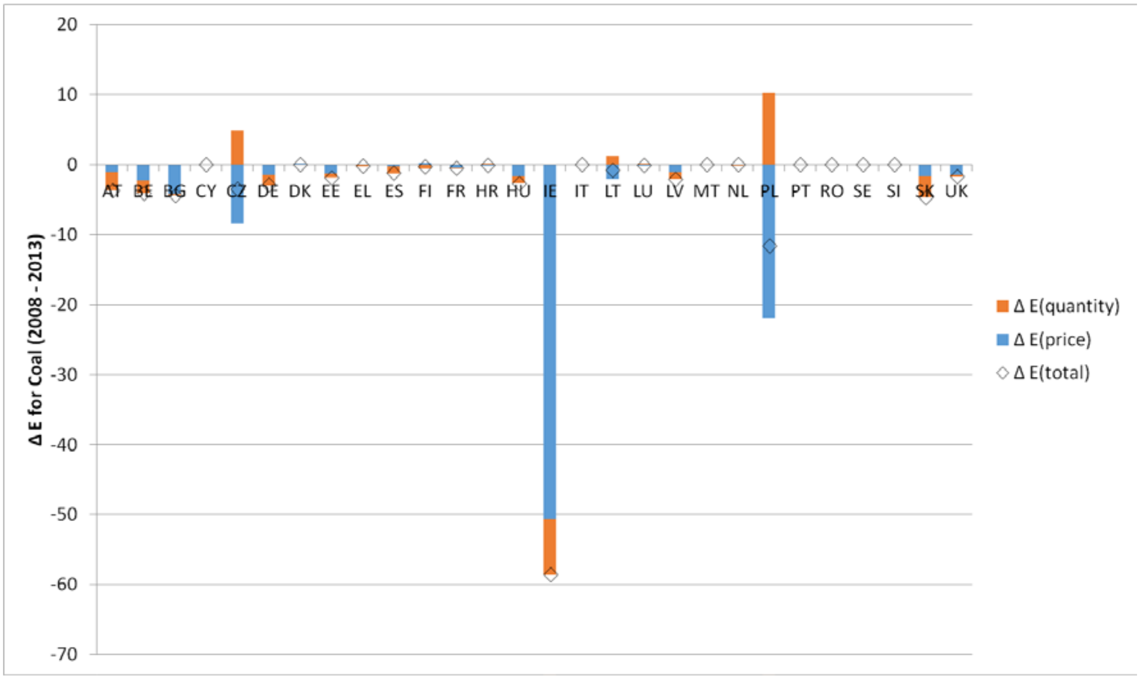

Figure 60: ΔE(price, quantity, total) for coal, comparison of 2013 with 2008 (Data: ODYSEE-MURE, Eurostat, BP)

4.5.5 Decomposition of expenditures for wood

Figure 61 shows the decomposition of the changes in expenditures for wood, comparing the expenditures in 2013 to those in 2008 for EU Member States where the data was available. As with the coal prices, the pre-tax prices of wood are assumed to be the same across Member States, differing over time. Here VAT but no excise taxes are added. Key insights are:

- *Price effect*: pre-tax prices increased slightly from 2008 to 2013, leading to positive price effects across all countries. Remarkably high increases are observed in Croatia, Estonia, Finland, Slovenia and Latvia, which seems to be the result of an increase in the VAT combined with high consumption levels of wood. In Croatia, Latvia and Slovenia the VAT increased by three percentage points, in Finland and Estonia by two percentage points.
- *Demand effect*: The consumed quantities increased, except for Denmark, Estonia, Croatia, Italy, Lithuania, Latvia and Portugal. A remarkable increase in consumption is observed in Slovenia.
- *Net effect*: Except for Italy, the net effect is positive for Latvia and Portugal, i.e. household expenditures on wood increased. The huge demand effect in Slovenia together with the high price effect leads to an exceptionally high net effect in Slovenia. While the size of the effect is lower than in Slovenia, household expenditure on wood increased largely also in Finland.

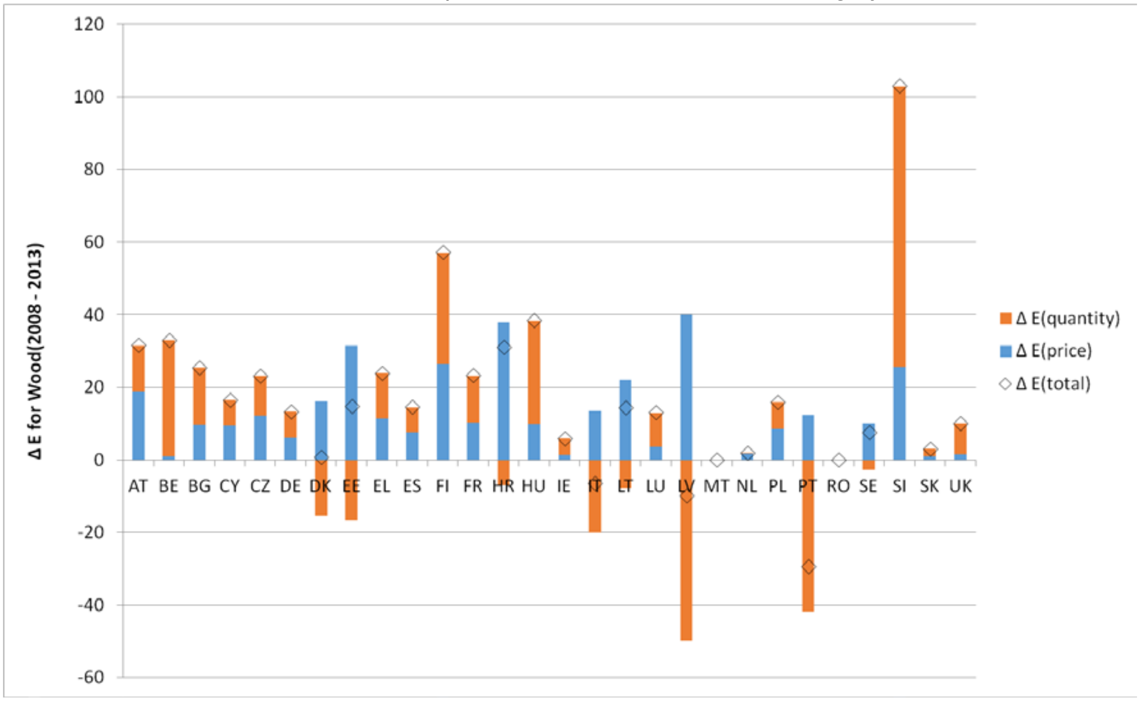

Figure 61: ΔE(price, quantity, total) for wood, comparison of 2013 with 2008 (Data: ODYSEE-MURE, Eurostat, FOEX)

4.6 Importance of energy products and affordability

The share of energy expenditure of the income can be interpreted as an indicator for affordability. Hence, analysing the effects of changes in the individual factors on this share provides insights into what is driving observed changes in the income share of energy expenditures. For example, fuel prices and fuel consumption may have increased over time, but if income has increased even more, the income share of fuel expenditures will have declined, suggesting an improvement in affordability.

To separate the contribution of individual factors to changes in the energy expenditure share of income, this section offers a decomposition analysis for the individual components of the income share of energy expenditures, using again the LMDI method. The LMDI decomposes the change in the share of energy expenditure over time into three components: price changes, changes in the quantity of fuel consumed, and changes in income. For an introduction to the method of LMDI, see Section 4.5; for a more formal overview, see the second half of Annex 3.

The following results are derived for the income expenditure share of individual energy carriers for countries where all respective data is available. Countries with missing data is reported but no bars are displayed.

4.6.1 Decomposition of the income share spent on electricity

The share of expenditures out of the household income in 2013 is compared to those in the base-year 2008. The bars in Figure 62 show the relative impact for each of the factors (price, consumption, income) on electricity expenditure share. For example, an increase in income lowers the electricity expenditure share, leading to a negative bar in Figure 62 ($\Delta S(\text{Income})<0$). The net effect is depicted by the change in total ($\Delta S(\text{Total})$). This value corresponds to the real change in the expenditure share. For example, in Bulgaria, the share of electricity expenditures out of the household income decreased from 12% to 10% which corresponds to a decrease by two percentage points.

- *Price effect*: for most countries, electricity price increased, thus leading to an increase in the electricity income share, but the magnitude of effects differs across countries. For about half of the countries, the increase in electricity price is the dominating effect, leading to an increase in the income share of electricity expenditures;
- *Demand effect:* the direction of effect is more heterogeneous than for the price effect; for most countries the output effect is smaller in magnitude than the price or the income effect;
- *Income effect:* for most countries, an increase in income led to a decrease in the electricity income expenditure share (but not Spain, Ireland, Latvia and the UK); for about half of the countries, the income effect is dominating the other effects, leading to a decrease in the share of income spent on electricity. This effect is very pronounced in the new Member States like Bulgaria, the Czech Republic and Slovakia.

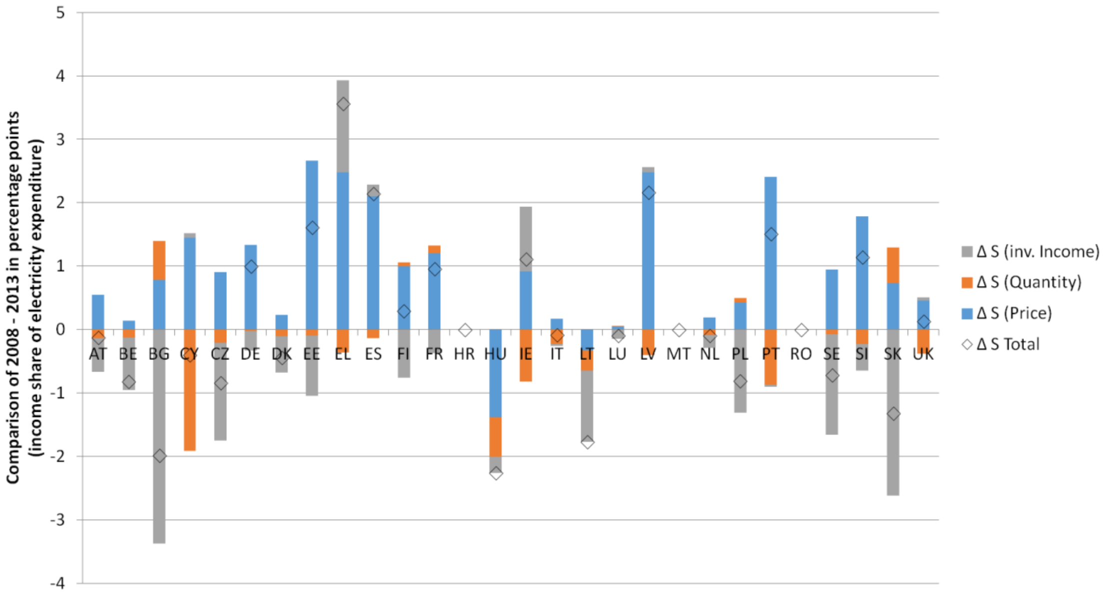

Figure 62: ΔS (price, quantity and income) in percentage points for electricity, comparison of 2008 with 2013 (Data: ODYSEE-MURE, Eurostat)

4.6.2 Decomposition of the income share spent on gas

For the decomposition of the gas expenditure income share, we observe the following:

- *Price effect*: for most countries (but not Germany and Hungary, see section 2.2), the natural gas price increased from 2008 to 2013. This leads to an increase in the income share of gas expenditures, but the magnitude of effects differs substantially across countries and is particularly high for the Czech Republic, for Italy, for Slovakia and for the United Kingdom. The increase in the gas price is the dominating effect in many countries, including Austria, Italy, the Netherlands, and Lithuania, leading to an increase in the income share of gas expenditures;
- *Output effect*: similar to the electricity price, the direction of the output effect for gas is more heterogeneous than for the price effect; for most countries the output effect is smaller in magnitude than the price effect or the income effects, an exception being Hungary where consumption declined heavily;
- *Income effect*: for most countries (but not the United Kingdom and Ireland), an increase in income led to a decrease in the income share of gas expenditures; for a few countries, in particular new Member States like the Czech Republic and Slovakia, the income effect is dominating the other effects, thus leading to a substantial decrease in the gas expenditure share of income.

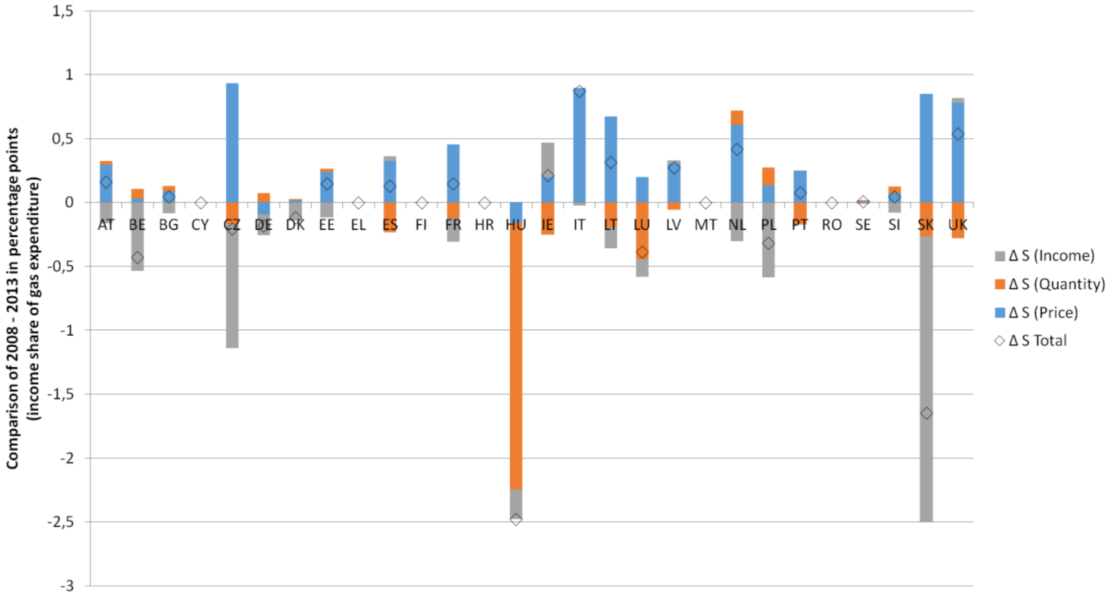

Figure 63: ΔS (price, quantity and income) for gas, comparison of 2008 with 2013 (Data: ODYSEE-MURE, Eurostat)

4.6.3 Decomposition of the income share spent on oil products

For the decomposition of the oil expenditure income share, we first observe that the changes are smaller than for other energy carriers, which is not surprising, since the income share spent on oil is lower than that spent on e.g. electricity. From the data presented in Figure 64, we observe the following:

- *Price effect*: the price effect is positive in all Member States, it is remarkably high in Ireland, Portugal and Slovenia.
- *Demand effect:* the demand effect is negative in all countries, except for Bulgaria, Latvia and Lithuania. The biggest decreases are observed in Slovenia, Ireland, Luxembourg and Cyprus.
- *Income effect:* as discussed before, incomes decreased in a few selected countries, which leads to the income effect to be, in general, negative, i.e. the share of expenditures on oil decreased, as household incomes increased. In most countries, the income dominates the other two effects, leading to negative net effects.

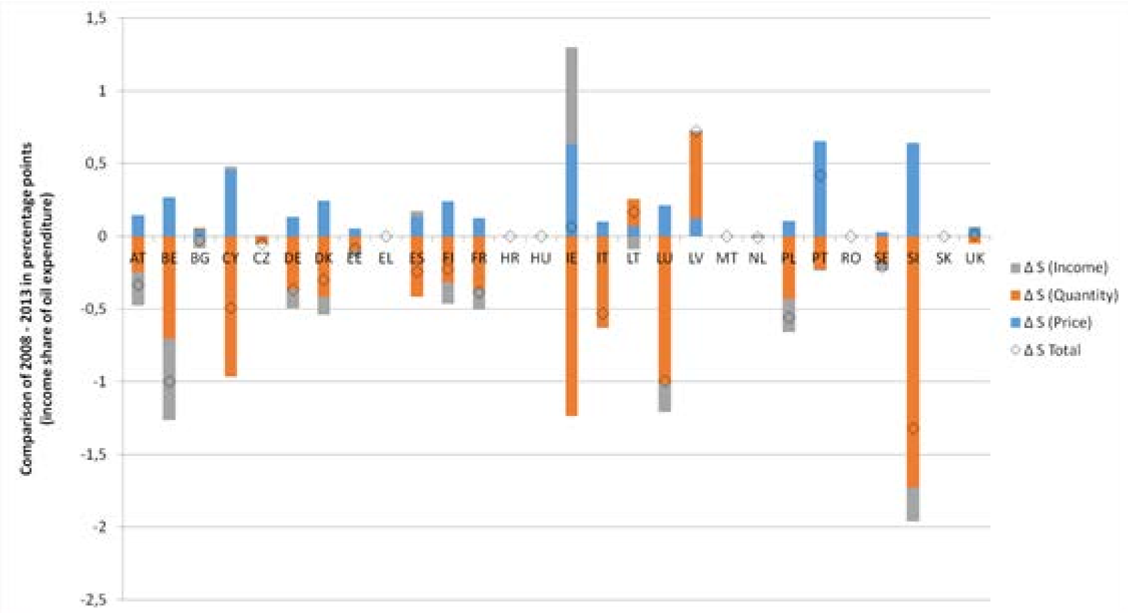

Figure 64: ΔS(price, quantity and income) for heating oil, comparison of 2008 with 2013 (Data: ODYSEE-MURE, Eurostat, Weekly Oil Bulletin)

4.6.4 Decomposition of the income share spent on coal

For the decomposition of the coal expenditure income share, we observe that the importance of coal in the consumption and expenditure differs widely between countries. For most countries, its importance is limited, which is why we do not observe large bars in Figure 65. In addition we observe that:

- *Price effect*: the price effect is negative, i.e. coal prices decreased and thereby contributed to a decreasing share of household income being spent on coal.
- *Demand effect*: except for the Czech Republic, Lithuania and Poland the demand effect is negative.
- *Income effect*: except for Ireland no significant positive income effect (the household income decreased and a larger share of it is spent on coal) is observed. Net effects are negative across all countries.

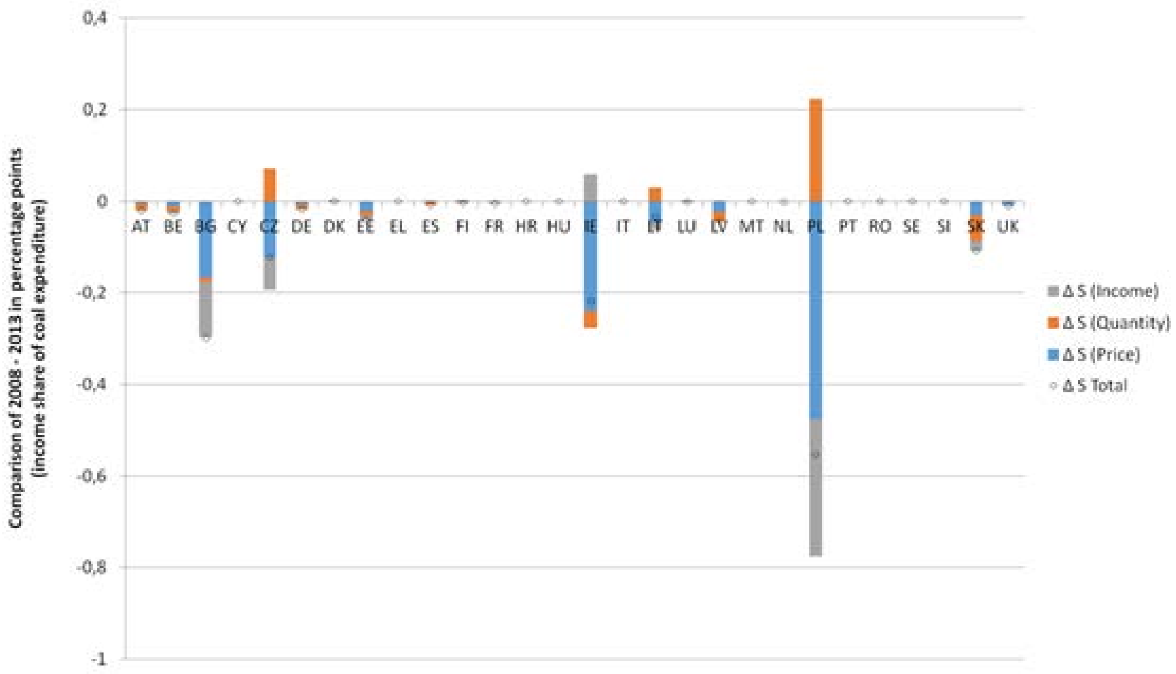

Figure 65: ΔS (price, quantity and income) for coal, comparison of 2008 with 2013 (Data: ODYSEE-MURE, Eurostat, BP)

4.6.5 Decomposition of the income share spent on wood

For the decomposition of the wood expenditure income share, we observe that the pattern observed in Figure 66 is more diverse than the pattern discussed for the expenditures on coal.

- *Price effect*: the price effect is positive across all countries.
- *Demand effect*: Bulgarian and Slovakian data shows a relatively large demand effect. Relatively large negative demand effects are observed in Latvia and Portugal.
- *Income effect*: the largest (negative) income effects are observed in Bulgaria, Estonia and Lithuania. In these countries they dominate the other effects and lead to negative net effects. In general, there is no clear trend with respect to the net effect.

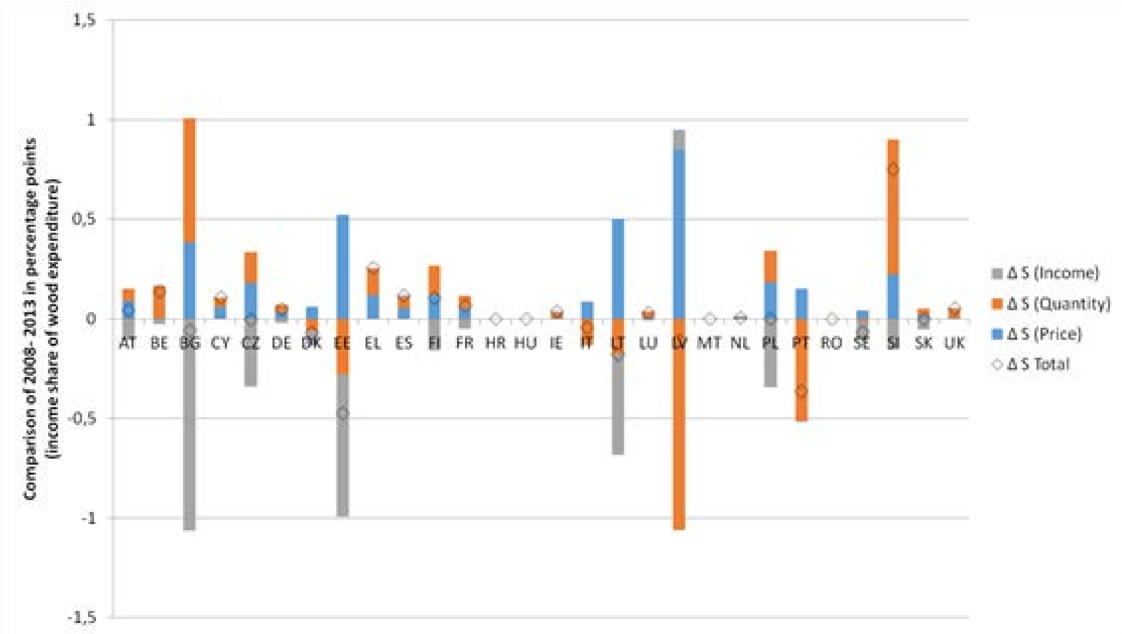

Figure 66: ΔS(price, quantity and income) for wood, comparison of 2008 with 2013 (Data: ODYSEE-MURE, Eurostat, FOEX)

4.7 Energy expenditures (excl. transport) in relation to income

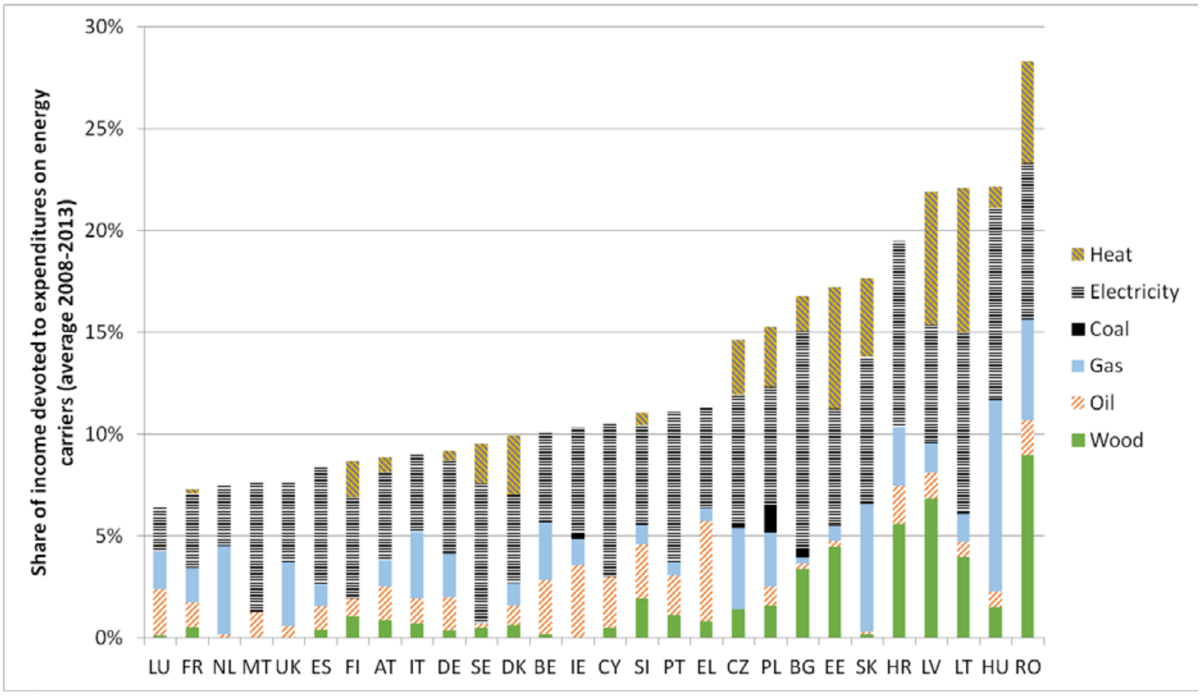

Figure 67: Share of income devoted to energy expenditures, by energy carrier (average over 2008-2013, data: ODYSEE-MURE, Eurostat, FOEX, Weekly Oil Bulletin, BP, Euroheat) [20]

Figure 67 corresponds to Figure 48, where we displayed absolute energy expenditures in Euro. Now the expenditures are placed in relation to the household income and a completely different ordering of countries emerges, even though it is not simply reversed. The share of income that is devoted to energy products is between 6% in Luxembourg and reaching higher to about 28% in Romania. The share is less than 15% in most of the countries and less than 10% in about half of the Member States. Figure 67 displays the average over all data points available. Figure 68 shows the change in the shares between 2013 and 2008 in percentage points. The countries are ordered by the net effect. We observe that in about half the countries the share decreased during the considered time-period. Recalling that energy spending increased in most of the countries (Figure 46) this decrease can only be attributed to an increase in income during this time, which we also discussed above. However, this is only true for half of the countries. The other half of Member States experienced higher shares of income being spent on energy, especially in Latvia, Greece, Spain and Portugal.

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[20] When data was not available, an average over the available data was taken.

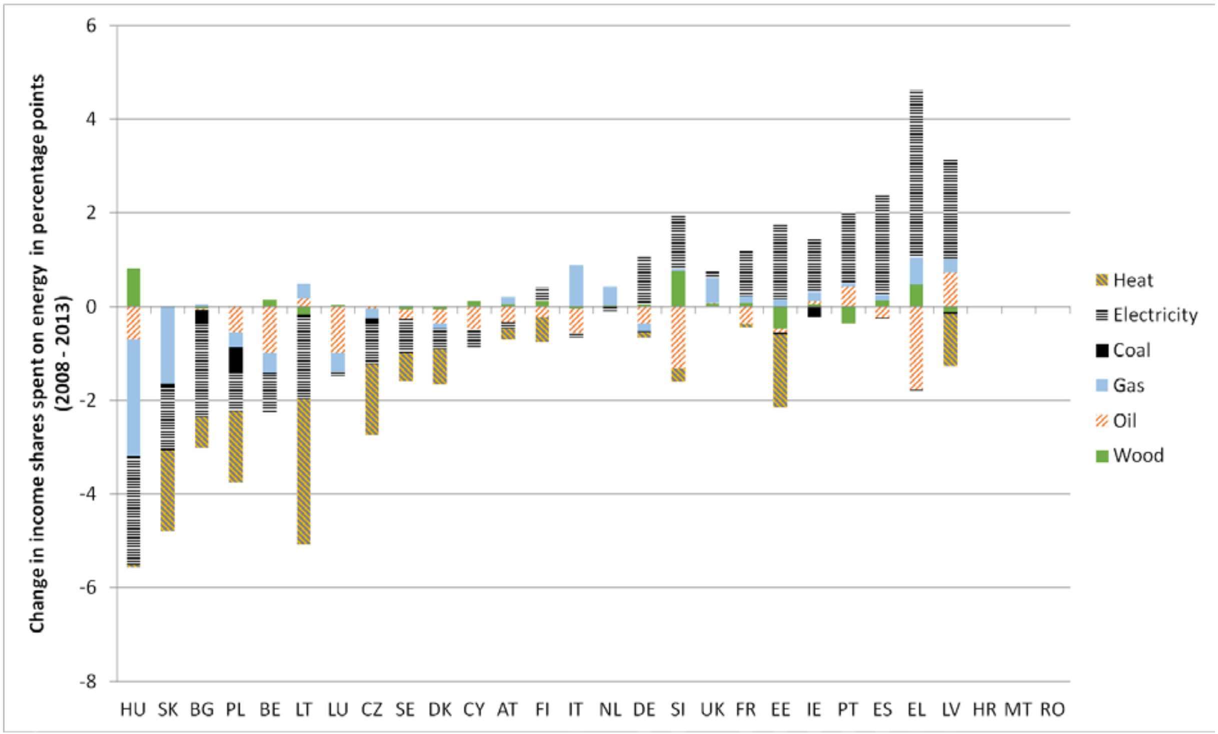

Figure 68: Change in income shares spent on energy (2013-2008), (Data: ODYSEE-MURE, Eurostat, FOEX, Weekly Oil Bulletin, BP, Euroheat)

4.8 Impact of taxes on household expenditures (excl. transport)

Energy retail prices for households include several politically induced components. Figure 69 displays a split of household spending on energy products into excise taxes and VAT (at the upper part of the bars) and other supply costs of energy (lower part of the bars). For simplicity, we only consider excise taxes and VAT. Other politically induced prices components are discussed in section 3.4.

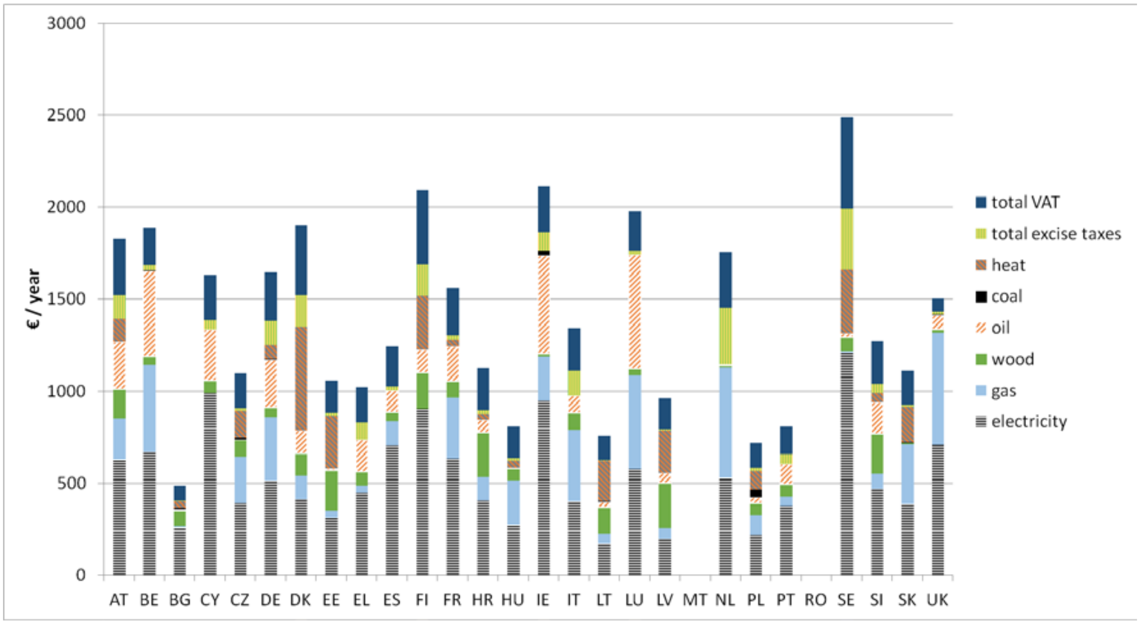

Figure 69: Spending on energy products and related taxes per household (2013) (Data: ODYSEE-MURE, Eurostat, FOEX, Weekly Oil Bulletin, BP, Euroheat)

It is apparent that VAT is the most prominent element of household expenditures. Still, excise taxes are substantial, as is displayed in Figure 69. The country which has the highest pre-tax share is the United Kingdom (93%), the country with the lowest pre-tax share is Denmark, which has at the same time the highest excise-tax component and the second highest VAT-component. The highest VAT-component is observed in Hungary. Figure 70 applies more detailed information about elements in electricity retail prices to the electricity spending per household.

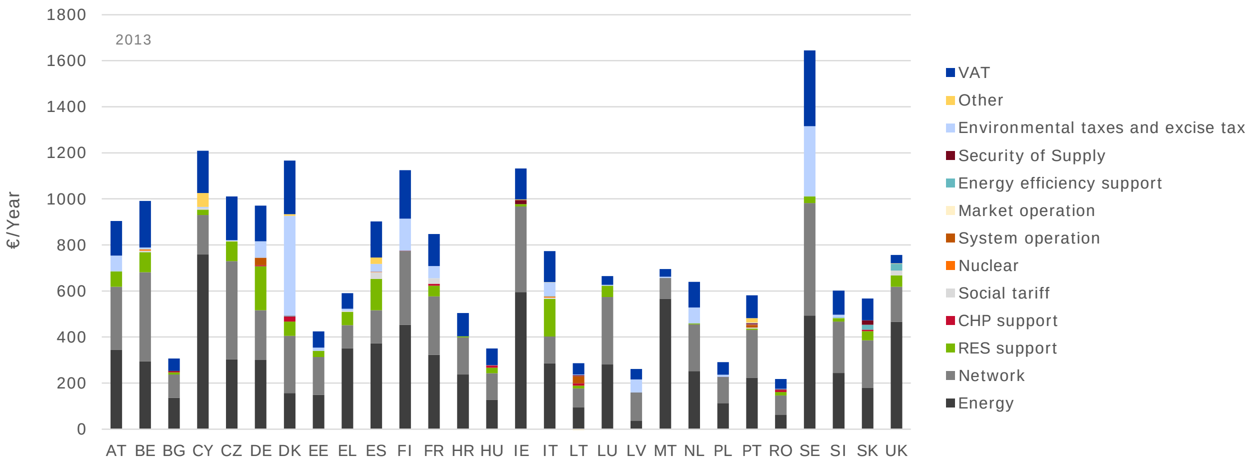

Figure 70: Spending on electricity and related taxes per household (2013)

4.9 Energy efficiency

Household consumption depends on the consumption pattern and the technologies in use. For analysing the effect of energy efficiency, the analysis will follow two different approaches: the first approach relies on a decomposition tool provided in the ODYSEE-database. The second approach compares heating energy across countries as the decomposition tool in ODYSEE is only available for a selected number of countries. Let us start with the comparison of heating energy. To this end the heating energy is calculated per heating degree day and adjusted for the size of the dwelling to be able to make comparisons across countries having a) different thermal conditions and b) different standards of living. The JRC sums heating degree days (HDD) per year. The average size of the dwelling is assumed to be constant across the examined years. Values are available from the SILC ad-hoc module in 2012.

Final consumption of residential space heating is calculated per household. This value is divided by the number of heating degree days. Afterwards this value is divided by the average size of the dwelling. Thus, as an indicator for energy efficiency in residential heating, we employ heating energy use (adjusted for HDD) per square meter which is displayed in Figure 71. From this graphic Croatia, Ireland and Italy are at the upper end of the distribution which means heating and insulation technologies seem to be less efficient than in other Member States. At the lower end of the distribution are Portugal, Sweden and Luxembourg. In most Member States there is a decreasing trend in heating energy suggesting improvements in energy efficiency.

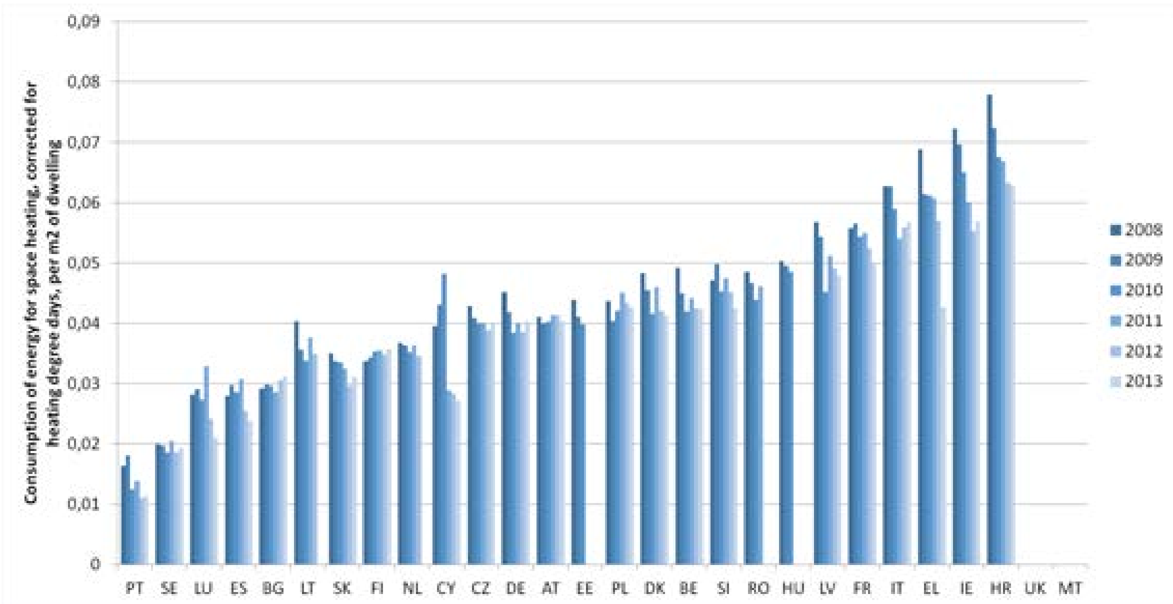

Figure 71: Consumption of space heating corrected for heating degree days, calculated per m2 of dwelling (Data: ODYSEE-MURE, Eurostat, JRC)

Figure 72 is based on the results of the decomposition tool in ODYSEE. The original data is structured such that it is only available for total energy consumption within a country, making it very difficult to compare the separate components across countries. For the analysis below, we divided the values by the average number of households during 2008-2013. The consequence being that effects driven by the number of households cannot be captured in full detail.

The selection of countries is driven purely by the availability of the data[21]. The names of the variables correspond directly to the categories used in the ODYSEE decomposition tool. The first observation is that the climate effect is positive in all countries but Portugal. This corresponds to the higher number of heating degree days in 2013 as compared to 2008. The exact size differs between the countries. The second observation is that "Energy savings", which corresponds to energy efficiency, are negative across all considered countries and the size of the effect is significant and in some countries even dominating. The effect is particularly large in Ireland, Denmark, the Netherlands, Sweden and the UK. The variable "more dwellings" is positive in almost all considered countries indicating an increase in energy consumption facilitated through an increase in dwellings[22]. This effect is strengthened by an increase in the size of homes.

The name of the variable "more appliances per dwelling" is misleading as it also includes heating systems. In those countries where this effect is negative, the size is likely driven by the heating systems. Finally, the variable "other" captures other effects, mainly a change in heating behaviour. The net effect is negative in many countries. In the Netherlands, the Czech Republic and in Poland, the increase in energy consumption per household corresponds to the data presented in Figure 47. In Sweden, Slovenia and Slovakia, the effect is driven by an effect that we cannot account for, increasing number of households from 2008 to 2013 in this analysis.

[21] Austria is not considered here because of reasons of plausibility of data.

[22] In a regular per-household calculation this should not be observable, as explained in the previous paragraph.

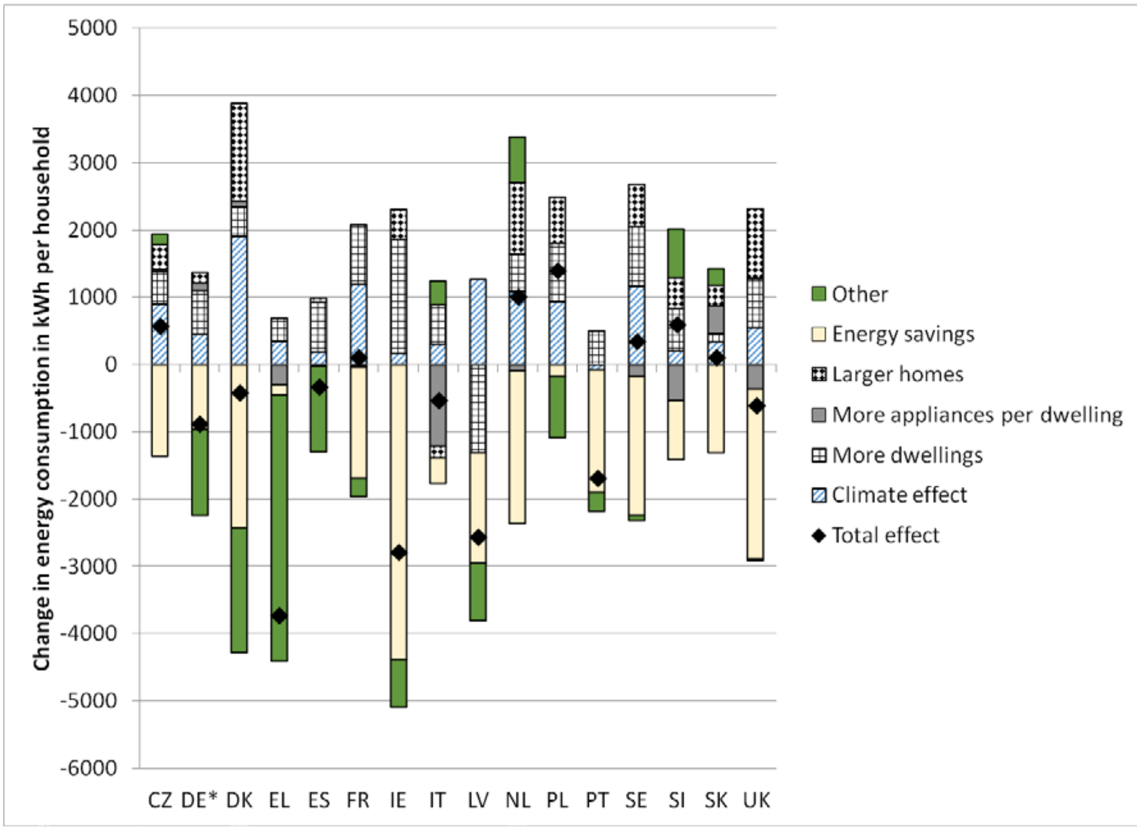

Figure 72: Change in energy consumption in kwh per household between 2008 and 2013 (Data: ODYSEE) [23]

4.10 Social measures on energy consumption support

Some governments define types of consumers, where additional support is needed to limit or reduce energy expenditure for welfare reasons. These can include low income households, but also for example, island populations. There are generally two ways to provide financial support. The first way is to provide social tariffs to the eligible consumers, the second is to give direct energy cost subsidies to those consumers, often through the social security system.

Austria, Belgium, Greece and Malta have specific tax exemptions for eligible households. In Belgium the first 100 kWh/year only cost €7 ct in total. Greece provides lower excise tariffs, €230/1000l instead of €330/1000l, for heating oil in the winter period between October 15 and April 30. Until 2011 it was €21/1000l instead of €412/1000l heating oil. Austria provides a rebate for low income

[23] Note that for Germany the comparison is between 2008 and 2012 as the tool displayed data-inconsistencies for this particular observation.

households in the "Ökostrompauschale" and "Ökostromförderbeitrag" that finances support to renewable energy sources in electricity supply.

In Croatia and Italy, support programs exist for eligible electricity customers and in the UK, Ireland and Romania, there is financial assistance for both electricity and gas customers. Belgium, Bulgaria, and Latvia grant heating support to households with low income, independent from the energy carrier. Eligible households might be defined in different ways, such as based on income, disability, or age. For instance, the winter fuel payment in the United Kingdom is specifically targeted to the elderly, with subsidies for ages over 60 years and higher subsidies for ages over 80 years old. In Cyprus, Latvia and Hungary, the number of children is one factor, in Ireland, there is a special bonus for deserted wives.

Despite the efforts to introduce competition in energy markets and lower prices for consumers, several governments identify a need to regulate prices for consumers that have little choice of suppliers, e.g. households with low income. Price regulation for households is still in place in many countries, especially the Eastern countries that entered the European Union after the process of liberalisation started in European energy markets. Bulgaria, Croatia, Hungary, Latvia, Lithuania, Poland, Romania and Slovakia report price regulation to ACER. An exemption to market liberalisation directives has also been granted to the island states of Malta and Cyprus. But also countries from Central Western Europe, such as France and Denmark, Spain and Portugal, regulate prices for households[24]. For an overview about governmental policies see Section 3.4 and the country descriptions in Annex 1.

[24] WP-11-06 - NATIONAL REPORTS, ACER MMR REPORT, ERGEG (REF:E07-cpr-08-04), ERGEG (E10-CEM-34-03)

5 Energy costs and industrial competitiveness

Expenditure on energy can affect industrial competitiveness. For industries, the cost of energy can range from having only a minor role in the total production cost to playing a much more major role, with energy costs making up 10%, 20% or more of total production cost in some of the most energy intensive industries, such as the cement, metal, chemical and pulp and paper sectors. A change in the domestic energy prices an industry has to pay could have a significant impact on international competitiveness, all else being equal.

In this section we analyse the energy prices, costs and the efficiency of energy use in industry, to provide insight into impacts of price increases on international competitiveness. First, we lay out typical drivers of energy prices for industrial customers and present current electricity and natural gas prices for industrial customers across the EU, split into their main components energy, network and taxes & levies. Second, we introduce the main industry sectors in the EU and their energy consumption and select focus sectors for further analyses. Third, we describe the available data sources and describe the methodology we have adopted and discuss limitations of our analyses. Fourth, we analyse the energy intensity of EU industries and their gross value added. Fifth, we dive deeper into the energy cost of EU industries, their share of total production cost, the importance of energy carriers and perform a sensitivity analysis.

We then evaluate similar data for competitor countries to the EU, especially the US, Japan and China, for which more comprehensive data is available than for many other countries. We compare and analyse relative international energy prices, the energy intensity and then energy cost shares. Finally, we analyse relative profit margins. In doing so we paint a broad picture of the EU industry's international competitiveness, with a focus on identifying the importance of energy prices and the key implications for EU industry and policymakers. This insight is supported by detailed case studies presented in Annex 1.

In line with the rest of this report, the analysis is statistics-based and, therefore, dependent on the data that is available. This data is relatively sparse at the desired level of disaggregation and not available consistently across Member States for different categories. The reader is recommended to be aware of the limitations described in the supporting text and, if interested in specific sector and Member States details, to please refer to the case studies provided as an annex to this report and/or the more comprehensive evaluations of competitiveness made elsewhere.

In this chapter we refer to industries. While industries can include both manufacturing and non-manufacturing industries, i.e. mining and quarrying, and both were considered in the initial scoping, the sector selection has focused on manufacturing industries. Therefore, where the term industry is used, unless otherwise stated this refers only to the manufacturing industry (division C in NACE rev.2).

5.1 Energy prices for EU industries

In the following we will present the main drivers for energy prices of industry players in the EU. A more general description of the drivers of retail energy prices is presented in Section 3. After giving a short overview of the drivers for different price components, we analyse the main components of the electricity and natural gas energy prices on a country level across the Europe.

5.1.1 Drivers of industrial commodity prices

Industrial energy prices depend on a number of factors that differ for each individual company. This section shortly describes the specific drivers of energy commodity prices, the "energy" component in retail prices.

Industries, especially energy intensive industries, can influence the price of energy through their energy **supply strategies**. There are two elements to this: whether the industry chooses to produce all, or part of, the energy itself, and how energy procurement is arranged. Self-production can result in significantly lower prices. For example, in Norway, self-production by aluminium producers using hydropower enabled direct production costs of €6-7 /MWh of electricity[25]. In France, the Exeltium consortium of energy intensive industries negotiated a contract in which companies pay for investments in additional power plants, while receiving low electricity prices[26]. In the gas sector, self-production is much less common, but there are examples. The chemical company BASF, for example, owns a subsidiary that explores gas fields (Wintershall).

For industries that require heat and electricity at the same time, combined heat and power generation facilities have the potential to reduce prices for both forms of energy. For example, it is common for integrated chemical companies to generate electricity on-site. In some chemical processes, and in integrated steel mills, waste gases are often used to fire a thermal electricity generation facility. In the paper industry, biomass waste from paper production is fed into combined heat and power plants.

For the case of electricity, self-supply is not subject to grid fees or to a number of taxes and levies that are added to electricity from the grid. In some countries, support payments for CHP provide additional incentives to co-produce electricity and heat on-site. However, self-supply can require high investment costs, which also have relatively long payback periods. As a result, this strategy is not suitable for all sectors/companies, particularly when access to capital is limited or expensive, as has been the case in recent years. These limitations are especially acute for SMEs that may not have the

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required scale to make the business case for such an investment, and/or have the access to capital and finance that larger firms have.

For procurement of energy from the grid there is a choice of strategies with different arrangements for term length, certainty, investment requirements, etc. Long-term contracts with one or several energy suppliers provide buyers with more certainty about price evolution. The price in these confidential contracts depends on the time of negotiation and the distribution of risks between buyer and supplier. In times of market liberalisation, long-term contracts of more than three years are rare and are expected to be phased out. Trading of "futures" at exchanges provide liquid markets for time horizons of several months and up to three years, depending on region and market area. Spot market trading allows for immediate reaction to price signals putting the full risks on the buyer. Depending on the development of wholesale market prices and risk premiums, energy prices for industrial consumers with long term contracts can differ significantly from energy prices for industrial consumers trading on spot markets.

The value of the energy component in retail prices reported by Eurostat is significantly lower for consumption bands with high yearly consumption (Band IF; Band I5). Big industrial consumers have a better position in negotiations over energy delivery contracts. Procurement costs, e.g. for contract negotiations or own trading departments are distributed over a large amount of energy units.

5.1.2 Drivers of network costs for industrial consumers

Industrial consumers and especially energy intensive industrial companies are often connected to the medium voltage or even high voltage grid. They do not make use of distribution grids, so they do not pay for the usage.

Some processes provide potential for optimisation with regards to network costs and energy prices, e.g. by increasing the full load hours of consumption or cutting peaks in consumption patterns. Tariffs of network operators often include a fixed charge on connected capacity or peak load, and a variable charge for consumption. Most tariffs favour base load consumers that constantly consume electricity and gas at a high level. Consumers with more than 7000 full load hours of consumption can receive specially reduced grid fees, e.g. in Germany and the Netherlands. For small and medium sized enterprises that mainly consume energy in the daytime, the network price component can be close to the same level as the energy component.

In general, large energy intensive users are more often connected to higher grid levels and the applied processes provide more opportunities to flatten their demand profile than small and medium sized companies. Therefore, the statistical values for average network components in energy prices decrease with increasing yearly consumption levels.

5.1.3 Drivers of taxes and levies in industrial energy prices

EU Member States' governments seek to increase the competitiveness of their national industries by limiting the burden of taxes and levies on industrial energy retail prices, within the rules set by the State Aid Guidelines. Taxes and levies differ by sector, by applied process, by total consumption, by level of grid connection, by energy (cost) intensity and by geographical location within the country. Table 5 provides an overview of criteria by which EU Member States differentiate taxes and levies on electricity. Table 6 shows the criteria for taxes and levies on natural gas.

Table 5: Criteria for reductions and exemptions in taxes and levies on electricity

Country	Defined process	Consumption level	Capacity (peak load)	Level of grid connection
Austria	Electricity tax RES			CHP support RES support
Belgium	RES support (W)	Federal contribution surcharge green certificates RES and CHP support (F) Grid connection fee (W)		Electricity tax RES and CHP support (F) Rational use of energy (F) RES support (W) Occupation of public domain (W)
Denmark	Electricity tax CO_2 tax	Electricity tax CO_2 tax Electricity distribution contribution		
Estonia	Electricity tax			
Finland	Excise duty		Excise duty	
France		Regional and municipality taxes	National, regional and municipality taxes	Social tariff payments
Germany	Electricity tax	Offshore levy Grid fee compensation levy CHP support RES support Concession fee		
Greece	PSO	RES support Public Service Obligation		Electricity tax RES support Public Service Obligation
Ireland	Electricity tax		PSO	
Italy	All levies	All levies Excise duty	All levies	All levies
Lithuania	Excise duty			
Luxembourg	Energy tax	Energy consumption tax		Compensation
Netherlands		RES support Excise duty		
Poland		Security of Supply		Security of Supply
Portugal		Access tariff		Access tariff
Slovakia	Excise duty			
Slovenia	RES and CHP support		RES / CHP support	RES / CHP support
Spain	Electricity tax		Access tariff	Access tariff
Sweden	RES certificates Electricity tax			
United Kingdom		Climate Change Levy		

Energy consumption for defined energy-intensive processes can be exempt from taxes and levies in several countries, i.e. consumption in metallurgical, mineralogical or specific chemical processes. Reasons for these exemptions include protecting competitiveness, due to the limited potential for further energy efficiency gains or changes in energy carriers. Details of these exemptions in each Member State are given in Annex 1.

The rates of many state-regulated energy price elements are graded, stepped or contain fixed base amounts. Thus companies with high consumption levels pay, on average, less per unit of energy. Graded tariffs are often provided for levies, e.g. to support renewable energy sources. In these schemes, consumers pay high tariffs for the first units of electricity consumption and lower tariffs for electricity units exceeding defined thresholds. Austria and France additionally introduced caps in their policies. In this case, payments for energy policy support is fixed to a maximum amount in Euro per company.

Some European Member States apply the same logic to units of capacity. In this case, rates of state-regulated price elements depend on connected capacity or peak load of a year or month. In general, companies with large capacities pay less per unit of energy.

In several European countries, costs for policies are added to the grid fees with differences for consumers connected to the transmission and distribution grids. In Spain and in Portugal, for example, “access tariffs” in electricity include not only the costs for managing the network, but also costs for renewable energy support, and capacity payments. Several other countries, like Italy, Slovenia, Belgium, Greece, and Poland apply specific policy financing tariffs depending on the grid level of connection in electricity.

Table 6: Criteria for reductions and exemptions in taxes and levies on natural gas

Country	Defined process	Consumption level	Level of grid connection
Austria	Gas tax		
Belgium	Gas tax	Federal contribution Grid connection fee (W)	
Bulgaria	Excise duty		
Croatia	Excise duty		
Cyprus			
Czech Republic	Natural gas tax		
Denmark	Natural gas tax Nox tax		
Estonia	Natural gas tax		
Finland			
France	Natural gas tax		Social tariff payments
Germany	Natural gas tax	Concession fee	
Greece	Natural gas tax	Customs tax	
Hungary	Natural gas tax		
Ireland	Carbon tax		
Italy	Excise duty	Excise duty	
Latvia	Excise duty		
Lithuania	Excise duty		
Luxembourg	Excise duty	Energy consumption tax	
Malta	Excise duty		
Netherlands		RES support Excise duty	
Poland	Excise duty		
Portugal	Special tax	Subsoil occupation tax	
Romania	Excise duty		
Slovakia	Excise duty		
Slovenia	Excise duty		
Spain	Hydrocarbons tax		
Sweden	RES certificates Electricity tax Natural gas tax		
United Kingdom	Fuel duty	Smart metering Climate Change Levy	

Some industries are more exposed to international competition than others, so exemptions and tariff reduction schemes from taxes and levies are often tied to sector affiliation, e.g. exemptions or tariff reduction schemes are only open to the manufacturing industries or to companies on the European list of sectors in danger of carbon leakage.

The effect of taxes and levies in electricity is especially high for companies having high electricity costs in comparison to their value added, turnover or net production value. In various regulations, companies that exceed a certain threshold of energy cost intensity are eligible for tariff reductions or compensation. The European state aid guidelines (2014/C 200/01) set specific rules for reductions in energy taxes and levies to finance renewable energy support.

In several countries, there are sector agreements about energy efficiency, e.g. in the UK, in the Netherlands and in the Belgian region Wallonia. Companies that participate in these agreements and verify a defined energy efficiency effort, pay lower excise duties or renewable support levies than companies from other sectors. Some governments reduce taxes and levies for companies that comply with energy efficiency targets. Several countries require companies to install energy management systems in their operation to be eligible for tax reductions or reduced tariffs in levies, e.g. in Germany.

Some of the price elements applied to electricity and gas aim at incentivising low carbon production processes. In particular, CO_2 taxes that put a price on the carbon content of energy carriers are reduced for companies that are covered by the European Emission Trading Scheme, e.g. in Ireland and Sweden. Croatia also reduces the effect of renewable energy support payments on companies that are covered by the EU ETS.

In summary: Depending on all of these characteristics, each industrial entity in Europe is confronted with a different price of energy. The price difference between companies of the same consumption size for the same energy carrier in the same country can exceed 50%. More information on how the different elements apply to different kinds of consumers can be found in Annex 1: Country descriptions.

5.1.4 Electricity prices

Electricity prices for industrial consumers vary broadly over time and within European Member States. Figure 73 provides an overview of electricity prices for industrial consumers that are not eligible for any tariff reduction or compensation scheme. For each element in electricity prices, the maximum tariff for industrial consumers has been applied. For the case of environmental taxes and levies, for example, the price shows the maximum tariff for industrial consumers (which will not generally be the same as that for households).

We assume that the industrial consumer has a minimum consumption of 100 MWh/year. This assumption helps remove statistical anomalies that occur if tariffs are especially high for the first kilo watt hours, or are paid for each point of connection. For the energy and network component, we applied the Eurostat data from table nrg_pc_205_c for Band IB. To enable consistent comparison between Member States, politically induced price elements which have been reported in categories other than taxes and levies in the Eurostat data and for which there is sector specific information, have been re-categorised as taxes and levies based on information from the ad-hoc data collection.

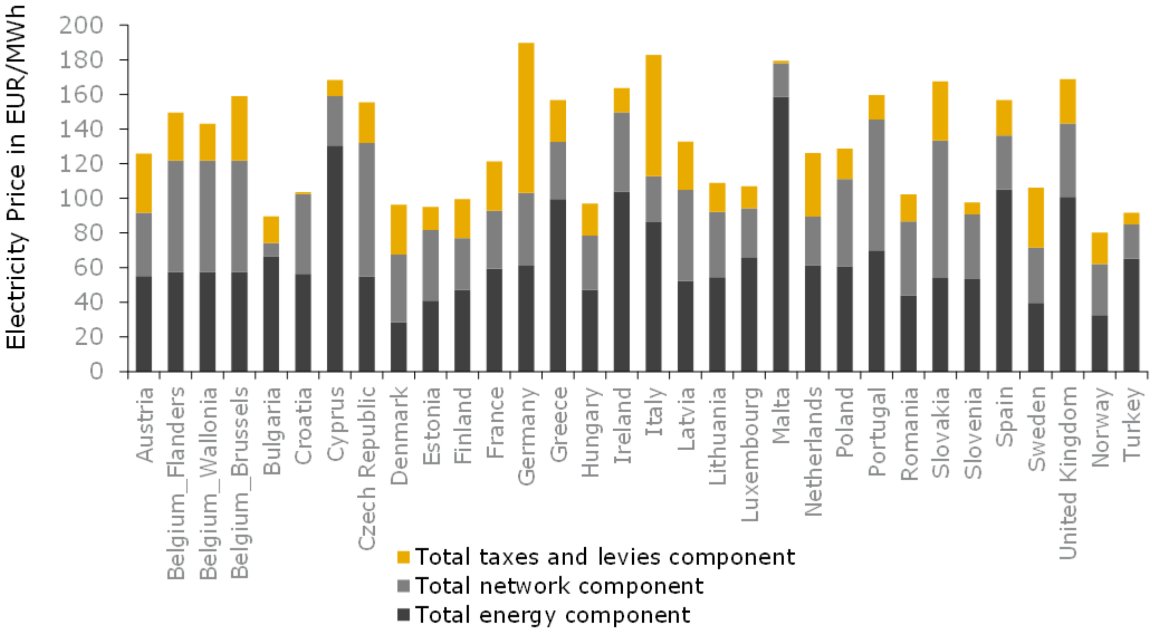

Figure 73: Electricity retail prices in 2015 for companies that are not eligible for any compensation (source: Ecofys)

The difference between the highest and lowest total electricity prices for industrial consumers not eligible for compensation or tariff reductions was about €110 /MWh in 2015. Values in the country with highest electricity prices (Germany, €190 /MWh) are more than twice as high as in the country with the lowest electricity retail prices for industrial consumers (Norway, €80 /MWh). The lowest prices within the European Union's Member States have been calculated for Bulgaria (€90 /MWh).

The importance of the various components differs strongly between countries. The island states of Malta, Cyprus, Ireland and UK have especially high energy and network components, but because of low taxes and levies, they rank below Germany and Italy in total prices. Prices for the energy component of electricity prices are especially low in the Scandinavian countries Norway, Sweden and Denmark. Taxes and levies for non-eligible industrial electricity consumers are especially high in Germany and Italy. Industrial consumers pay €87 /MWh in Germany and €70 /MWh in Italy. In both cases, renewable support policies have the highest effect in this price component. In Germany, the tariff for the EEG-levy was €62 /MWh in 2015, the tariff for the A3 levy in Italy was at €50 /MWh.

In contrast, Figure 74 shows a price comparison for companies that are eligible for all tariff reduction and compensation schemes, the energy intensive industry. As analysed in section 3.2 and 3.3, and for the reasons presented in section 5.1.1, industrial consumers with high consumption pay lower prices for the energy and the network component. For comparison, we applied the Eurostat data from table nrg_pc_205_c for Band IF as only few countries report values for the largest Band IG. To enable consistent comparison between Member States, politically induced price elements which have been reported in categories other than taxes and levies in the Eurostat data, and for which there is sector specific information, have been re-categorised as taxes and levies based on information from the ad-hoc data collection.

The values for taxes and levies depend on a number of assumptions. We applied the most favourable characteristics in terms of tariff exemptions and reductions. The total consumption of the applied example company was assumed to occur in processes from the metallurgical sector, as this sector is eligible for all process-based tariff reductions and compensations schemes. We assumed a total consumption of about 2 TWh/year, to additionally cover all exemptions and reduced tariffs, depending on total consumption. The company was assumed to be connected to the highest voltage level to use the lowest tariffs of schemes that differentiate by voltage level. Connected capacity and peak load have been calculated by using a number of 8000 full load hours, which represents a nearly constant consumption level over the full year with 8760 hours. Energy cost intensity in turnover and added value has been set to a value of >50% to cover for reduced tariffs that include a threshold for this indicator, e.g. in Finland, Italy, Romania, Germany, Austria and France. Further information on which industrial consumers are eligible for reduced tariffs, exemptions or compensations can be found in Annex I: Country descriptions. In certain cases, reductions in grid fees are given based on full load hours. This is not considered separately as the statistical information for Band IF already includes values for eligible companies.

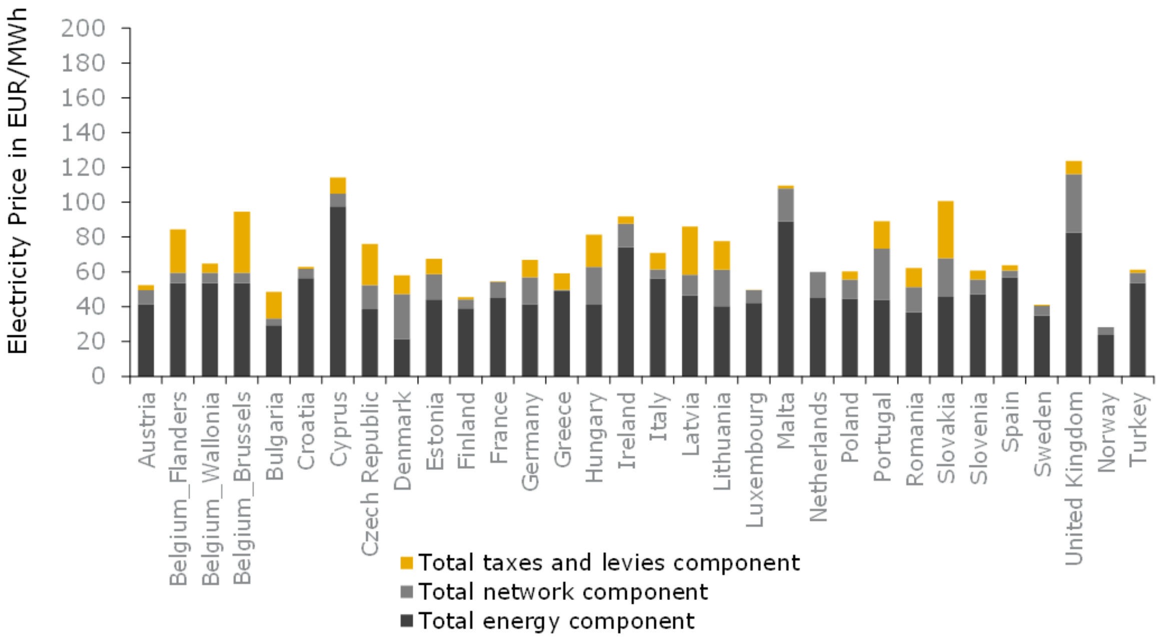

Figure 74: Electricity retail prices for industrial consumers eligible for all reduced tariffs and compensations in 2015 (source: Ecofys)

The lowest prices for industrial electricity consumers eligible for all compensation and tariff reduction schemes and with very high electricity consumption can be found in Norway at €28 /MWh. Of the European Member States, Sweden (€41 /MWh) and Finland (€45 /MWh) show the lowest values. In total, energy intensive industries in the UK pay the highest minimum amount for electricity per kilo watt hour, followed by Cyprus and Malta.

In general, developments in the energy and network component play an important role in electricity prices for energy intensive industries, due to strong reductions in taxes and levies. The island states of the UK, Cyprus and Malta therefore, rank highest in total prices, they have very high energy and network costs. The fourth ranked country, Slovakia, provides by far the highest value of minimum payments of taxes and levies for industrial consumers (€33 /MWh). Only energy intensive industries in the Belgian region of Brussels pay similarly high taxes and levies. In the countries with lowest total prices, the taxes and levies component is negligible, at values close to €1 /MWh. Netherlands is the only country where companies can, in theory, be compensated for all taxes and levies. In Sweden and Finland, Croatia, Luxembourg, and Malta the taxes and levies component is close to €1 /MWh.

In all countries, the sums of energy and network costs are lower for companies with higher consumption. The highest differences between the tariffs given in Figure 74 and Figure 76 occur in Greece (€83 /MWh), Czech Republic (€80 /MWh), Spain (€76 /MWh), and Portugal (€72 /MWh). The lowest variation can be found in Hungary, with about €16 /MWh difference between industrial consumers with low and high electricity consumption in 2015.

The difference between the maximum taxes and levies paid by an industrial consumer and the minimum, including all exemptions, is highest in the countries with the highest taxes and levies component: Germany (€76 /MWh) and Italy (€60 /MWh). Minimum payments for taxes and levies in these two countries are still higher than in many other countries, although at about €10 /MWh they are around the middle of all values. A few countries apply the same taxes and levies to all industrial consumers: Bulgaria, Malta, Latvia, Czech Republic and Hungary.[27]

[27] In Cyprus, the scheme to cover the costs of an explosion in a power plant (Vasilikos) has been applied with the same percentage for all industrial consumers, but as companies with higher consumption have lower energy and network costs, the payments for this element have been lower for big industrial consumers.

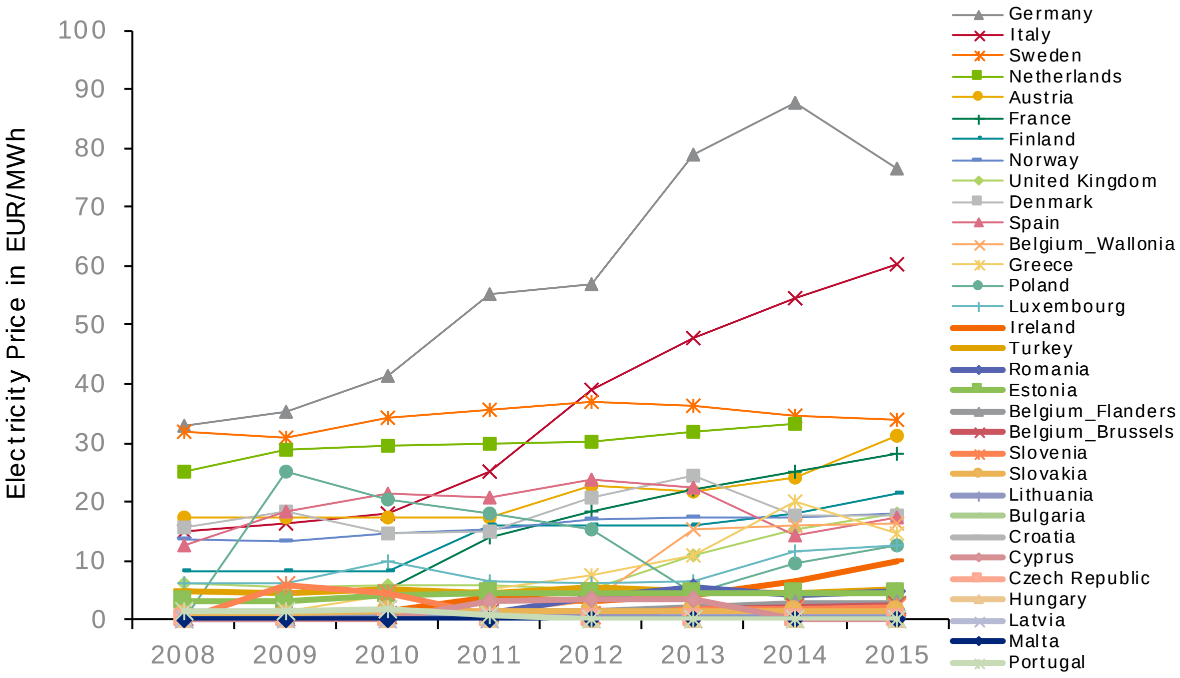

Figure 75: Maximum differences in total taxes and levies on electricity prices for industrial consumers (source: Ecofys, Frauhofer ISI, CASE)

5.1.5 Natural gas prices

Industrial retail prices for natural gas are subject to fewer taxes and levies. Figure 76 provides a price comparison for 2015 for companies that are not eligible for any tariff reduction schemes or compensations. For the case of environmental taxes and levies, for example, the price shows the maximum tariff for industrial consumers (which is generally different than the tariff for households). We assumed a yearly consumption of only 10 MWh. Energy and network components for consumption Band I2 have been used. Information about the split in energy and network component is not available for this consumption band.

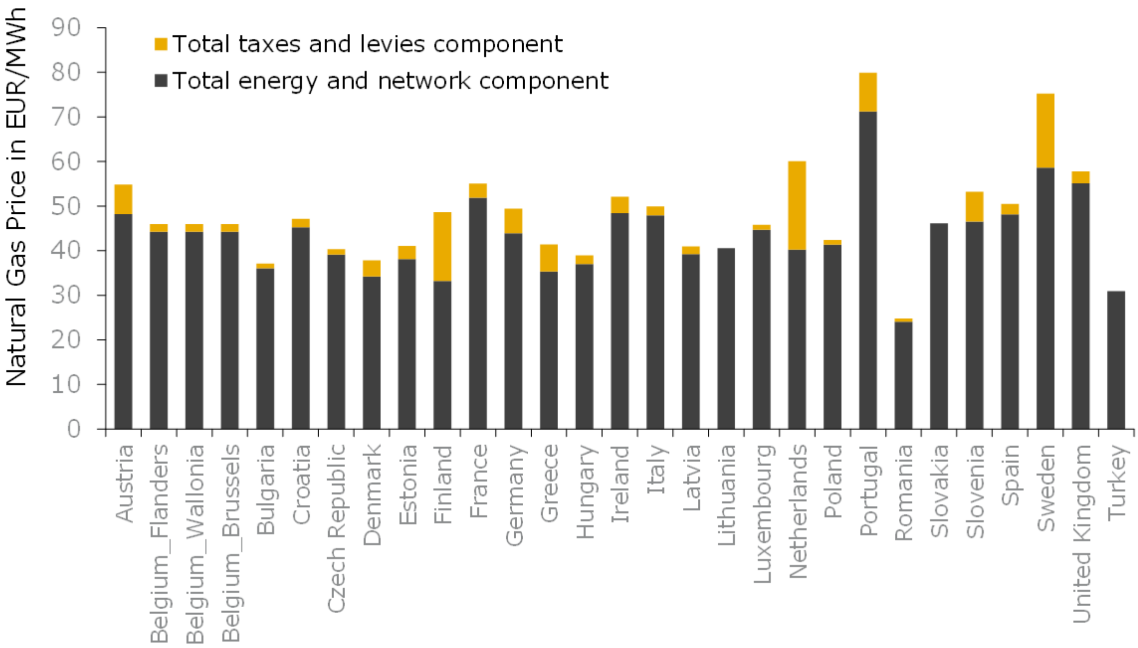

Figure 76: Natural gas retail prices in 2015 for companies that are not eligible for any compensation (source: Ecofys)

Portugal (€80 /MWh) and Sweden (€75 /MWh) have the highest industrial retail prices for natural gas, Romania (€25 /MWh) has the lowest. There is no statistical data available for Norway, Cyprus and Malta, therefore, these three countries have been omitted. The taxes and levies component is especially high in the Netherlands, Sweden and Finland. In the Netherlands, the tax on natural gas and the levy to support renewable energies are subject to regressive rates. The high tariffs for the first 170 000m^3 are applied to companies that are not eligible for tax exemptions. Sweden applies comparatively high taxes to industrial and other business users. In 2009, Sweden lowered tariffs for natural gas use in industrial processes. Finland applied three taxes on natural gas in 2015: a strategic stockpile fee, an energy tax, and a carbon tax. The latter two have a high impact on natural gas prices for smaller companies.

Natural gas retail prices for industrial consumers with high yearly consumption of more than 1 TWh have lower prices. Figure 77 presents retail prices estimations for companies with a consumption of 1 TWh. For the energy and network component, we applied statistical information for Band I5.

The values for taxes and levies depend on a number of assumptions. We applied the most favourable characteristics in terms of tariff exemptions and reductions. Table 6 shows which characteristics differentiate taxes and levies in natural gas prices. The main criteria for reductions in taxes and levies is the process that natural gas is used for. The European Tax Directive allows for exemptions and reductions in taxes for the usage of natural gas in metallurgical, mineralogical and chemical reduction processes. Our assumption for calculating the minimum burden of taxes and levies on natural gas was usage in the metallurgical sector, which is the sector that was subject to most European tariff reduction and compensation schemes. Furthermore, a very high consumption level of 2 TWh/year was assumed, as well as a connection to the transmission grid level.

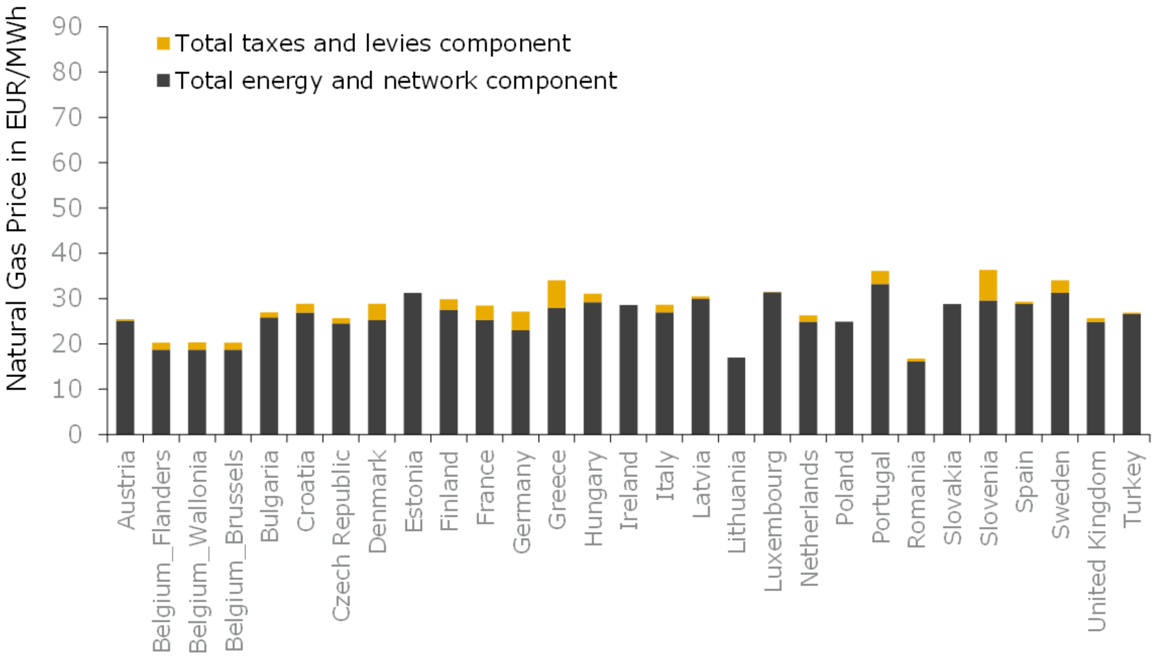

Figure 77: Natural gas retail prices for industrial consumers eligible for all reduced tariffs and compensations (source: Ecofys)

For industries with high gas use, retail prices are between €17 /MWh in Romania and Lithuania and €36 /MWh in Portugal and Slovenia. Taxes and levies are affecting consumers in Greece and Slovenia particularly strongly. In Estonia, Ireland, Lithuania, Poland and Slovakia, large consumers from the metallurgical sector would pay close to €0 /MWh for taxes and levies.

Comparing prices within countries highlights large differences, especially in Lithuania, the Netherlands, Belgium, Portugal, Sweden, UK, and Austria. Large gas consumers in eligible sectors pay less than half of the price of non-eligible small consumers of natural gas. In Hungary and Greece, this difference is only about 20%.

The maximum difference in taxes and levies can be observed in the Netherlands. Excise taxes and renewable energy support have graded tariffs in this country, therefore, companies with low consumption pay more per unit of natural gas than companies with very high consumption levels. Sweden and Finland are the other two countries with strong difference in taxes and levies compared to other Member States on natural gas (Figure 78).

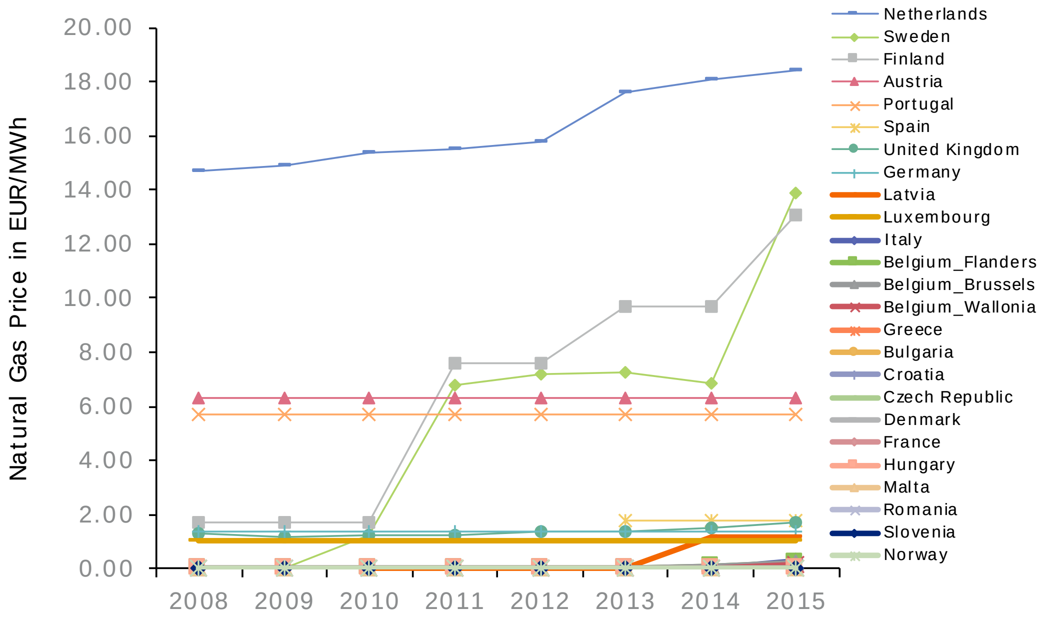

Figure 78: Maximum differences in total taxes and levies on natural gas prices for industrial consumers (source: Ecofys, Fraunhofer ISI, CASE)

5.1.6 Derivation of sector specific energy prices

As discussed above, it is clear that there are many factors that influence the price paid for energy by individual companies, and it is not possible to account for all these factors with publically available information. For the further analysis on industrial competitiveness, we calculate a typical price for a company within each sector based on assumptions regarding specific factors. These factors are: usage in energy intensive processes, annual energy consumption, connected capacity, peak load, level of grid connection and the implementation of energy efficiency agreements. The calculated prices are used in the analysis presented in section 5.6 and the case studies detailed in Annex 5. We selected the parameter settings per Member State using the following methods:

- Assumptions about typical energy consumption, turnover and EBIT based on input from statistical sources, e.g. Eurostat. The assumed consumption level for the analysis on NACE 3 level is the result of dividing total consumption of the sector by the number of companies with more than 50 employees in the same sector. This calculation leaves out companies which only exist on paper and companies that have a negligible energy consumption. On NACE 4 we applied characteristics of large companies in the specific sector, as the analysis is on product level;
- Based on secondary data, e.g. from BREF reports or sector publications, we calculated typical connected capacity, full-load hours, peak loads and energy intensities for each sector;

- Literature and national sector reports provided information about typical values, e.g. for sulphur content, energy efficiency agreements with governments or the level of grid connection;
- Details of sector-specific processes from general literature (e.g. type of consumer class, sector type or main reason for fuel use).

In how far specific characteristics of consumers change energy prices for electricity and natural gas in individual MS is explained in Annex I: Country descriptions.

5.2 Selection of industries for detailed analysis

This section starts with an overview of the energy consumption per sector in the EU. Afterwards we introduce three criteria for selecting sectors for the detailed analyses and present the resulting sectors.

Total energy consumption in European industries is declining. In 2008, the manufacturing sector[28] of all EU-28 Member States summed to about 12.7 EJ, or about 17% of the total EU28 gross inland consumption. For 2014, Eurostat reports a total final energy consumption of 11.1 EJ, a decline of 12%, a little more than the 11% decline in gross inland consumption as a whole. Figure 79 shows the total consumption by sector. Major consumers in Europe are the iron and steel sector (19% of the manufacturing industry total in 2014), chemical and petrochemical sectors (20%), the non-metallic minerals (13%) sector, paper, pulp and print sector (12%) and the food and tobacco sector (11%). Energy consumption has declined most rapidly between 2008 and 2014 in the textile and leather sector (-29%) and the non-metallic minerals sector (-25%).

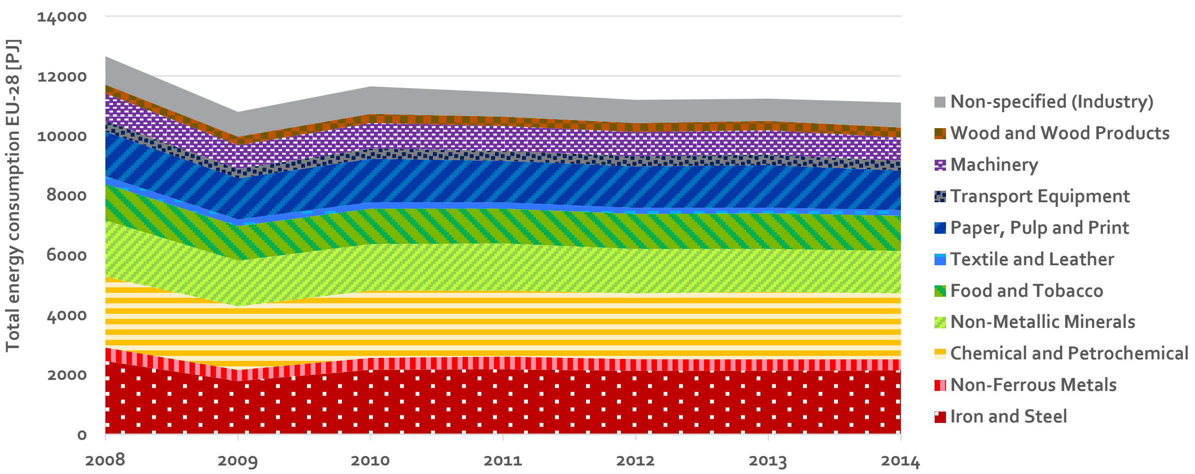

Figure 79: Total energy consumption of European industries (source: Eurostat table nrg_110a)

[28] Defined as the manufacturing industries (NACE rev. 2 division C).

For the detailed analysis, we have selected 15 sectors at NACE3 level, to provide insight into energy costs on a sectoral level, and 5 sectors at NACE4 level, to provide deeper insight closer to a product level, through case studies (see Text Box below). The sectors have been selected on the basis of:

(i) Energy costs per production value: calculated by dividing expenses for energy by the total production value of each sector;
(ii) Importance for the economy: measured as the share of sectoral value added in total GDP; and,
(iii) Trade intensity: assessed by dividing the sum of imports and exports of a product to and from the EU in total by the size of the market represented by the sum of production value and imports.

The table below gives an overview of the sectors and products that have been selected, while the criteria assessment can be found in Annex 4.

Table 7: Industrial sectors selected for analysis, and case studies

Code	Description	Case study
C106	Manufacture of grain mill products, starches and starch products	
C132	Weaving of textiles	
C161	Sawmilling and planing of wood	
C171	Manufacture of pulp, paper and paperboard	C1712 - Manufacture of paper and paperboard
C192	Manufacture of refined petroleum products	
C201	Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms	C2013 - Manufacture of other inorganic basic chemicals, focus chlorine
C206	Manufacture of man-made fibres	
C231	Manufacture of glass and glass products	C2313 – Hollow glass, focus container glass
C232	Manufacture of refractory products	
C233	Manufacture of clay building materials	
C234	Manufacture of other porcelain and ceramic products	
C235	Manufacture of cement, lime and plaster	
C237	Cutting, shaping and finishing of stone	
C241	Manufacture of basic iron and steel and of ferro-alloys	C2410 - Manufacture of basic iron and steel and of ferro-alloys, focus crude steel
C244	Manufacture of basic precious and other non-ferrous metals	C2442 - Aluminium production, focus primary aluminium

The case studies

For each of the selected NACE4 sectors, the case studies in Annex 5 give a brief product description and then describe:

- The product cost structure in terms of the contribution of different cost categories to production value
- Market situation in terms of production in different markets
- International competitiveness through discussion on imports and exports.

Detailed information about energy consumption of subsectors is not available for all European Member States so the detailed analysis is focussed on the countries that contribute the largest shares to valued added and together cover more than 50% of European value added within the respective sector.

5.3 Data sources and limitations

5.3.1 Data sources

Data was collected and analysed at three main levels, (1) EU-wide data from Eurostat; (2) national statistics of EU Member States; and, (3) data from international organisations and/or national statistics offices. The first set of data is used for the majority of EU-wide analysis, the second data set was sourced to provide detailed energy consumption per energy carrier per sector data, and the third dataset for the international comparisons that are made. The following section reflects on the quality and coverage of the data sources, specific details on how the data has been used and its limitations are presented in the analysis in the following sections.

Eurostat data

The Eurostat structural business statistics (SBS) dataset was the key source used to analyse the role of energy costs per sector and Member State. The key variables (all expressed in euros) used in the analysis were:

- Value added at factor cost
- Production value
- Total purchases of goods and services
- Personnel costs
- Purchases of energy products in value
- Gross operating surplus

Not all of these values were available for all years, for all Member States and all sectors. To ensure consistency in the comparisons over time, in most cases Member States data were only included in the totals when data for that Member State for all relevant variables was available for all years of the analysis (see discussion below for the exception for France). The coverage per Member State and sector is presented in the appropriate analysis section.

National statistical office data

To investigate the role of prices, we also examined energy consumption per energy carrier per country and sector. This added a further level to the data requirements which could not be sourced from the Eurostat SBS data or other Eurostat datasets. Therefore, national statistical databases were also accessed, unfortunately the available data was also limited. Table 8 summarises the data availability at this level, as used for the analysis in the following sections. The key data sources were the German national statistics, the Finnish national statistics and the Odyssee-Mure dataset. It is clear that the available data represents only a minority of the total EU industry (6-25% of sector gross value added GVA) and therefore, limits the conclusions that can be drawn for the EU28 as a whole.

Table 8: Summary of data availability for energy consumption per energy carrier per sector, 2008-2013 and average coverage of total EU28 sector GVA of the available data points

Code	Description	Countries	Coverage of GVA
C106	Manufacture of grain mill products, starches and starch products	DE	7%
C132	Weaving of textiles	DE	6%
C161	Sawmilling and planing of wood	DE	7%
C171	Manufacture of pulp, paper and paperboard	DE, SE, FI	25%
C192	Manufacture of refined petroleum products		#N/A
C201	Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms	DE	17%
C206	Manufacture of man-made fibres	DE	22%
C231	Manufacture of glass and glass products	DE, FR	20%
C232	Manufacture of refractory products	DE	14%
C233	Manufacture of clay building materials	DE	8%
C234	Manufacture of other porcelain and ceramic products	DE	17%
C235	Manufacture of cement, lime and plaster	DE, UK, FR	15%
C237	Cutting, shaping and finishing of stone	DE	16%
C241	Manufacture of basic iron and steel and of ferro-alloys	DE, AT, IT, FR	14%
C244	Manufacture of basic precious and other non-ferrous metals	DE, UK, FR	24%

International data

For the international comparison data equivalents to the EU SBS were sought. This involved sourcing data from international organisations, such as the OECD, which also provides SBS; the IEA for energy data; and national statistics bodies in the United States, China and Japan. A mix of data was available from each source, allowing for a limited international comparison to be made.

5.3.2 Limitations

There are a number of important limitations to the datasets and therefore, the analysis provided in the following sections. The general limitations applicable across all data include:

- **Trade-off between sector aggregation and data availability:** generally, as the sector definition becomes more aggregated, i.e. at NACE 3(digit) or NACE 2(digit) level, there is greater data availability per Member State and sector in the statistics and conversely the more disaggregated the sector the more limited the data.
- **Level of data aggregation means heterogeneous products and processes are grouped:** NACE 3 level is the highest level of disaggregation possible for this work with reasonable data availability. Nevertheless, NACE 3 includes significant aggregation of disparate products and processes within a sector, any trends can be the result of complex structural differences in for example product mix. This limits the general conclusions that can be drawn from analysis of the data.
- **Data gaps remain, no data yet for 2014 or 2015, only partial data in earlier years for some MS and sectors:** therefore, the analysis focuses on 2008-2013 in the majority of cases. This problem is common to both EU, national and international datasets.
- **Data in euros does not provide direct link to volumes and consumption:** energy consumption and therefore, cost depends on the volume consumed and the price paid. The energy consumption in manufacturing is closely linked to the volume of production. Unfortunately, production volume data is not available at NACE 3 level, only production value or cost data. Whilst production value relates to production volumes it is also subject to price effects and therefore, the relationship is less direct. Similar issues exist for production cost as this includes both fixed costs and variable costs that increase with production volumes. Ratios are analysed based on production value and cost given the available data, but it is important to note this limitation.
- **Changes in product quality or production structure cannot be identified from the data:** This limitation applies to both value based and volume based data, where changes in product quality, i.e. a move to higher quality products, and/or changes in production structure within a sector, i.e. increasing production volumes of one product and decreasing volumes of another. Both of these factors could have significant influences on energy consumption and costs.
- **Statistical and definitional inconsistencies:** this is particularly relevant to the international datasets used. The statistics are based on specific definitions and data gathering methods, which are not always well aligned. While there is a standardised international

approach to industrial sector classification, different versions exist, and national agencies still interpret some aspects and group or attribute activities in sectors differently, leading to comparisons based on different activities. Similarly, for the SBS statistics definitions of personnel or other production costs can be different in scope between countries.

- **Difficulties in drawing conclusions for a sector across multiple indicators:** the different sector level indicators presented below are based on different sub-sets of data. Data is not available consistently across the same Member States for different indicators. While analysis of energy cost shares in the EU is based on the SBS dataset, which has relatively comprehensive data coverage, data on for example fuel shares for a particular sector is only available for a very limited set of Member States.
- **Gap filling, personnel costs in France 2008:** as a major economy and manufacturing country it is important to include France in the analysis. By the rules applied to all countries it would be excluded from the energy cost analysis, as it is missing personnel costs for all sectors in 2008, meaning there is not a complete time series. As the gap was only one variable and one year it was decided to fill this by assuming that personnel costs in 2008 would be included by applying the ratio of personnel costs to total purchases of goods and services in 2009, to the 2008 total purchases of goods and services data points. In this way personnel costs are assumed. It is clear that there are limitations to this approach, which slightly weakens the potential to analyse any trend between 2008-2009, particularly for France. Nevertheless, the limitations are considered tolerable. Gap filling was also considered for Poland, Ireland and Slovenia, but these miss crucial data from either multiple years and/or multiple variables and a robust bridging technique was not possible.

Specific limitations are addressed directly in the relevant analysis sections, but one specific case is addressed in the box below, together with some conclusions from literature on developments in the sector.

Manufacture of refined petroleum products sector

The refinery sector was selected as one of the focus sectors but is excluded from many of the following figures and analysis, as there are difficulties in the energy cost and consumption statistics from the Eurostat SBS dataset. This is based on the fact that energy products, i.e. crude oil, are purchased and consumed by the sector, but as a feedstock, rather than for energy generation. The SBS only accounts for the latter, excluding the largest part of energy costs for the sector, which results in a calculated EU average energy cost share for the sector of only 3% of total costs. Clearly this does not accurately reflect the actual energy costs of the sector, which will be much higher. The EC 2014 Competitiveness report estimated energy costs at 62% of production value (gross output) for the Coke, refined petroleum and nuclear fuel sector in 2011. Analysis by Solomon Associates (2016) suggests average energy costs per barrel of oil for EU28 has increased slightly between 2008-2012, but had decreased again by 2014. In the same period, US energy costs have decreased to below those in the EU28. Russia and the Middle East also have prices below that in the EU28. Korea/Singapore and India had higher average energy costs than the EU in 2014. In terms of net cash margin, US and Korea/Singapore have high average margins in the period than the EU28 with the others close to or below the EU28.

5.3.3 Estimations for energy prices

Energy price data on the European level is classified according to consumption level. There is no data available about average energy prices for companies from the selected sectors. We estimated typical prices for industrial consumers from each of the sectors, based on the information about energy price drivers, and especially about the criteria for reductions and exemptions in taxes and levies (section 5.1). Table 9 provides the main assumptions about processes, consumption and electricity peak load for the selected sectors. While data for the five sectors on NACE-4 level has been derived from qualitative information, the numbers for consumption for the 15 NACE-3 codes have been calculated from statistics, dividing the total electricity and natural gas consumption by number of companies with more than 20 employees.

Table 9: Assumptions about processes, consumption and peak load in selected sectors

Industry	Defined process	Natural gas consumption (GWh/year)	Electricity consumption (GWh/year)	Electricity peak load (kW)
C1712 - Manufacture of paper and paperboard	Other	1200	400	66667
C2013 - Manufacture of other inorganic basic chemicals	Electrolysis	1625	650	92857
C2313 - Manufacture of hollow glass	Mineralogical	100	25	6250
C2410 - Manufacture of basic iron and steel and of ferro-alloys	Metallurgical	130	1600	200000
C2442 - Aluminium production	Metallurgical	1170	1950	243750
C106 - Manufacture of grain mill products, starches and starch products	Other	26.9	14.0	2800
C132 - Weaving of textiles	Other	3.7	4.4	1467
C161 - Sawmilling and planing of wood	Other	0.0	3.2	455
C171 - Manufacture of pulp, paper and paperboard	Other	127.1	87.4	12480
C192 – Manufacture of refined petroleum products	Other	0.0	111.3	13917
C201 - Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms	Electrolysis	177.2	75.0	12496
C206 - Manufacture of man-made fibres	Other	58.9	31.1	7784
C231 - Manufacture of glass and glass products	Mineralogical	33.3	10.3	2057
C232 - Manufacture of refractory products	Other	15.8	3.5	586
C233 - Manufacture of clay building materials	Other	47.1	6.3	1586
C234 - Manufacture of other porcelain and ceramic products	Mineralogical	11.1	3.0	754
C235 - Manufacture of cement, lime and plaster	Mineralogical	19.5	46.7	6667
C237 - Cutting, shaping and finishing of stone	Other	0.3	2.2	546
C241 - Manufacture of basic iron and steel and of ferro-alloys	Metallurgical	663.4	222.2	27774
C244 - Manufacture of basic precious and other non-ferrous metals	Metallurgical	32.1	51.5	6443

5.4 Energy intensity for EU industry

The efficiency of energy use has a crucial bearing on the energy costs of a sector. Statistical analysis of the efficiency of a sector at NACE 3 level and how this evolves over time is challenging given the large number of variables at work. A further challenge is the large number of products and processes aggregated at this level. In this section, we discuss this approach and give results.

Approach: Energy intensity has to be clearly distinguished from energy efficiency. It measures the energy required to generate a unit of value added (VA), expressed in this report as kWh/Euro VA. Intensities across sectors cannot be compared to provide insight into the energy efficiency of a sector. Energy use can be dictated simply by the required processes, so for example the energy intensity of the iron and steel sector could be high, but the sector can be (relatively) highly efficient for the energy required to manufacture these products. Indeed, it can be argued that sectors with relatively high energy intensities are more highly incentivised to pursue energy efficiency measures to reduce costs.

A further complexity of the energy intensity measure is the role of value added. Value added is understood as the sum of returns to labour and capital, which is effectively the sum of personnel costs and gross operating surplus, the latter being a proxy for profit. Obviously many different factors, such as salary costs, other personnel costs, pricing strategies, health of domestic markets, etc., can have an important bearing on the amount of value added generated. Therefore, energy consumption is not the only important variable in this ratio. To more closely understand trends in efficiency in a sector a production volume at a sufficient level of disaggregation rather than value based measure would be preferred e.g. kWh/tonne of cement. Given that this data is not available across the range of sectors and for the Member States analysed, we use energy intensities to track trends over time in a particular sector. We also compare the same sectors across countries, although in neither case can we disaggregate the effect of different or changing product mix from energy efficiency.

Data sources: we have only been able to calculate energy intensity at NACE3 level for a small number of sectors and EU Member States, due to the limited sector level energy consumption data, with energy consumption breakdown per fuel.

Gross value added data matching the Member State, sector and year of the energy consumption data was sourced from the Eurostat SBS statistics (value added at factor cost).

Coverage: A summary of the data points used for this analysis is provided in section 5.3.1, Table 8. Therefore, the results are relevant only for a handful of EU Member States and should not be interpreted as EU averages. In addition to the refineries sector (see section 5.3.2) the stone-cutting sector is also omitted from the analysis due to insufficient data.

Results are presented in Figure 80 below. This shows a mixed picture per sector of the energy use per unit of GVA. As expected, pulp and paper, cement, lime and plaster and iron and steel are the most energy intensive sectors[29], typically requiring more than 20 kWh of energy consumption per Euro of GVA generated. The basic chemical industry sector is the other major energy consuming sector which is also relatively energy intensive. Analysis of trends for this limited sub-set of EU Member States shows:

- **Energy intensity increased in seven sectors and declined in seven sectors between 2008 and 2013.**
    - Energy intensity increased in the four most energy intensive sectors, over the 2008-2013 period, although for pulp and paper this trend is only evident as of 2011. Energy intensity also increased for the sawmills, man-made fibres and stonecutting sectors from 2008-2013.
- **GVA was static or decreasing in all but three of the fourteen sectors between 2008 and 2013**. This is consistent with the known intensity of global competition and pressures on margins (and therefore, GVA) in recent years, issues which are explored in more detail in the case studies (see Annex 5).
    - The three sectors in which GVA increased between 2008 and 2013 are grain products (+15%), basic chemicals (+5%) and clay building materials (+23%).
- **Energy consumption declined in all but four of the fourteen sectors between 2008 and 2013** (see Figure 81 below)**.**
    - The four sectors with increasing energy consumption were grain products (+9%), sawmills (+118%), basic chemicals (+20%) and man-made fibres (+28%).
    - Of these four, only the grain products sector saw GVA increase by more and energy intensity decrease.

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[29] Normally we would also expect to see the refineries sector also included here, but there is a problem with the source statistics. Namely that, although energy products are consumed by the sector, they are not consumed for the purposes of energy generation and therefore, are not included in the energy consumption statistics. This leads to a significant underestimate of refinery sector energy consumption, to the point where it does not make sense to include the sector in many of the analyses below.

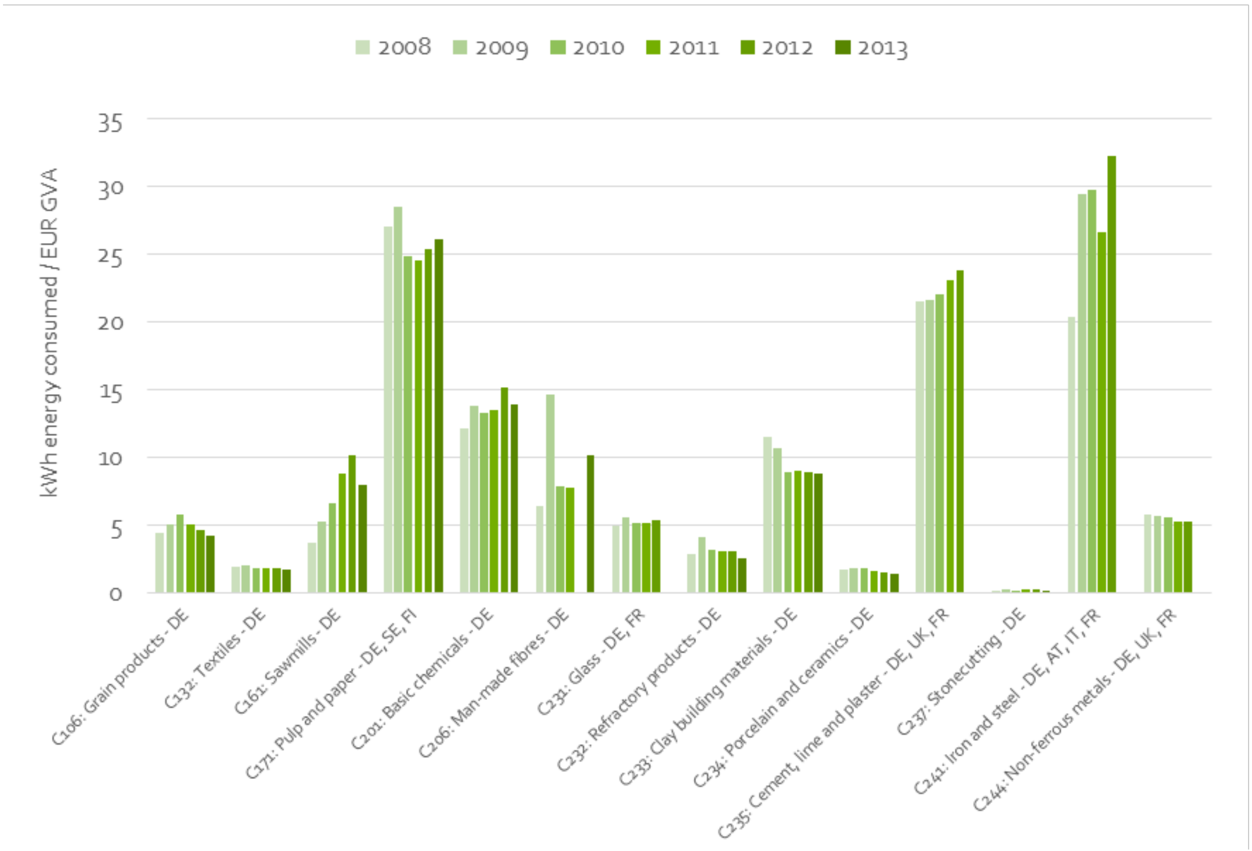

Figure 80: Energy intensity of EU industrial sectors 2008-2013 [kWh energy consumed per Euro of GVA], data based on limited number of EU Member States (see sector labels and Table 8 for MS coverage)

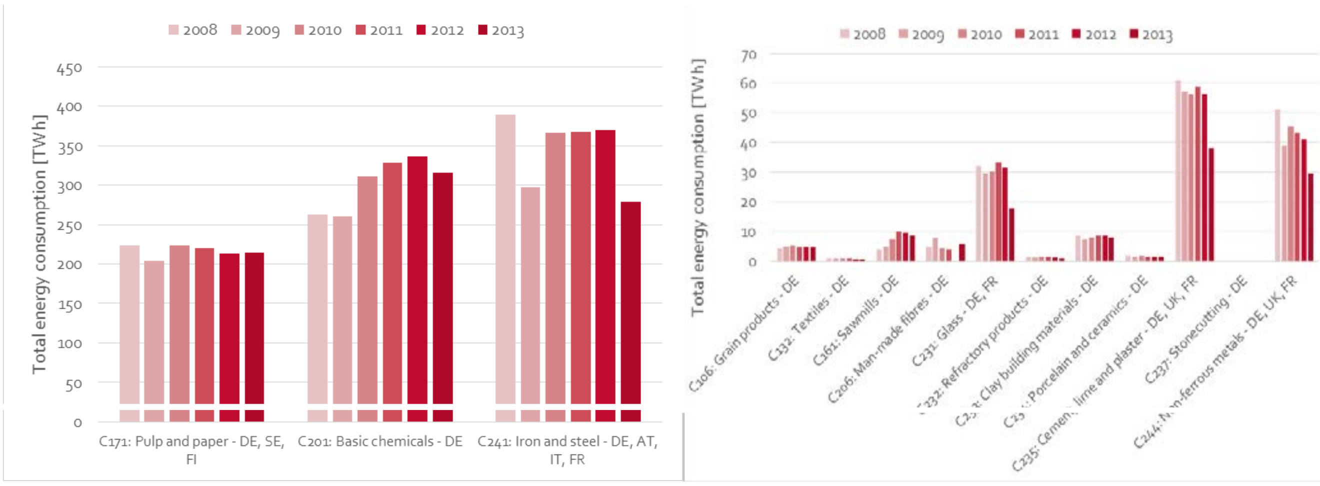

Figure 81: Aggregate energy consumption for available data points per sector 2008-2013 [TWh]. Aggregate of countries with available data for all years (see sector labels and Table 8 for MS coverage). Data from national statistics and Odyssey-Mure database.

Looking more closely at the role of efficiency in determining energy consumption, other sources have been able to analyse, at NACE 2 level, trends in industrial energy efficiency. A publication funded by the Intelligent Energy Europe Programme (IEE) in 2015 provides insight into trends in industrial energy efficiency, based on a calculated index of specific energy consumption [energy consumed per unit of production]. Among the findings was Figure 82, presented below, mapping an energy efficiency index in industry 2000-2013. This shows that for many sectors energy efficiency has improved over this period, especially the chemical sector (inferred annual energy efficiency improvement rate of 1.6% per year). It is notable that energy efficiency in the cement and iron and steel sectors has barely changed since 2008, while the improvement achieved by the paper sector since 2008 (0.6% improvement per year), and over the whole period, is relatively low. The rate of energy efficiency improvement is driven by a number of factors, including state of energy efficiency at the beginning of the period, technical possibilities for improvement and availability of capital to invest in plant improvements. The financial situation since 2008 obviously has had implications for investments generally.

Compared to the energy intensity changes presented in Figure 80 the trends for paper and pulp are consistent with only slow energy efficiency improvement. The efficiency trend in the chemicals sector is not reflected in the energy intensity of the basic chemicals sector. Slow improvements in steel and cement may play a role in increasing energy intensity in these sectors in Figure 80, as the efficiency improvements less than the reductions in sector GVA. In any case the differing sector scopes and underlying data sources make it very difficult to draw any robust explanations or conclusions at this level of sector disaggregation.

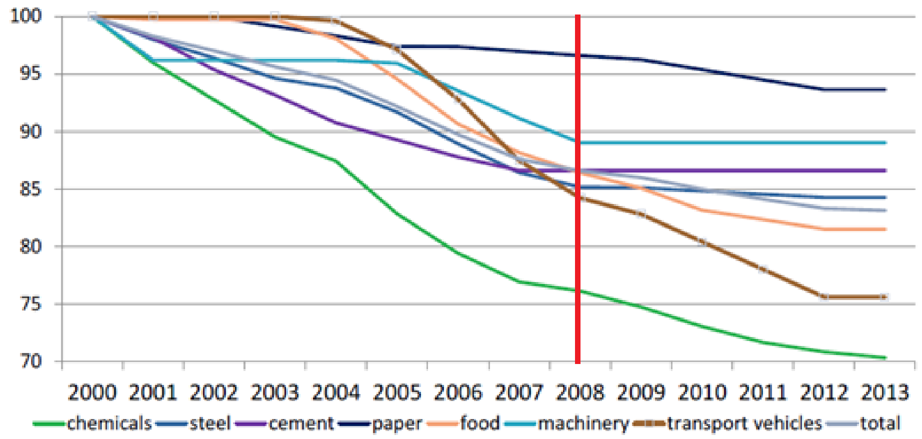

Figure 82: Energy efficiency index in EU industry, Figure 18 from IEE (2015) Energy efficiency trends and policies in industry

Comparing our EU energy intensity results with other studies

Chapter 6 of the 2014 European Competitiveness Study (ECR 2014) provides analysis of energy intensity, but only at a NACE category level for the manufacturing industry as a whole and only up to 2009. This does not allow for a meaningful comparison with the energy intensity results of this study. More specific data for energy intensive industries is provided, but this data measures intensity in comparison to production volumes, and therefore, this study has no comparable data.

The 2014 study by DG ECFIN into the "Energy Economic Developments in Europe" also provides analysis of energy intensity, but it provides this for sectors under the NACE rev.1.1 system, only to the NACE 2-digit level and only for 2009. This introduces considerable differences into the basis of comparison. Nevertheless, by converting the metrics we can make a comparison. Around half of the sectors show similar energy intensities, with significant differences evident when comparing: grain products to food, beverages and tobacco as a whole; pulp and paper to the wider sector, including printing and publishing; man-made fibres compared to rubber; and plastics and iron and steel compared to basic metals. There are large structural differences between the NACE 3-digit sector and that at NACE 2 digit that would explain the differences, for example printing has a much lower energy intensity than pulp and paper which would tend to bring the whole sector intensity down.

Table 10: Comparison of 2009 energy intensities of this study with closest sector match from 2014 DG ECFIN study 'Energy Economic Developments in Europe', converted to kWh/EUR (energy cost/value added [%]) equivalents.

Sector (NACE rev.2, NACE 3-digit)	2009 Energy intensity from aggregate of available EU28 data points	ECFIN 2014 Energy intensity converted from 10MJ/USD to kWh/EUR	Sector match - NACE rev 1.1, NACE 2-digit level sector
C106: Grain products	5.0	2.2	Food, beverages and tobacco
C132: Textiles	2.0	1.5	Textiles and textile products
C161: Sawmills	5.3	4.3	Wood and products of wood and cork
C171: Pulp and paper	28.5	3.8	Pulp, paper, printing and publishing
C201: Basic chemicals	13.8	11.5	Chemicals and chemical products
C206: Man-made fibres	14.6	1.8	Rubber and plastics
C241: Iron and steel	29.5	5.5	Basic metals and fabricated metal
C244: Non-ferrous metals	5.7	5.5	Basic metals and fabricated metal

The ECFIN study analyses a different period of energy intensity development at sector level, from 1995-2009, rather than 2008-2013 in this study, there is very little overlap between the two and not long enough to allow meaningful validation of our trend results.

5.5 Analysis of industries' profitability

The importance of energy costs to the competitiveness of an industry is also related to the margins that can be achieved. Value added is the sum of returns to labour and capital. Returns to labour are captured by personnel costs, while the returns to capital are captured as gross operating surplus. This broadly corresponds to profits.

- Value added = personnel costs + **gross operating surplus**

The specific influence of personnel costs on value added is examined in section 5.6.

In this section we analyse the level and trends in gross operating surplus for the selected industries as an indicator of pressure on margins within the sectors. It is clear that there is an interaction between different production costs and prices and the gross operating surplus that is achievable in a sector. Therefore, it is useful to examine gross operating surplus which reflects the margins achieved.

Approach: gross operating surplus (GOS) is taken directly from the Eurostat SBS statistics. Alternatively, it could be calculated by subtracting personnel costs from value added, a manual check of this calculation shows very close alignment with the statistics. The resulting GOS value is expressed as a percentage of total production costs, effectively representing a profit margin on top of the production cost. Results are calculated by Member State, presenting the average gross operating surplus across all sectors, and per sector.

Data source: gross operating surplus is sourced directly from the Eurostat SBS statistics.

Coverage: corresponds to Table 11.

Results: at EU level the average gross operating surplus is calculated for the years 2008-2013 and presented in Figure 83, this shows gross operating surplus in the range of 8-10% per annum at EU28 level. For individual Member States:

- **Average gross operating surplus (across all sectors) are in excess of 20-30% in some Member States** in some years (CY, EE, LV, LU, PL)
- **Average gross operating surplus declined across all but four Member States (BG, DK, IT, SI) over the period 2008-2013**. This demonstrates that average margins are under significant pressure in the EU.
- **It is not possible to identify which cost drivers have the greatest influence on profitability**, therefore, while this analysis identifies the overall trends in margins, it is not possible to draw conclusions on the role of energy (or other production) costs in influencing gross operating surplus.

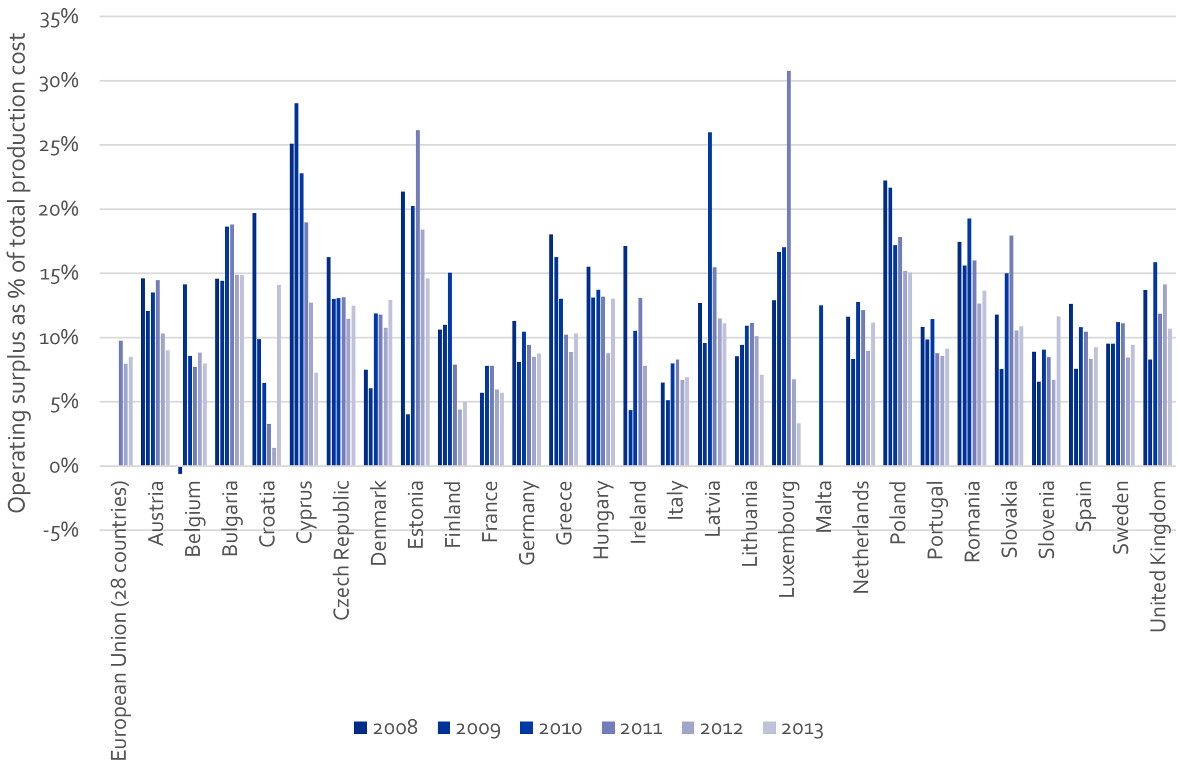

Figure 83: Gross operating surplus as % of total production costs, average across all sectors at EU28 and Member State level, 2008-2013.

Looking at specific sectors in Figure 84 we find that the EU sector average gross operating surplus as percentage of production cost (for full results per sector and member state see Annex 4):

- **Averaged between 5-15% in all but two sectors in the period 2008-2013.** The two exceptions were iron and steel, where GOS was between 0-5%; and cement, lime and plaster where GOS was between 15-30%.
- **Average GOS declined by 15-85% in 10 of the 14 sectors between 2008-2013**. Increases were recorded by the sawmills, pulp and paper, man-made fibre and clay building materials sectors.
- **Production costs decreased in 9 of 14 sectors over the 2008-2013 period, with declines of between 3-30%.** Production costs increased (by 1-15% in the grain, paper and pulp, refineries and basic chemicals sector, an exceptional increase of 280% was recorded in the precious metals sector which could be linked to increasing commodity prices.
- **Gross operating surplus declined faster than production costs increase in all but 4 sectors,** implying increased pressure on margins and profitability for these sectors. Sawmill, pulp and paper and man-made fibres all saw GOS increase by more than production costs. While precious metals, which saw GOS increase saw production costs increase more quickly,

resulting in a negative trend in the share of GOS of production cost. Clay building materials saw both production costs and GOS decline, but production costs declined by more, resulting in a positive trend for GOS share of production costs.

- **Trends in gross operating surplus are driven by many factors aside from energy costs.** For example, in the iron and steel sector, for which the lowest GOS share of production cost was recorded, the sector has been strongly affected by significant increases in production capacity in China and reduced demand following the global financial crisis, resulting in significant oversupply, low prices but high fixed costs in the sector. This is a major contributor to the low margins.

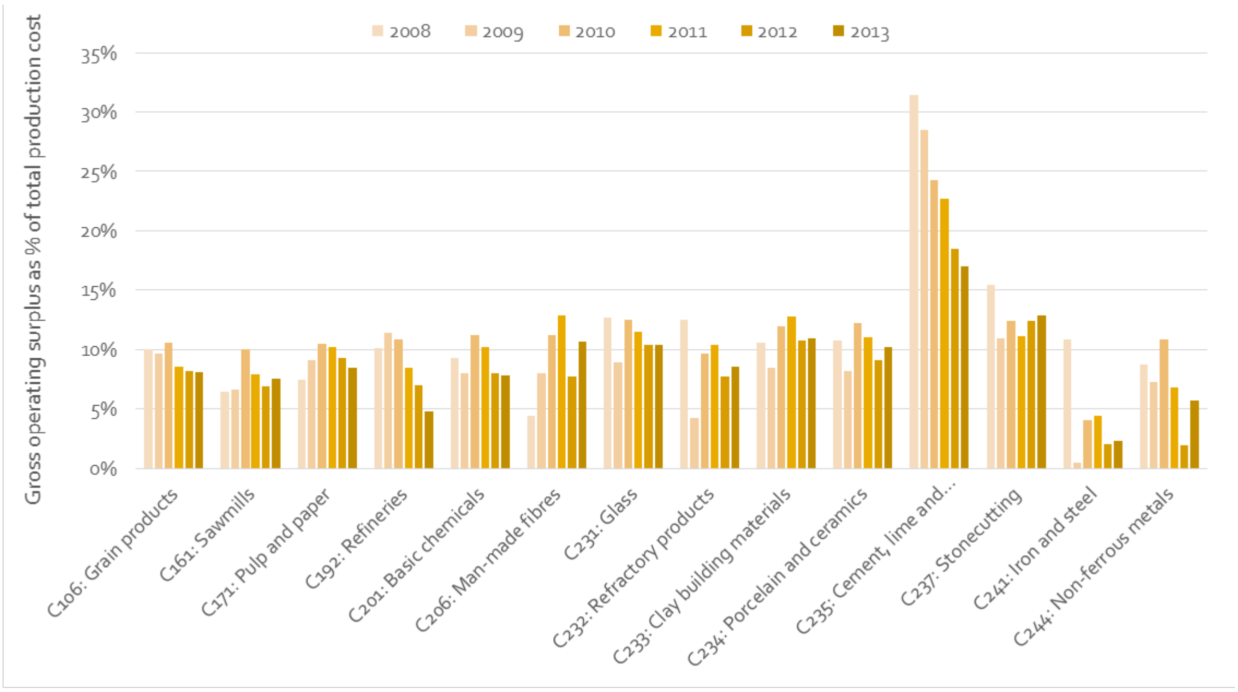

Figure 84: EU average gross operating surplus as a percentage of total production costs, aggregate of MS for which total production cost and gross operating surplus data available for all years. Note: Textiles sector is excluded as no gross operating surplus data is available.

5.6 Energy costs for EU industry

Energy prices and consumption combine to provide energy costs, in 2013 the value of the total purchases of energy products by the EU manufacturing industry was more than €136 billion[30].

5.6.1 Energy costs as a share of total production costs

To understand the competitiveness impact of energy prices it is important first to understand the importance of energy costs as a part of a sector's production costs. In this section we analyse energy cost data as a share of total production cost.

Approach: Energy costs are divided by total production costs, where total production costs are equal to total purchases of goods and services (including energy)[31] plus personnel costs. Personnel costs are made up of salaries and employers' social security costs. As total energy costs are also available separately, this allows calculation of the total purchases of goods and services excluding energy costs.

Data source: Each of the variables is available directly from the Eurostat SBS.

Coverage: The calculation was carried out for all countries and sectors for which a full time series covering 2008-2013 is available, details of which are summarised below. In almost all sectors the data points cover Member States which contribute 85-95% of total EU28 sector GVA[32]. As noted in section 5.3.2, data for France was gap filled, while data gaps for Poland, Ireland and Slovenia could not be robustly filled and therefore, these are excluded.

[30] From Eurostat SBS, all manufacturing, purchases of energy products. No values available for IE, MT and PL, therefore, EU28 total will be higher.

[31] Total purchases of goods and services represents the value of all goods and services purchased during the accounting period for resale or consumption in the production process, excluding capital goods (the consumption of which is registered as consumption of fixed capital). This therefore, includes the costs of materials that enter directly into the goods produced (raw materials, intermediary products, components), non-capitalised small tools and equipment and the value of ancillary materials. Service costs, such as repairs and maintenance, transport and logistics, communication, insurance, legal and accountancy fees, are also included in this total.

[32] Based on calculation of Member State average GVA share of EU28 total per sector 2008-2013.

Table 11: Countries and sectors for which a full time series 2008-2013 was available for the energy cost as a share of total production cost calculation, 1=all data available, 0=at least one year of one data point missing, and therefore, not included in the EU aggregate calculation.

	C106: Grain products	C132: Textiles	C161: Sawmills	C171: Pulp and paper	C192: Refineries	C201: Basic chemicals	C206: Man-made fibres	C231: Glass	C232: Refractory products	C233: Building materials	C234: Porcelain, ceramics	C235: Cement, lime, plaster	C237: Stone	C241: Iron and steel	C244: Non-ferrous metals
Austria	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1
Belgium	1	1	1	1	0	1	0	1	0	1	0	0	0	1	1
Bulgaria	1	1	1	1	0	1	0	1	0	1	1	1	0	0	1
Croatia	1	0	1	0	0	0	0	1	0	1	0	1	1	0	0
Cyprus	1	0	0	1	0	0	1	1	0	1	0	0	1	1	0
Czech Republic	1	1	0	1	0	1	0	1	1	1	1	1	1	1	1
Denmark	0	0	1	1	0	1	0	1	0	1	1	0	1	0	1
Estonia	0	0	1	0	1	1	0	1	0	0	1	0	1	1	0
Finland	1	0	1	1	0	0	0	1	0	1	0	0	1	0	0
France	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0
Germany	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1
Greece	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Hungary	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Ireland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Italy	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1
Latvia	0	0	1	0	0	1	0	1	0	0	1	0	1	0	0
Lithuania	1	1	1	1	0	1	0	1	0	1	1	0	1	0	0
Luxembourg	0	1	0	0	1	0	0	0	0	1	0	0	1	0	0
Malta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Netherlands	1	0	1	0	0	0	1	1	0	0	0	0	1	0	1
Poland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Portugal	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1
Romania	1	1	1	1	0	1	0	1	1	1	1	1	1	1	1
Slovakia	0	1	1	1	0	1	1	1	1	1	1	1	1	0	1
Slovenia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spain	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1
Sweden	1	1	1	1	0	1	0	1	1	0	1	1	0	1	1
UK	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1
Total data points included	**19**	**17**	**21**	**19**	**4**	**19**	**12**	**23**	**13**	**20**	**18**	**15**	**21**	**15**	**16**
Coverage of EU28 sector GVA of included data points [%]	**93**	**92**	**93**	**93**	**14**	**85**	**83**	**94**	**90**	**91**	**91**	**73**	**90**	**77**	**85**

Results: of the energy cost share calculation are presented in Figure 85 and Table 12, based on aggregated EU cost data for each sector.[33] Figures featuring country level comparison at sector level are provided in Annex 4.

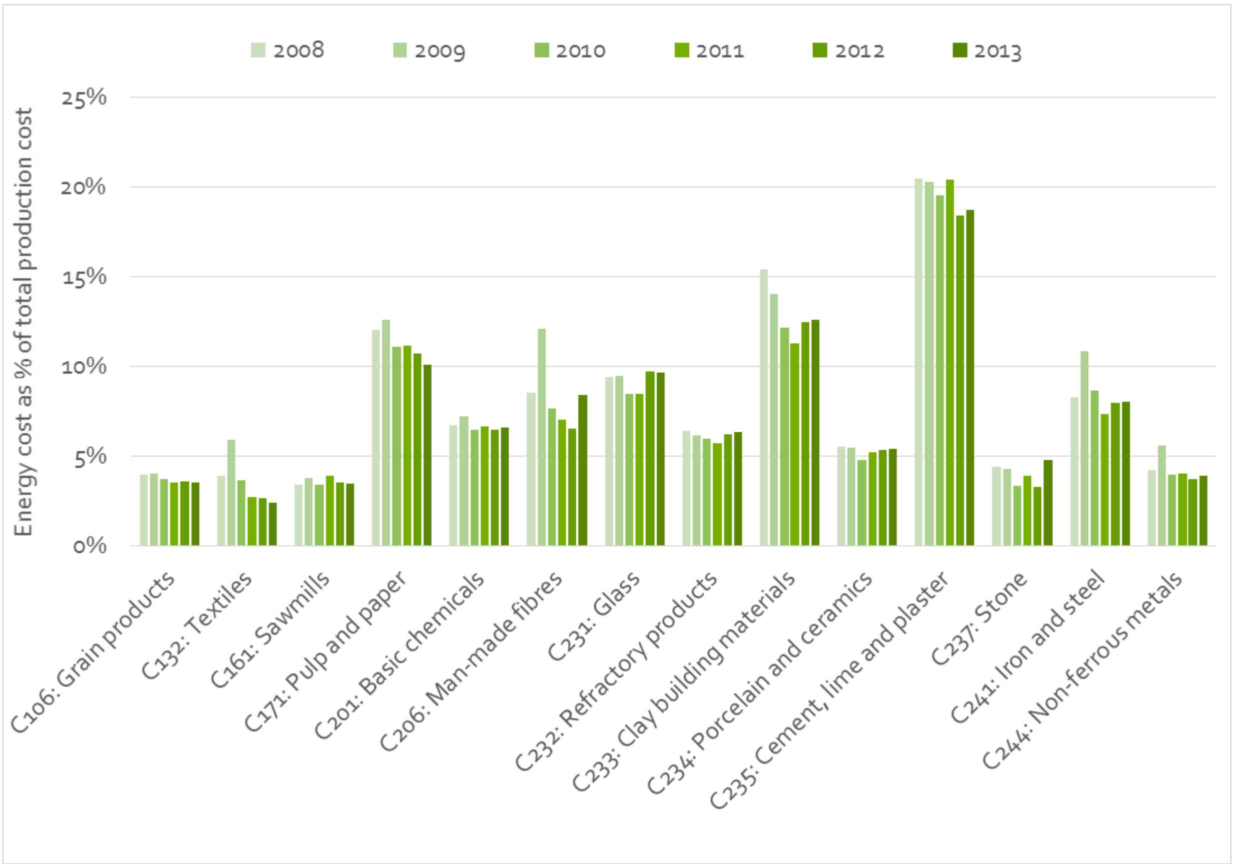

Figure 85: EU aggregated average energy cost as % of total production cost for all sectors

[33] Energy costs and production costs are aggregated per sector only for Member States where all data inputs are present across all years for the relevant sector so that a consistent basis of comparison is applied to all years. This somewhat limits the total number of data points (see Table 11) and can lead to differences in results compared to analysis of a single year, where other Member States may be included. As before, the refinery sector has been excluded as the energy cost data does not accurately reflect (significantly underestimates) the actual cost to the sector.

Table 12: Aggregated data on sector level (source: own calculations)

Sector	Average energy cost share: 2008-2013	Data points	Minimum value	Maximum value	Change 2008-2013 [%]	Change 2011-2013 [%]
C106 - Manufacture of grain mill products, starches and starch products	3.7%	19	1.3%	17.9%	-10.5%	-0.2%
C132 - Weaving of textiles	3.5%	17	0.5%	12.1%	-38.5%	-10.6%
C161 - Sawmilling and planing of wood	3.6%	21	0.6%	10.5%	2.1%	-11.4%
C171 - Manufacture of pulp, paper and paperboard	11.3%	19	2.8%	42.0%	-16.2%	-9.8%
C201 - Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms	6.7%	19	0.0%	6.7%	-1.8%	-1.3%
C206 - Manufacture of man-made fibres	8.4%	12	0.0%	20.4%	-1.9%	18.9%
C231 - Manufacture of glass and glass products	9.2%	23	1.9%	24.2%	2.3%	14.0%
C232 - Manufacture of refractory products	6.1%	13	1.1%	33.1%	-0.9%	11.8%
C233 - Manufacture of clay building materials	13.0%	20	3.2%	42.4%	-18.3%	11.7%
C234 - Manufacture of other porcelain and ceramic products	5.3%	18	0.9%	17.4%	-1.8%	4.3%
C235 - Manufacture of cement, lime and plaster	19.6%	15	12.7%	35.6%	-8.7%	-8.3%
C237 - Cutting, shaping and finishing of stone	4.0%	21	0.6%	24.8%	7.9%	21.6%
C241 - Manufacture of basic iron and steel and of ferro-alloys	8.5%	15	2.1%	26.8%	-2.9%	10.0%
C244 - Manufacture of basic precious and other non-ferrous metals	4.2%	16	0.7%	29.8%	-7.7%	-3.4%

Analysis of the results for energy costs as a share of production costs shows that based on the EU aggregate calculations for the data points in Table 11:

- **Energy costs for the selected sectors typically constitute between ~3-10% of total production costs**, only for the manufacture of pulp and paper, clay building materials and cement, lime and plaster are energy costs typically more than 10% of production costs.
- **Between 2008-2013 EU average energy cost shares have fallen in almost every sector,** some have seen large falls, it is particularly evident in the weaving of textiles sector, which observed a 39% decline in the energy cost share over this period.
  - **Energy cost shares did increase in the sawmills, glass and stone cutting sector over the period,** although the sawmills sector has seen a decline in this share between 2011-2013.
  - **Averaged across the EU absolute total energy costs decreased in all the sectors analysed between 2008-2013,** with decreases of 1-51% observed, this includes the sectors in which energy cost shares increased.
- **Between 2011 and 2013 energy cost shares have increased in half of the selected sectors,** the explanatory price factors are explored in the following sections.
  - **Averaged across the EU, total absolute energy costs increased in five sectors (grain, man-made fibres, glass, refractory products and stonecutting) between 2011 and 2013,** with increases of between 1-15%. Energy costs

decreased by between 1-20% in the other sectors. For three of these sectors (sawmills, glass and stonecutting) the decrease was less than the equivalent decrease in other production costs (leading to the increased energy cost share).

- **Aggregated EU28 production costs increased in only two sectors (grain and pulp and paper) in the same period,** by 8% and 1% respectively. Total costs decreased by 0-30% across the other sectors.

Note: for comparison the analysis was also carried out on the basis of production value rather than production costs. A similar analysis comparing to production value led to broadly similar results, only the cost shares were 5-10% lower, as production value also includes the margin on costs.

Comparing our energy cost results with other studies

A production value (gross output) basis was used in the 2014 European Competitiveness Study's (ECR 2014) Chapter 6 to also calculate energy cost shares at NACE 2-digit level (see table 6.5 in that report). This higher level of aggregation and also the difference in NACE version used (rev. 1.1 vs rev. 2), prevents a detailed comparison of data sets, and also goes a long way to explaining any differences. Nevertheless, matching on a broad basis it was possible to compare calculated values to find that these are broadly consistent with our results, see Table 13 below. For the sectors covering non-metallic minerals, the comparison cannot be made between the overall category other non-metallic minerals used in the ECR 2014 report and the specific NACE3 categories used in this report as the energy cost share for specific products, such as glass or cement would be expected to be very different from the sector as a whole[34].

Table 13: Comparison of 2011 energy cost shares of this study with closest match from 2014 European Competitiveness Study

Sector (NACE rev.2, NACE 3-digit)	2011 Energy cost/ production value – average of available EU28 data points	ECR 2014 Energy cost share, EU 2011	Sector match - NACE rev 1.1, NACE 2-digit level sector
C106: Grain products	3.3%	2.5%	Food, beverages and tobacco
C132: Textiles	2.6%	3.1%	Textiles and textile products
C161: Sawmills	3.7%	2.8%	Wood and products of wood and cork
C171: Pulp and paper	10.3%	3.2%	Pulp, paper, printing and publishing
C201: Basic chemicals	6.2%	7.4%	Chemicals and chemical products
C206: Man-made fibres	6.4%	3.5%	Rubber and plastics
C241: Iron and steel	7.2%	4.1%	Basic metals and fabricated metal
C244: Non-ferrous metals	3.8%	4.1%	Basic metals and fabricated metal

Therefore, the sector difference can clearly be explained. There are also some differences in the

[34] In more detail, the NACE 2 sector Non-metallic minerals assessed in the ECR 2014 study (energy cost share of 7.4%) covers the NACE 3 sectors C231 Glass, C232 Refractory products, C233 Clay products, C234 Porcelain and other ceramics, C235 Cement, Lime and Plaster and C237 Stonecutting. Therefore, a comparison of the ECR aggregate with the diverse sub-sectors makes little sense. This is also, although typically a lesser extent, the case for all of the other sectors.

overall trends presented in the two studies, in respect to energy cost shares. The sector definition again partly explains this, but there is also an important difference in time periods considered. The ECR 2014 evaluates changes over the period 1995-2011, whereas this work evaluates 2008-2013, clearly there were significant differences in key energy price and other industrial trends over these periods. In particular, there is a trend towards increased energy cost shares in the ECR 2014 driven by, for example, large oil (and therefore, also natural gas) price increases over the 1995-2011. Already high oil prices in 2008, meant that this same trend was not evident in our 2008-2013 analysis.

The same sector mismatch between our 3-digit NACE rev.2 based analysis and a 2-digit NACE rev.1 analysis can be seen when comparing results with those from the 2014 study by DG ECFIN into the "Energy Economic Developments in Europe". Again, a comparison can be made by calculating equivalent metrics, as shown in Table 14 below, where we calculate energy costs as a % of value added, equivalent to the Real Energy Unit Cost (RUEC) metric used in the DG ECFIN study. Here, small differences, such as in sector definitions, can lead to greater differences in results than with the ECR 2014 study as the DG ECFIN study uses value added as the denominator, which by being much small than production value, means that small differences in value added lead to significant changes in the RUEC ratio. Our results are broadly comparable for many of the sectors, although differences are large in the pulp and paper, man-made fibres and iron and steel sectors.

Table 14: Comparison of 2009 energy cost shares of this study with closest match from 2014 DG ECFIN study 'Energy Economic Developments in Europe', on basis of Real Unit Energy Cost (energy cost/value added [%]) equivalents.

Sector (NACE rev.2, NACE 3-digit)	2009 Calculated Real Unit Energy Cost (RUEC) [%] from aggregate of available EU28 data points	ECFIN 2014 RUEC [%], EU 2009	Sector match - NACE rev 1.1, NACE 2-digit level sector
C106: Grain products	20.4%	12.1%	Food, beverages and tobacco
C132: Textiles	22.2%	11.5%	Textiles and textile products
C161: Sawmills	16.6%	11.6%	Wood and products of wood and cork
C171: Pulp and paper	53.0%	11.0%	Pulp, paper, printing and publishing
C201: Basic chemicals	32.2%	33.2%	Chemicals and chemical products
C206: Man-made fibres	49.3%	13.4%	Rubber and plastics
C241: Iron and steel	72.4%	17.3%	Basic metals and fabricated metal
C244: Non-ferrous metals	32.1%	17.3%	Basic metals and fabricated metal

Similar to the ECR 2014 report the ECFIN study also analyses a different period of energy cost development at sector level, from 1995-2009, rather than 2008-2013 in this study. Therefore, there is very little period of overlap and not long enough to allow meaningful validation of our results. Comparing trends in our calculated RUEC, we observe that in 9 of the 14 sectors, our calculated RUEC increased between 2008-2013, consistent with the longer term trend also observed in the DG ECFIN study.

To understand the trends in energy cost shares it is also important to further decompose the trends in total production costs, to understand how energy costs have changed relative to other costs. We have undertaken this analysis at sector aggregate level, with full results presented in Annex 4. Examples from the pulp, paper and paperboard and iron and steel sectors are presented below in Figure 86. This figure and the broader sector analysis shows that:

- **On average between 2008-2013 total energy costs have changed more favourably, i.e. increased by less, decreased by more, than other production costs in absolute terms**, and therefore, have reduced as a share of total costs. For example, in the paper and pulp sector (see below), energy costs have decreased at the same time as other purchase costs have increased and personnel costs decreased but by less than energy costs. This trend is repeated across the sectors.
- **Between 2011-2013 the trend has reversed or is less pronounced in most sectors,** for example in the iron and steel sector the energy cost share has increased despite falling absolute energy costs, as the costs of other purchases has fallen faster.
    - **Commodity prices are understood to have played a role in this**, for example declining prices of iron ore have played an important role in the iron and steel sector. Comparing trends in energy and resource prices over the period 2008-2013 shows that resource prices have also typically increased significantly in the period 2008-2013, i.e. iron ore prices which switched from their stable long term price of ~US$15 per tonne until 2003-2004, to a rapidly increasing trend and a peak of more than US$175/tonne in 2011. This example is typical for many sectors. This goes some way towards explaining the decreasing relative share of costs taken by energy. In more recent years as the 'commodity boom' has slowed, this situation is likely to have reversed, with the more recent trends in cost shares in the period 2011-2013 already providing evidence supporting this.
- **The nature of energy as a (production volume) variable cost may explain at least part of the trend,** although full explanation is not possible on the basis of the available data. The fact that energy costs typically scale very closely with production volumes, yet other costs, i.e. personnel, rent, rates, services, may not be so flexible, can help to explain why energy costs generally vary more than other cost factors. In times of declining production this can act to reduce energy cost shares of total production costs, as other costs must still be paid or are difficult to reduce even if underutilised. In times of increasing production, the converse is true, as fixed costs remain fixed and underutilisation is eliminated. As can be seen in the iron and steel example, this is not always the case, i.e. energy cost shares increasing between 2011-2013 despite a decrease in total production costs. In this case other factors, such as commodity prices, and the imperfect match between production costs and actual production volumes, and therefore, consumption, both play a role.

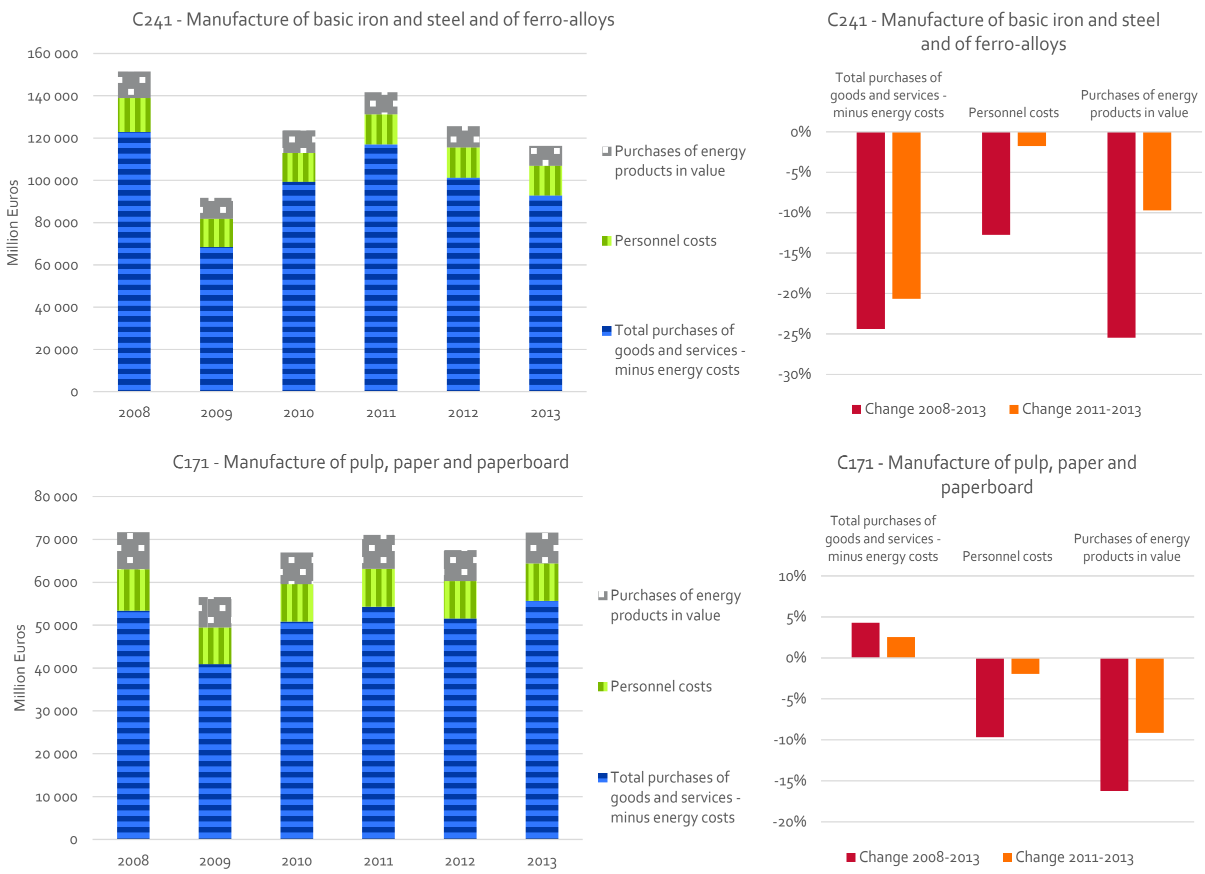

Figure 86: Absolute and relative changes in main production cost components for the paper and pulp and iron and steel sectors, 2008-2013 and 2011-2013, EU aggregates based on data points in Table 11.

Annex 4 provides the full sector- and Member State-level figures produced by the analysis, the key messages on energy costs that can be summarised from these more detailed figures are:

- **The energy cost shares within a sector can cover a very large range**, from Member States where the energy cost share is only a few percent of the total production cost, to Member States where the energy cost share is many times the average, and more than 40% of total production costs in some years.
- **A cluster of countries (BG, HR, CY, EL, HU, LT, LV, PT, RO, SK) typically have higher than average energy cost shares within total production costs,** this is consistent with average wages being lower in these countries and therefore, personnel costs contributing a lower share of total costs than elsewhere.

Production cost structure from case studies

NACE C2410 - Manufacture of basic iron and steel and of ferro-alloys Austria and Germany have a rather similar magnitude of intensity of energy product costs to production value between 2008 and 2015 (0.14 €/€ Austrian average and 0.10 €/€ German average). The average Italian energy product costs intensities are significantly lower at 0.05 €/€. This difference is mainly due to Italy having a much higher share of the less energy intensive EAF-production route (EAF production shares in 2013: AT 8%, DE 32%, IT 72% (Steel Statistical Yearbook 2014)).

NACE Rev 2 C1712 Paper making. In Sweden and in Germany, energy purchases are roughly 0.12€/€ of production value. In Sweden this value has been decreasing slightly to ca. 0.1€/€ over the past years. In Finland, energy purchases make up only around 0.08€/€ of production value. The different cost structure of the three focus countries is likely rooted in a difference in product portfolio and industry structure. In the Nordic countries, fine paper mills have often been built adjacent to a pulp mill (JRC 2015) which allows synergies e.g. through the use of black liquor - for Sweden 60% of the energy used in papermaking is biofuels (for Finland no data was available).

NACE Rev 2 C2442 Aluminium production. NACE 2442 includes several products among them semi-finished products as well as alloyed aluminium (usually delivered as bulk as well). Comparing the German, Greek and French production cost structure shows, that Greece has a rather high energy product cost intensity to production value. With an average of approximately 0.16 €/€ by product costs to production value between 2008 and 2015 it is significantly higher than in Germany (0.06 €/€) and France (0.05 €/€). The difference in the Greek case is likely rooted in the sector structure since Greece has little downstream activity. Alloyed aluminium up to customer requests usually creates a higher value added which may contribute to lower intensities e.g. in Germany.

NACE Rev 2. C2313 Manufacture of hollow glass. Purchases of energy products are around 0.1€/€ in France, and slightly higher with around 0.12€/€ in Germany. In Italy, energy purchases were only roughly 0.5€/€ from 2010 to 2012 and are still below 0.10€/€ after an increase in 2013. No energy consumption details were available except for Germany so it is difficult to identify the main reasons for the difference.

NACE Rev 2 C2013 Manufacture of other inorganic basic chemicals. Comparing the French, German and UK (the major value added contributors of the EU28) production cost structure shows, that while Germany and UK have a higher magnitude of intensity of energy product costs to production value between 2008 and 2015 (0.11 €/€ German average and 0.11 €/€ United Kingdom average), the average French energy product costs intensities are significantly lower at 0.04 €/€. As shown in Figure 73 and Figure 74, electricity prices in France are significantly lower than the UK and Germany which will contribute to the lower intensity. Several other factors will also play a part e.g. production process, integration with other

5.6.2 Energy prices and energy costs – a sector and energy carrier level analysis

As already discussed, energy costs are a product of many different factors, but the two most important factors are energy prices and the quantity of energy consumed. In this section we first analyse the importance of each energy carrier in consumption and how via prices this translates to its importance to total energy costs. Following this, we analyse the sensitivity of total energy costs to the price changes in energy carriers observed in the period 2008-2013.

Importance of energy carriers in consumption and costs

Approach: Energy consumption data per energy carrier is multiplied by prices per energy carrier as calculated using the industrial energy prices tool, see section 5.1 for the method used to generate the price data per country and sector and the assumptions made. For the consumption and cost data the figures represent the shares of the total based on summing the total consumption per energy carrier of available data points. Consumption of other energy carriers i.e. heat, biomass, are excluded as price data is not available for these carriers. This is most relevant for the sawmills (84% of energy consumption), pulp and paper (43%), basic chemicals (35%) and cement, lime and plaster sectors (38%). In all other sectors other energy consumption was less than 5% of the total.

Data source: National statistics and the Odyssey-Mure dataset. These provide energy consumption per energy carrier (electricity, natural gas, petroleum products, coal, other) per sector, which are converted to TWh.

Price data for electricity and natural gas was calculated from the tool used in section 5.2. Price data for oil (petroleum products) was sourced from Eurostat: prices for Heating Oil without taxes. Price data from coal is based on the monthly prices reported in the Platts CIF ARA 6,000 NAR.[35]

Coverage: The calculation was carried out for the limited number of countries and sectors for which the data is available – see Table 8.

Results: Aggregated results of the handful of available data points are presented in Figure 87 and Figure 88. This shows the average importance of fuels per sector. This shows for the available data points:

- **Electricity consumption has a bigger influence on total energy costs than other energy carriers, due to its relatively high price.** It is influential across all sectors, particularly in textiles, man-made fibres and non-ferrous metals. It is also influential in

[35] The Platts CIF ARA 6,000 NAR is a daily 15-60 day forward price assessment for thermal coal shipped from Colombia, Russia, South Africa, Poland, Australia or the US to the northwest European trading hub of Amsterdam, Rotterdam and Antwerp. The term '6,000 NAR' refers to the net calorific value (heating value) of the coal in kilocalories per kilogram.

sawmills and pulp and paper, but other (non-quantified) energy costs are likely to play a significant role and diminish the relative importance of electricity.

- **Natural gas consumption is important in most sectors, but it has a lesser influence on energy costs.** It remains significant (>30% share of costs) in the grain milling, glass, refractory products, clay building products, clay building materials and porcelain and ceramic products sectors. It also has a high share in the basic chemicals sector, but other (non-quantified) costs would diminish the importance of natural gas. Natural gas is not important in the sawmills, cement, lime and plaster, and stone-cutting sectors.
- **Oil (petroleum products) and especially coal have a relatively small influence on energy costs, even if consumption is high**. This is relevant only to a few sectors, i.e. glass, cement, lime and plaster, and stone-cutting for oil; and cement, lime and plaster, and iron and steel for coal.

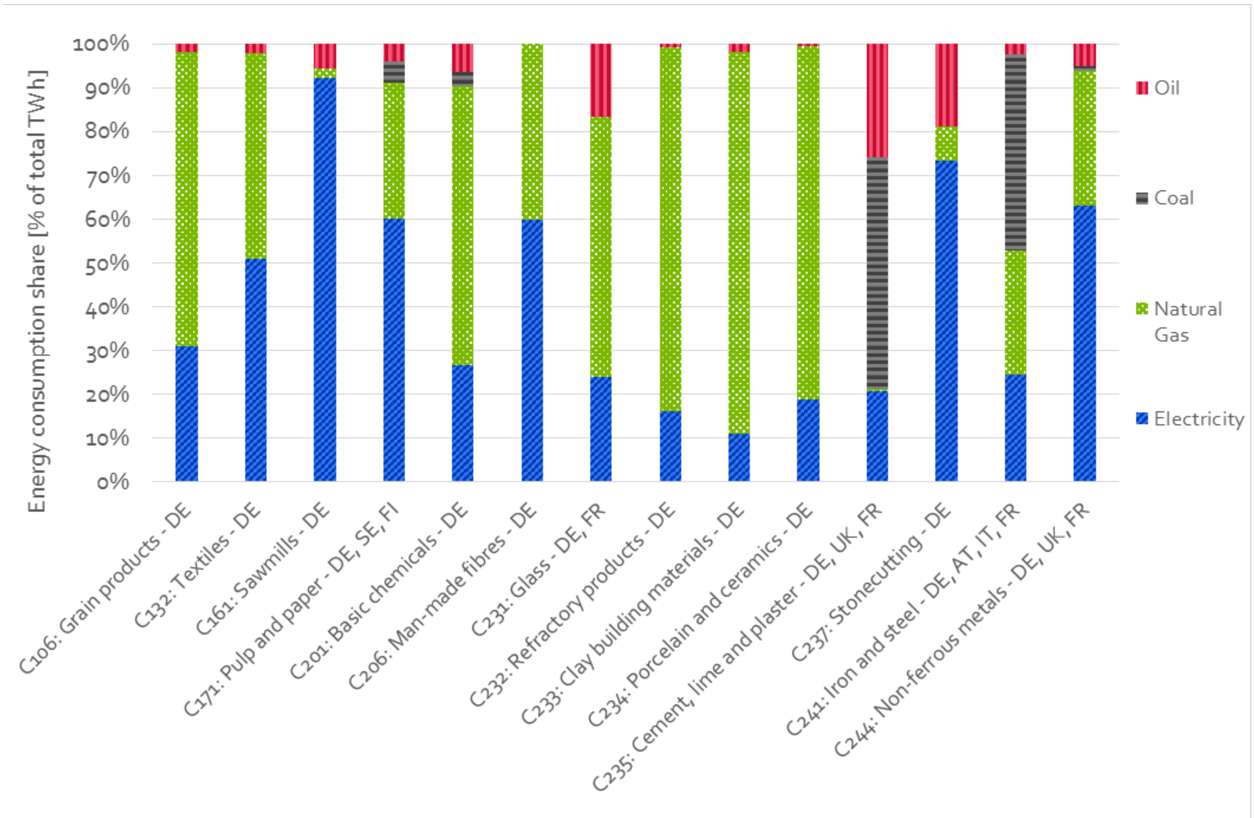

Figure 87: Average energy consumption shares per energy carrier per sector – based on available data points (see Table 8), 2008-2013 averages

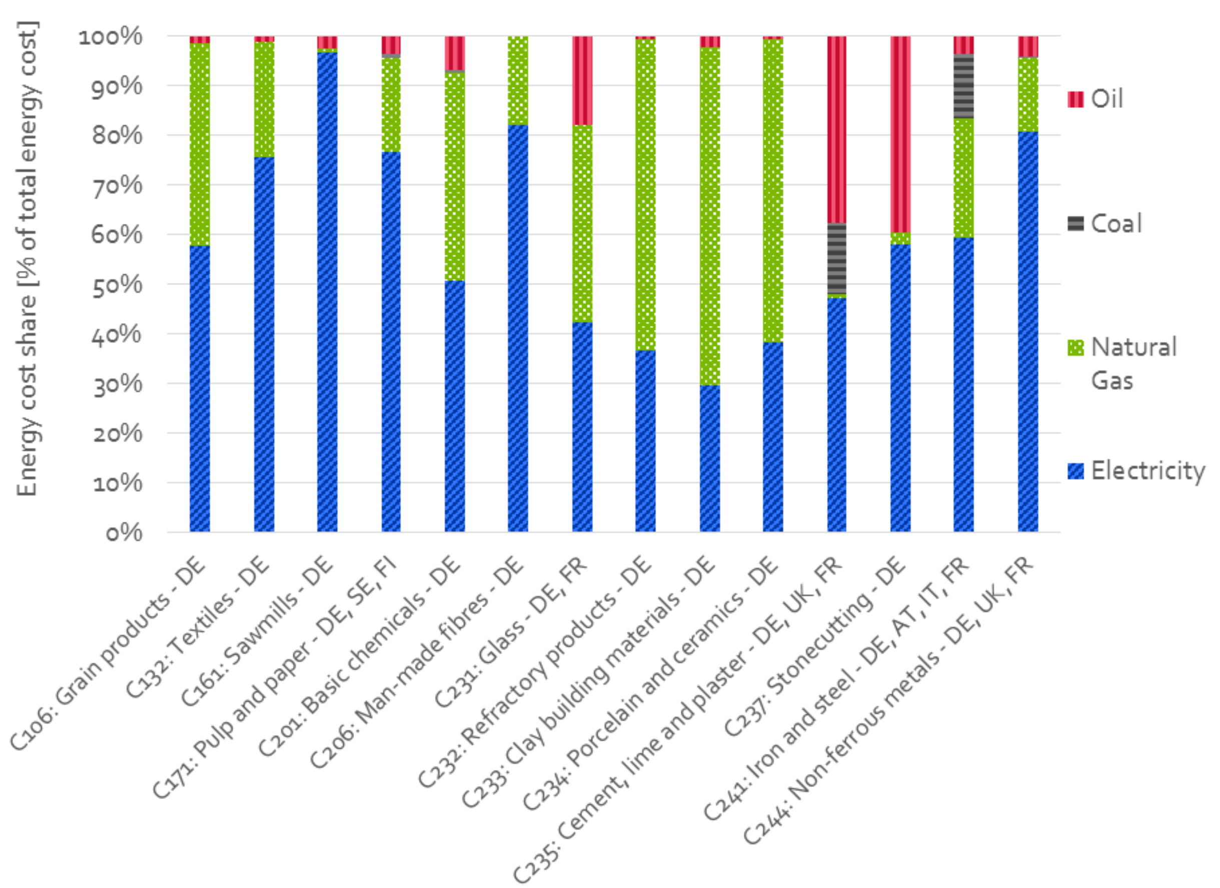

Figure 88: Average energy cost shares per sector – based on available data points, split by energy carrier, 2008-2013 averages

The figures presented above, based on the aggregated data, generally represent the average picture across the data points, but there are some sector and Member State specific variations of interest, summarised as follows:

C171 – manufacture of paper, pulp and paperboard – in Germany there is significant consumption and costs attributable to the use of natural gas in the sector. Natural gas is not used in either Sweden or Finland. Natural gas prices in Germany are therefore, important for this sector, while electricity prices are crucial in Sweden and Finland, with the costs of other energy carriers (heat, biomass) also of particular importance in Sweden.

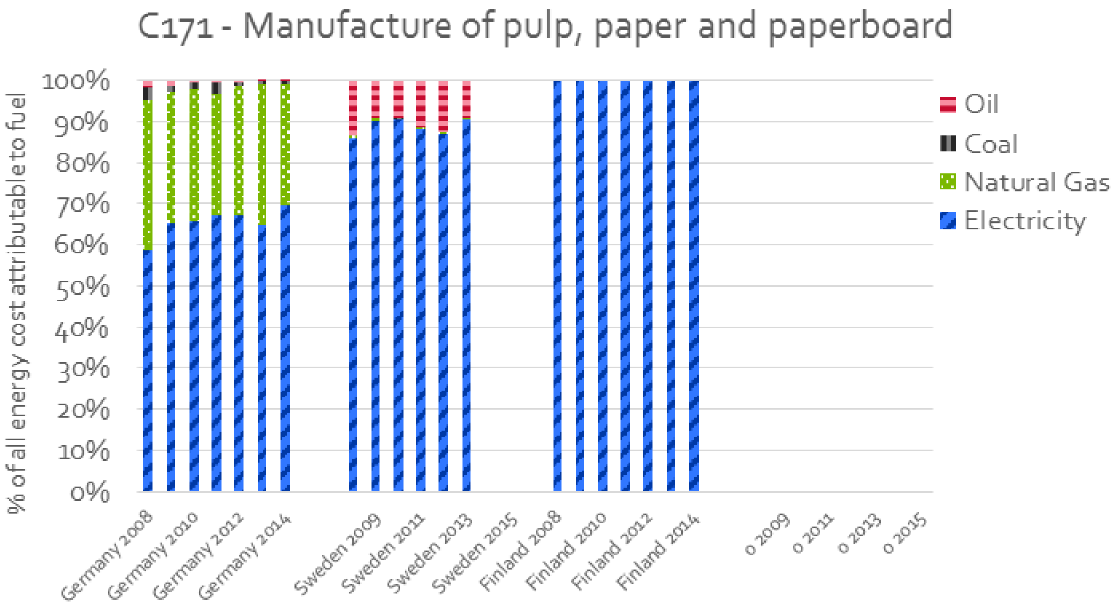

Figure 89: Energy cost structure for the paper and pulp sector, excluding other energy carriers (source: own calculations based on national statistics)

C235 – Manufacture of cement, lime and plaster – a divergence in energy costs can be observed between each of the three Member States, Germany and UK both incurring around 60% of their energy costs from electricity, despite its share in consumption being relatively low (10-15%) in each. Part of this is explained by other (non quantified) energy consumption increasing the relative importance of each energy carrier, including electricity. It also exemplifies the role of relatively high electricity prices and especially the role of relatively low coal prices. The cost share for electricity in France is much lower as electricity prices for the sector are around 30-40% lower than in Germany and the UK.

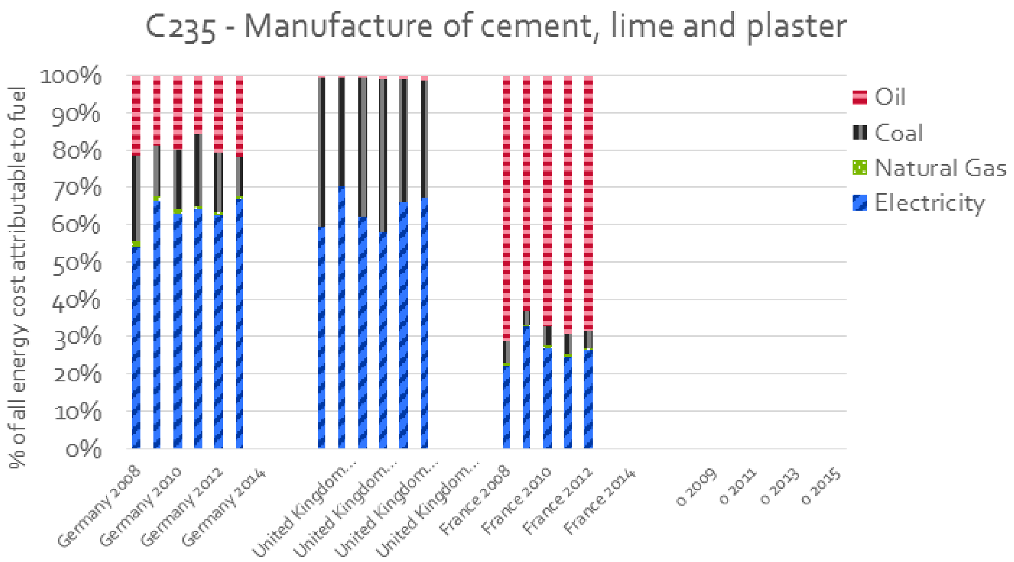

Figure 90: Energy cost structure for the manufacture of cement, lime and plaster, excluding other energy carriers (source: own calculations based on national statistics)

5.6.3 Energy price sensitivity analysis

Based on the data points in the previous section it is possible to further develop the analysis to examine the extent to which price changes in the energy carriers over the period 2008-2013 may have influenced the energy costs of a sector.

Approach: our approach takes the energy cost share as a proportion of total production costs, allocates this across the different energy carriers in proportion to their cost share and then using the change in prices of each energy carrier estimates the impact on total production costs of the price movements.

The energy cost share as a proportion of total production costs used corresponds to the averages presented in Table 12 in section 5.6.1.

The cost shares are modified by subtracting a proportion attributed to ‘other’ energy carriers, i.e. heat, biomass for which no price or cost data was available. This is carried out on the basis of their proportion in consumption, i.e. in the pulp and paper sector the ‘other’ energy carrier category is responsible for 43% of energy consumption, therefore the 2008-2013 average energy cost share for the pulp and paper sector of 11.3% is reduced by 43% to 6.4%. This is a simplification and implies an assumption that the cost of ‘other’ energy carriers is proportional to consumption which has only a limited basis. This assumption is most relevant for the sawmills (84% of energy consumption), pulp and paper (43%), basic chemicals (35%) and cement, lime and plaster sectors (38%), these are marked with an * in the figure below to denote the uncertainty associated with the results based on the assumption above. In all other sectors 'other' energy carrier consumption was less than 5% of the total energy consumption and therefore has little impact on the results.

The remaining energy cost share is then split across the energy carriers in proportion to the energy carrier share in total energy costs as presented in Figure 88. Giving the energy carrier specific energy cost as a share of total production cost. This is presented in Table 15.

Table 15: Calculated energy carrier specific proportions of total production costs per sector

Sector	Energy cost share as a % of total production cost: 2008-2013 average	Other' energy carrier consumption as % of total consumption fuel proportion	Revised energy cost share as a % of total production cost	Of which:			
				Electricity	Natural Gas	Coal	Oil
C106: Grain products	3.7%	3.8%	3.6%	2.1%	1.5%	0.0%	0.1%
C132: Textiles	3.5%	0.0%	3.5%	2.7%	0.8%	0.0%	0.0%
C161: Sawmills*	3.6%	84.2%	0.6%	0.5%	0.0%	0.0%	0.0%
C171: Pulp and paper*	11.3%	43.0%	6.4%	4.9%	1.2%	0.1%	0.2%
C201: Basic chemicals*	6.7%	35.5%	4.3%	2.2%	1.8%	0.0%	0.3%
C206: Man-made fibres	8.4%	0.0%	8.4%	6.9%	1.5%	0.0%	0.0%
C231: Glass	9.2%	2.1%	9.0%	3.8%	3.6%	0.0%	1.6%
C232: Refractory products	6.1%	0.0%	6.1%	2.3%	3.8%	0.0%	0.0%
C233: Clay building materials	13.0%	4.8%	12.3%	3.7%	8.4%	0.0%	0.3%
C234: Porcelain and ceramics	5.3%	3.6%	5.1%	2.0%	3.1%	0.0%	0.0%
C235: Cement, lime and plaster*	19.6%	37.8%	12.2%	5.8%	0.1%	1.8%	4.6%
C237: Stonecutting	4.0%	0.0%	4.0%	2.3%	0.1%	0.0%	1.6%
C241: Iron and steel	8.5%	1.1%	8.4%	5.0%	2.0%	1.1%	0.3%
C244: Non-ferrous metals	4.2%	1.1%	4.2%	3.4%	0.6%	0.0%	0.2%

The energy prices are sourced from the industrial energy price tool which provided the prices of electricity and natural gas paid by consumers taking into account the various exemptions. The results were extracted on the basis of an assumed consumption band, see Table 16 below, this was derived from the energy consumption data available from a limited number of countries (see Table 8), divided by the number of firms active in the sector in those countries.

Table 16: Assumed consumption and bands per sector for electricity and natural gas

Sector	Assumed average firm electricity consumption [GWh]	Eurostat electricity consumption band	Assumed average firm natural gas consumption [GWh]	Eurostat natural gas consumption band
C106: Grain products	14.0	ID	26.9	I3
C132: Textiles	4.4	ID	3.7	I3
C161: Sawmills	3.2	ID	0.0	I2
C171: Pulp and paper	87.4	IF	127.1	I4
C192: Refineries	111.3	IF	0.0	
C201: Basic chemicals	75.0	IF	177.2	I4
C206: Man-made fibres	31.1	IE	58.9	I4
C231: Glass	10.3	ID	33.3	I4
C232: Refractory products	3.5	ID	15.8	I3
C233: Clay building materials	6.3	ID	47.1	I4
C234: Porcelain and ceramics	3.0	ID	11.1	I3
C235: Cement, lime and plaster	46.7	IE	19.5	I3
C237: Stonecutting	2.2	ID	0.3	I2
C241: Iron and steel	222.2	IF	663.4	I5
C244: Non-ferrous metals	51.5	IE	32.1	I4

Prices are converted to EU averages and weighted by the Member State share in total EU production costs. The same data filter as for energy cost shares (see section 5.6.1) is applied so that only member states and sectors for which data is available for all years is used. As a result the coverage of EU totals is also similar in the range of 85-95% of the EU total. The weighted average prices per sector used for the calculation are presented below:

Table 17: EU production cost weighted average industrial electricity prices (including exemptions) per sector 2008-2013 [EUR/MWh]

Sector	2008	2009	2010	2011	2012	2013	2008-2013 Change	2014	2015
C106: Grain products	97.2	95.5	94.2	101.6	108.3	112.6	**15.9%**	113.3	114.8
C132: Textiles	107.7	108.8	106.2	115.3	128.9	134.8	**25.2%**	132.6	130.9
C161: Sawmills*	87.5	90.3	91.2	94.2	96.9	98.5	**12.5%**	96.6	97.2
C171: Pulp and paper*	78.3	74.9	79.8	82.8	83.4	82.2	**5.0%**	81.4	78.5
C201: Basic chemicals*	82.5	79.6	82.1	90.4	93.0	98.9	**19.9%**	101.1	98.7
C206: Man-made fibres	102.2	97.7	96.4	104.1	111.3	112.8	**10.4%**	113.0	109.3
C231: Glass	91.6	93.0	91.9	99.1	105.1	111.7	**22.0%**	111.3	111.5
C232: Refractory products	100.1	102.1	101.7	107.3	113.5	116.0	**15.9%**	115.1	116.0
C233: Clay building materials	105.3	105.9	103.4	111.6	122.6	128.2	**21.8%**	126.1	123.2
C234: Porcelain and ceramics	93.0	94.0	93.3	102.6	108.4	116.2	**25.0%**	115.8	116.8
C235: Cement, lime and plaster*	85.6	85.8	85.1	93.5	99.4	103.5	**21.0%**	102.6	100.0
C237: Stonecutting	106.4	107.8	105.4	112.7	125.8	129.9	**22.1%**	128.3	126.9
C241: Iron and steel	78.5	76.9	81.8	86.2	87.8	93.9	**19.6%**	92.4	89.0
C244: Non-ferrous metals	87.4	85.8	85.1	95.4	99.0	105.9	**21.2%**	105.9	102.8

Table 18: EU production cost weighted average industrial natural gas prices (including exemptions) per sector 2008-2013 [EUR/MWh]

Sector	2008	2009	2010	2011	2012	2013	2008-2013 Change	2014	2015
C106: Grain products	38.17	29.77	31.08	34.59	38.37	39.46	**3.4%**	36.47	36.10
C132: Textiles	38.86	29.00	31.49	34.82	38.50	39.35	**1.3%**	36.05	35.83
C161: Sawmills*	47.72	45.94	46.56	51.92	57.15	55.31	**15.9%**	52.23	51.57
C171: Pulp and paper*	36.84	31.38	31.12	35.35	36.37	36.85	**0.0%**	32.97	32.00
C201: Basic chemicals*	36.21	29.01	29.32	32.30	34.06	35.33	**-2.4%**	31.32	30.77
C206: Man-made fibres	34.48	27.20	28.84	32.00	33.89	34.37	**-0.3%**	30.62	30.35
C231: Glass	34.86	27.74	28.83	31.80	34.03	34.71	**-0.4%**	31.37	30.81
C232: Refractory products	39.31	31.37	33.87	36.90	38.53	41.25	**4.9%**	37.48	36.98
C233: Clay building materials	33.98	25.74	27.60	31.22	34.61	34.76	**2.3%**	31.86	31.07
C234: Porcelain and ceramics	39.44	30.30	32.89	36.49	39.01	41.83	**6.1%**	38.02	37.64
C235: Cement, lime and plaster*	36.43	28.77	31.56	35.03	39.26	40.92	**12.3%**	37.74	36.88
C237: Stonecutting	41.25	34.25	36.58	41.54	46.48	47.98	**16.3%**	45.21	43.81
C241: Iron and steel	34.54	26.97	27.95	31.42	33.61	33.35	**-3.5%**	30.29	29.44
C244: Non-ferrous metals	30.49	22.76	27.98	30.91	33.34	33.91	**11.2%**	29.10	29.06

For oil (petroleum products) prices were calculated to have increased by 9% in all sectors between 2008-2013, and coal, on the basis of the Platts CIF ARA prices were calculated to have decreased by 38% across all sectors between 2008-2013.

The changes in the weighted average prices are then calculated and multiplied by the energy carrier share of total production costs to calculate the impact on total production costs of the price change.

Data sources: are the same as those for section 5.6.1 and 5.6.2.

Coverage: The main figure presented below represents an EU average price impact based on production costs coverage corresponding to Table 11 and energy carrier cost shares based on the more limited dataset per sector as described in Table 8.

Results: of the calculated impact of the change in energy prices per energy carrier 2008-2013 per sector are presented below in Figure 91. This shows that:

- **The net effect on total production costs of energy price changes is calculated at 1% or less in every sector between 2008-2013**.
- **Weighted average electricity prices increased in every sector, leading to an increase in total production costs of between 0.1%-1.2% across the sectors.** The impact was particularly acute in the iron and steel and cement, lime and plaster sectors.
- **Weighted average natural gas price movements had very little impact on total production costs.** A maximum impact of +0.2% was experienced in the refractory products, clay building material and porcelain and ceramics sectors. Weighted average natural gas prices decreased slightly in four sectors: iron and steel, basic chemicals, man-made fibres and glass.
- **Sectors which use coal may have benefitted from price changes, or at least offset the impact of increasing prices of other energy carriers.** This is particularly relevant for the cement, lime and plaster and iron and steel sectors. As noted in the previous section (see Figure 90), for cement, lime and plaster, these prices changes could have benefitted the sector in the UK more than in Germany and France given the larger role of coal in energy costs.
- **Between 2013-2015 the impact of energy price changes would be towards lower production costs.** As weighted average industrial electricity and natural gas prices have been stable or declined since 2013. This is on the basis of 2014 and 2015 price data, used along with 2013 production cost weighting assumptions for 2014 and 2015 and the other assumptions remaining the same.
- **There are important limitations to these results**, including the missing other energy carriers noted above, namely:
    - The energy carrier split is based on only a very limited number of data points – but this assumption is extended to the sector across the EU.
    - The energy carrier split is assumed to remain constant over time, no fuel switching – in reality there will have been fuel switching so the actual price impacts on production costs may have been lesser or greater than shown. This variable is frozen to isolate the energy price impacts.
    - The energy cost share is also assumed as a single value which does not change over time, as shown in 5.6.1 this is not the case. This variable is frozen to isolate the energy price impacts.
    - The impact varies depending on the start and end date selected and the respective price movements. For electricity prices weighted average prices particularly increased between 2010 and 2013, they have since stabilised or fallen between 2013-2015. For Natural gas a sharp weighted average price fall was observed between 2008-2009, then, similar to electricity, natural gas prices increased towards a 2013 peak before stabilising or falling in the period 2013-2015.

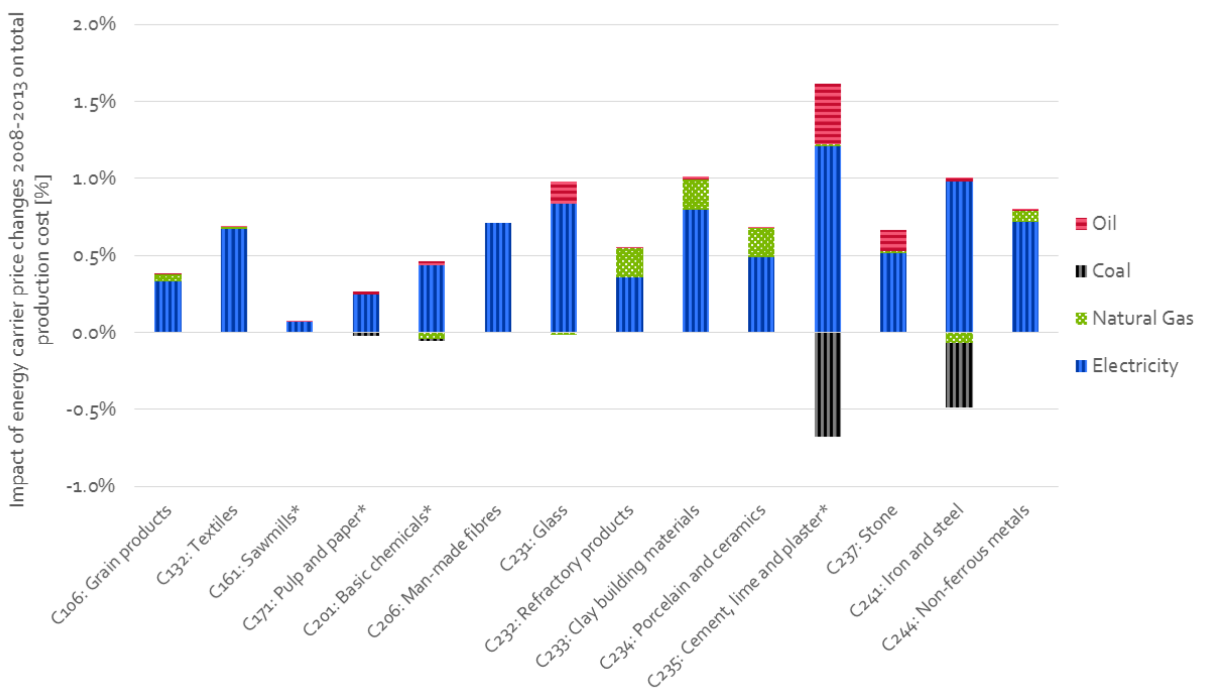

Figure 91: Estimated sector level impact of changes in price of energy carriers 2008-2013 on total production cost of sector. * = sectors where other energy carriers, whose costs were unquantifiable, play a significant role in the sector and which adds increased uncertainty to the results.

5.6.4 Summary of analysis per sector

The previous, and following sections, provide analysis per indicator to allow cross comparison across sectors. It is also interesting to present the analysis grouped by sectors to elaborate the main trends within a sector between 2008-2013. A full per sector grouping of the figures presented in chapter 5 is provided in Annex 4, with a summary of the key results and trends. Here we present a distilled summary of the key findings per sector. The interested reader is referred to the Annex 4 for the data and more detailed considerations.

Manufacture of grain mill products, starches and starch products

The EU average energy cost as a share of production costs was 3.7% over 2008–2013 and a decreasing energy cost share was observed in this period. The total energy costs in the EU also fell over that same period. Compared to the US, EU energy costs represented a lower share of the total production costs over 2008–2010. However, the energy cost share in the US fell over 2010–2013, and in 2013 the share of energy costs in the US was lower than in the EU. The energy intensity in the EU peaked in 2010 and was higher than in the US. The EU average gross operating surplus as a percentage of total production costs declined over 2011–2013.

Weaving of textiles

The EU average energy cost as a share of the total production cost and total energy costs in the EU declined over 2008–2013. The total energy costs in the EU also fell over that same period. The average energy cost as a percentage of total production costs was generally lower in the EU than in the United States. However, the average energy cost share in Japan was substantially lower than in the EU. The energy intensity in the EU was relatively stable and substantially lower than in the US.

Sawmilling and planing of wood

The EU average energy cost as a share of the total production cost over 2008–2013 was 3.6%, and the energy cost share was relatively stable. However, the total energy costs in the EU fell over that same period. Energy cost shares in the US were generally higher than in the EU, however, energy cost shares in Japan were substantially lower. The energy intensity in the EU grew over 2009–2012 and then fell in 2013. The gross operating surplus as a percentage of total production costs in the EU was relatively stable at about 7% over 2011–2013.

Manufacture of pulp, paper and paperboard

The EU average energy cost as a share of the total production costs decreased over 2008–2013, and the total energy costs also fell over this period. Energy cost shares in the US were higher than in the EU, however, energy cost shares in Japan were substantially lower. The energy intensity in Japan was lower than in the US and the EU. The gross operating surplus as a percentage of total production costs in the EU declined over 2011–2013 from 10% to 8%.

Manufacture of refined petroleum products

As noted in the main report, statistics for this sector can be misleading. Energy costs for the sector in reality include both energy used in processes and also fuels purchased for processing, both of which are subject to energy price fluctuations. There was limited data availability on the energy costs and gross operating surpluses as a share of total production costs in the EU. The total energy cost increased over 2010–2013.

Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms

The EU average energy cost as a share of the total production costs was 6.7% over 2008–2013, and the energy cost share was relatively stable over this period. However, the total energy cost over this period decreased. In 2013, the energy cost as a percentage of total production costs in the US was lower than in the EU, while over 2008–2010, energy costs as a percentage of total production costs in Japan were lower than in the EU. The energy intensity in the EU was higher than in Japan and the US. The gross operating surplus as a percentage of total production costs in the EU declined from 10% to 9% over 2011–2012, and was stable in 2013.

Manufacture of man-made fibres

The EU average energy cost as a share of the total production cost peaked at 12.1% in 2009, fell over 2010–2012, and increased slightly in 2013 to 8.4%. Over 2008 – 2013, the total energy cost also declined. The energy cost as a share of the total production cost in the US fell more rapidly than in the EU over 2008–2013. The energy intensity in the EU peaked in 2009 and declined over 2010–2011. The energy intensity in 2013 was higher than 2011 levels.

Manufacture of glass and glass products

The EU average energy cost as a share of the total production costs fell from the 2008-2009 level of 9.4% to 8.5% in 2010–2011. Also, total energy costs in the EU in 2013 were lower than in 2008. Over 2008–2011 and 2013, energy costs as a percentage of total production costs in the US were higher than in the EU. The energy intensity in the EU peaked in 2009 and declined in 2010; since then, the energy intensity rose slightly. The gross operating surplus as a percentage of total production costs in the EU declined slightly over 2011–2013 from 11% to 10%.

Manufacture of refractory products

The EU average energy cost as a share of the total production cost was 6.1% over 2008–2013 and the energy cost share was relatively stable over this period. However, total energy costs in the EU fell over 2008–2013. The energy intensity in the EU peaked in 2009, and declined over 2010–2013. The gross operating surplus as a percentage of total production costs in the EU was about 9% over 2011–2013.

Manufacture of clay building materials

The EU average energy cost as a share of the total production cost fell from a peak of 15.4% in 2008 to 11.3% in 2011; over 2012–2013, the energy cost share rose slightly. Total energy costs in the EU fell over 2008–2013. The energy intensity in the EU peaked in 2008 and declined over 2009–2010. The average gross operating surplus as a percentage of total production costs fell from 13% in 2011 to 11% in 2012–2013.

Manufacture of other porcelain and ceramic products

The EU average energy cost as a share of the total production cost over 2008–2013 was 5.3%. Apart from a slight decline in 2010, and the energy cost share was relatively stable over this period. However, total energy costs in the EU fell over 2008–2013. Over 2008–2011 and 2013, energy costs as a percentage of total production costs in the US were higher than in the EU. The energy intensity in the EU[36] peaked in 2009 and declined over 2011–2013. The average gross operating surplus as a percentage of total production costs over 2011–2013 was 10%.

Manufacture of cement, lime and plaster

The EU average energy cost as a share of the total production cost decreased from 20.5% in 2008 to 18.7% in 2013. Total energy costs in the EU also fell over this period. Over 2008–2011 and 2013, energy costs as a percentage of total production costs in the US were higher than in the EU. The energy intensity in the EU rose gradually over 2008–2012. The gross operating surplus as a percentage of total production costs fell from 23% to 16% over 2011–2013.

Cutting, shaping and finishing of stone

The EU average energy cost as a share of the total production cost fluctuated over 2008– 2013, ranging from 3.4–4.8%. However, total energy costs in the EU fell over this same period. In 2008 and 2013, the EU average energy cost as a percentage of total production cost was higher than in the United States; an inverse trend was observed 2009–2011. The average gross operating surplus as a percentage of total production costs over 2012-2013 was 13%.

Manufacture of basic iron and steel and of ferro-alloys

The EU average energy cost as a share of the total production cost fluctuated over 2008–2013, ranging from 7.3–10.9%. However, total energy costs in the EU fell over 2008–2013. Energy costs as a percentage of total production costs were generally lower in the US and Japan than in the EU. The energy intensity in the EU rose in 2009 and 2010, dipped slightly in 2011, and increased in 2012 to the peak value over 2008-2012. The gross operating surplus as a percentage of total production **costs fell from 4% to 2% over 2011–2012 and remained constant in 2013.**

Manufacture of basic precious and other non-ferrous metals

The EU average energy cost as a share of total production costs peaked in 2009 at 5.6% and then gradually fell to 2013 level of 3.9%. The total energy costs in the EU fell over 2008–2013. Energy costs as a percentage of total production costs were lower in the US and Japan than in the EU. The energy intensity in the EU declined over 2008–2012. The gross operating surplus as a percentage of total production costs at an EU level was 6% in 2011 and 5% in 2013.

[36] Of Member States with available data, see table 6 in the main report.

5.7 International competitiveness of EU industry

Analysis of the competitiveness position for industry is complex and involves many more factors than energy prices. There is a wide body of literature on this issue, including the European Competitiveness Report and sector specific studies, such as Oxford Economics (2014) and Ecofys (2016). In this report, we concentrate on the role of differences in energy costs between countries, both in total and as a share of total production costs.

In general, it is challenging to draw robust conclusions at sector level as there is a lack of comparable data at sector level for competitor countries. We therefore, provide some general observations on the relative trends in energy prices and costs, supplemented by more insights from case studies on specific sectors and products. These case studies are detailed in Annex 5. It should be noted that the case studies give some insight at the sector level but still suffer from some of the limitations discussed in section 5.3.2 and do not give specific insights into company level competitiveness.

5.7.1 Industrial energy prices – an international comparison

The price paid for energy is a key driver of energy costs, in this section we analyse published data on electricity and gas prices for industrial consumers. By comparing international prices, we can provide insight into the relative role of energy prices in energy costs. As discussed previously, the price paid by individual companies is determined by a number of factors and may of course be much higher or lower than the average.

Approach: Industrial energy prices are presented. These are the nominal values harmonised to MWh and converted to euros using exchange rates as published by the European Central Bank[37]. EU weighted average industrial energy prices are also included, excluding any exemptions. As shown for the EU in section 5.1 exemptions play a crucial role in the actual prices paid by industry, in many cases reducing the price paid by half or more. Exemptions for industrial consumers internationally are unknown, but can be assumed to exist to a greater or lesser extent than those in the EU. The data should therefore, be interpreted with this in mind. If international price exemptions are more generous than the EU, then the competitiveness impact of price differences will be greater than suggested by the basic price trend analysis.

Data sources: Industrial energy price data for G20 countries (excluding the EU Member States) was obtained from two sources: the IEA database[38] on energy prices and CEIC data[39] (see below). In addition, for the United States, regional energy prices from the Energy Information Administration

[37] https://www.ecb.europa.eu/stats/exchange/eurofxref/html/index.en.html
[38] IEA database of energy prices provided by DG ENER
[39] Accessed from http://www.ceicdata.com/en under licence

was extracted. The data availability and limitations of each source are given in Annex 4. Data on prices were relatively scarce, particularly for fuels other than electricity.

The IEA database provides annual data on the prices and taxes on electricity and natural gas in the industrial sector. Comparison of the IEA energy prices for EU countries and Eurostat price data shows that the IEA electricity prices are closest to Eurostat prices excluding VAT and other recoverable taxes and levies for band IC (500 MWh < Consumption < 2,000 MWh) or ID (2,000 MWh < Consumption < 20,000 MWh). For natural gas, the prices are comparable to band I3 (10,000 GJ < Consumption < 100,000 GJ) or I4 (100,000 GJ < Consumption < 1,000,000 GJ) prices excluding VAT and other recoverable taxes and levies in Eurostat. There is no consistent trend linking IEA prices to Eurostat prices from the first or second half of the year.

CEIC obtain their data on energy prices from national statistics databases. Comparing the CEIC industrial price data for EU countries with Eurostat prices shows that the CEIC electricity prices are typically similar to Eurostat prices from band ID (2,000 MWh < Consumption < 20,000 MWh) or IE (20,000 MWh < Consumption < 70,000 MWh) excluding VAT and other recoverable taxes and levies. The CEIC natural gas price is comparable to that of Band I3 (10,000 GJ < Consumption < 100,000 GJ) excluding VAT and other recoverable taxes and levies.

Coverage: Data is presented for all major competitor countries for which data was available for the period 2008-2015.

Role of exchange rates in international price comparisons

Comparing international prices requires conversion to a common currency, this introduces an exchange rate effect when analysed over time, in addition to any changes in price in the original currency. Exchange rates can move for a variety of reasons unrelated to the energy sector. Therefore, it is also important to consider these movements and the impact they have on the energy prices presented here.

Energy prices from 10 different countries are analysed, none of which use Euros as their currency, although the sources that were used include the IEA which already presents the energy prices in US dollars. It was necessary to make currency conversions, firstly for the countries whose prices were presented in USD but for which it was not the national currency (Brazil, Japan, Korea, Turkey, Mexico and Canada), where prices were converted from USD to national currency using World Bank exchange rates. Secondly, all national currencies were then converted to euros using exchange rates from the European Central Bank.

The following figure provides an illustration of the currency movements in respect of the Euro over the period 2008-2015, indexed to the exchange rate in 2008=100. This shows that over the period 2008-2015 the Russian rouble depreciated significantly against the Euro, as did the Turkish Lira and the Brazilian Real. The Indonesian Rupiah, Mexican Peso, Japanese Yen and Canadian Dollar remained relatively stable to the euro, a fluctuation of around +/-10% either compared to 2008. The

Korean Won, US dollar and Chinese Yuan appreciated by 20-40% against the Euro between 2008-2015.

These trends can mask or accentuate the actual trends in national energy prices, for example an increase in Russian, Turkish or Brazilian energy prices would not necessarily be reflected in euros, due to the exchange rate movements, and vice-versa. We provide in the following analysis a reflection on the role of exchange rate movements on the presented outcomes.

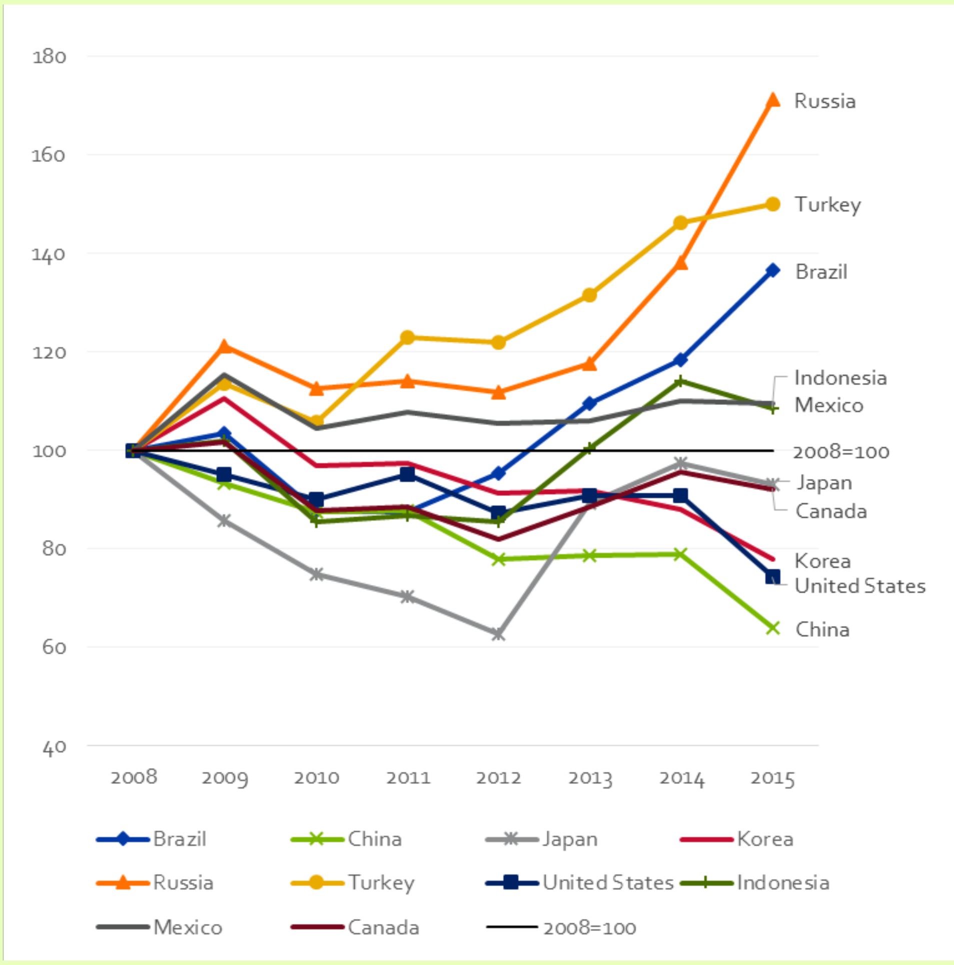

Figure 92: Exchange rate movements indexed to Euro exchange rate in 2008=100.

It is important to note also that these types of currency movement can also have an effect within the EU for the countries outside the Eurozone.

The price movements in national currencies, indexed to the year 2008 are provided in the following figure, these provide further background and explanation to the following analysis.

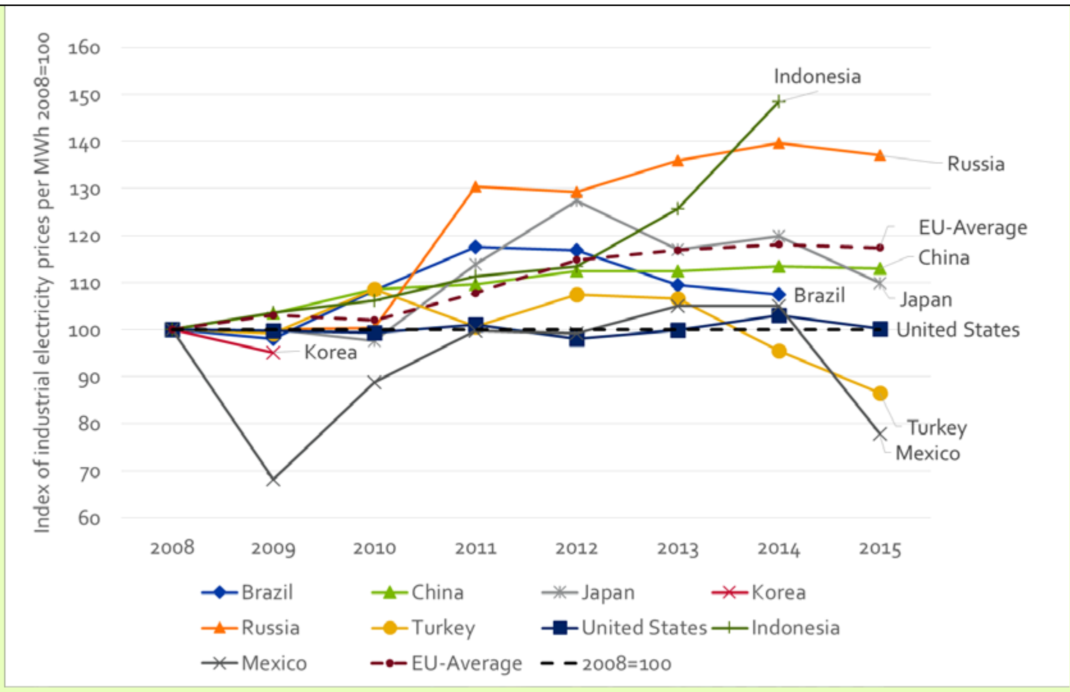

Figure 93: Industrial electricity prices in national currencies 2008-2013, indexed to year 2008=100. In the case of Japan and Russia prices are indexed to 2009=100 as no 2008 values are available.

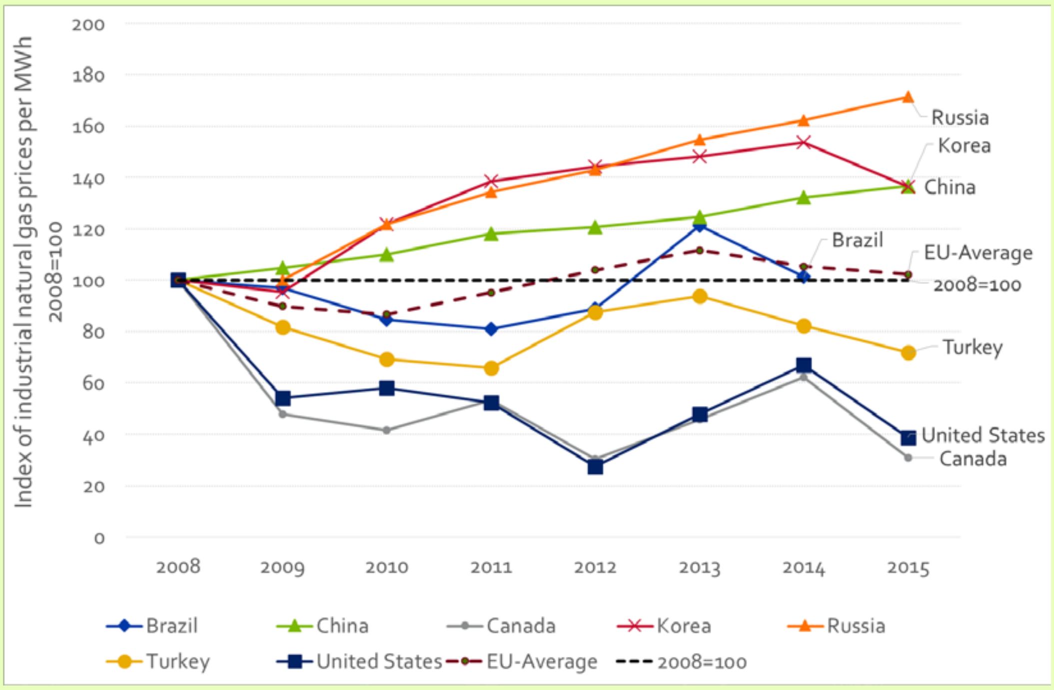

Figure 94: Industrial natural gas prices in national currencies 2008-2013, indexed to year 2008=100. In the case of Russia prices are indexed to 2009=100 as no 2008 values are available.

5.7.1.1 Electricity

Average electricity prices paid by industrial consumers are presented in Figure 93 below for the period 2008-2015. Prices for 9 competitor countries are presented alongside the weighted EU average, as produced by the industrial energy price tool described in section 0.

These results show that:

- **Average EU industrial electricity prices are around the average paid internationally,** at around €110/MWh.
  - This is higher than prices paid in Russia, Indonesia, Korea, the United States and Mexico.
  - About the same as prices paid in Turkey and China.
  - But lower than prices paid in Brazil and Japan.
- **EU average prices have increased by 18% over the 2008-2015 period**, from a starting point of around €90/MWh in 2008. Prices have been relatively stable since 2012
- **Prices in Japan have markedly increased between 2008-2015** from €120/MWh to more than €150/MWh (+34%), and are the highest among international competitors, the increase is at least partially caused by the Fukushima nuclear disaster.
- **Prices in China have increased by the most (+66%) over the period** from €70/MWh to more than €110/kWh, and are now nominally higher than the average EU price. Although this change is somewhat inflated by exchange rate movements.
- **Prices in other countries have not moved more than €10-€20/MWh between 2008-2015.** Although prices in the US (+32%) and Indonesia (+41%) have significantly increased relative to their starting point, the US change is somewhat inflated by exchange rate movements.
- **The role of exchange rates in this figure is to**:
  - Amplify price increase trends in China and the United States – there would still be an increasing trend but it would not be so strong without the exchange rate effect.
  - Have little or no impact on trends for Korea, Japan, Mexico and Indonesia.
  - **Hide the trend for price increase in Russia** – prices increased in Russia by approximately 30% but are shown as a decrease of 10% in EUR terms due to significant currency depreciation.
  - Reduce the increasing price trend in Brazil and Turkey – where prices in the national currency increased by more than shown due to depreciation versus the EUR.

Overall, trends among trading partners are generally, but not exclusively, towards increasing industrial electricity prices.

Within the EU prices paid for electricity can vary significantly from the average as demonstrated in previous chapters, electricity prices in some Member States and sectors will be considerably higher than the average, and in others considerably lower, and comparable with the lowest prices paid internationally.

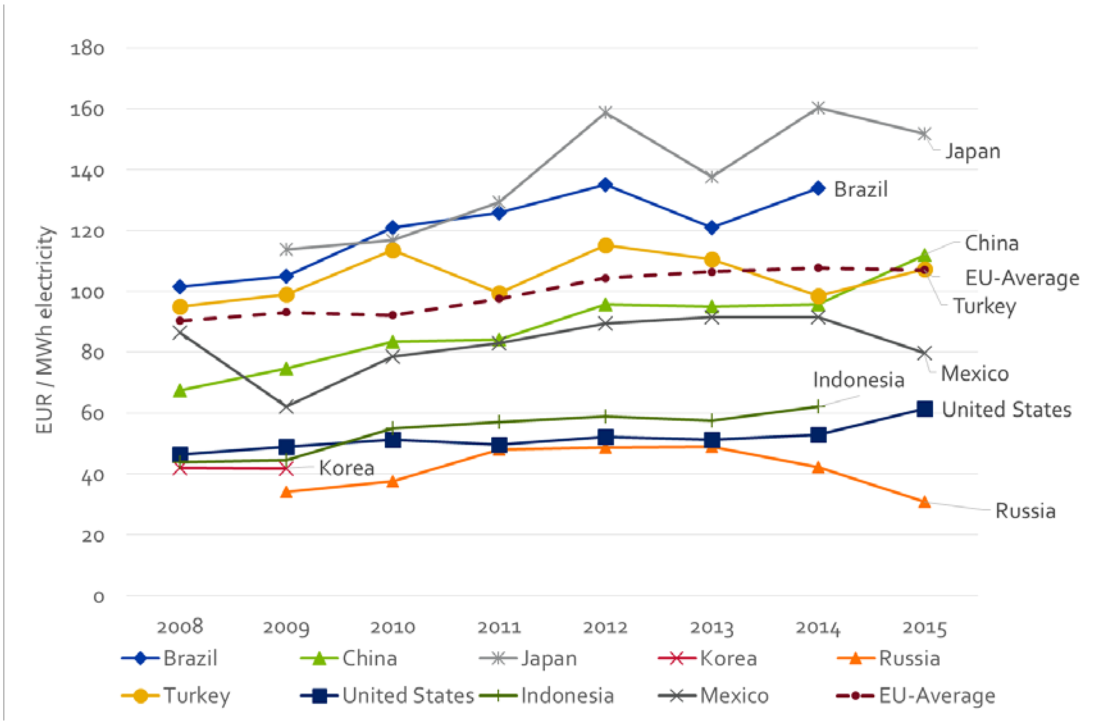

Figure 95: Average electricity prices paid by industrial consumers in EU major trading partners.

Source: Brazilian Ministry of Mining and Energy, Chinese Price Monitoring Centre, NDRC, Indonesian State Electricity Company, Russian Federal State Statistics Service, and for Turkey, Korea, Japan, US and Mexico EIA data has been used.

As discussed in section 0, the electricity price has more impact in certain sectors particularly in textiles, man-made fibres and non-ferrous metals. These sectors would be particularly vulnerable to electricity price increases relative to competitors.

5.7.1.2 Natural gas

Average natural gas prices paid by industrial consumers are presented below in Figure 94. Prices for seven competitor countries are presented alongside the EU average price as produced by the industrial energy price tool described in section 5.2.

These results show that:

- **Average EU industrial natural gas prices are relatively high compared to those paid internationally,** at around €37/MWh.
  - o This is higher than prices paid in Russia, the United States, Canada, Brazil and Turkey, and consistent with the 2014 European Competitiveness report.
  - o Prices are lower than those paid in Korea and China.

- **EU average prices have not increased significantly over the 2008-2015 period**, although there have been price variations over time, with prices declining from 2008-2010, increasing again 2010-2012, and (mostly) decreasing since 2012.
- **Prices in China (+109%) and Korea (+79%) have increased by the most over the period** from less than the EU average price in 2008, to considerably more than the average in 2015, both now around €50/MWh.
- **Prices in North America have declined steeply over this period,** with prices in the US (-46%) and Canada (-53%) having significantly decreased relative to their starting point to around €10-12/MWh in 2015, benefitting from the shale gas boom in North America.
- **Prices in other countries have generally followed the EU trends over time,** and have stayed within a relatively narrow price band over the period.
- **The role of exchange rates in this figure is to**:
  - Amplify price increase trends in China and Korea – there would still be an increasing trend but it would not be so strong without the exchange rate effect.
  - Has little or no impact on trends for Canada.
  - Reduces the trend for price increases in Russia and Brazil – prices increased in Russia by more than 65%, but depreciation of the rouble reduced the increase in EUR to 27%. Similarly for Brazil, a 35% increase shown as a 16% increase in EUR terms.
  - **Hide the trend for price increase in Turkey** – prices increased in Turkey by more than 40% in lira terms but are shown as a decrease of 7% in EUR terms due to depreciation of the lira versus the EUR.
  - Reduces the decreasing price trend effect in the United States – prices have decreased by more than 70% but in EUR terms are shown to have decreased by 45%.

As with electricity, EU prices for natural gas can vary significantly from the average as demonstrated in previous chapters. In some Member States and sectors natural gas prices will be considerably higher than the average, in others, considerably lower and comparable with the lowest prices paid internationally.

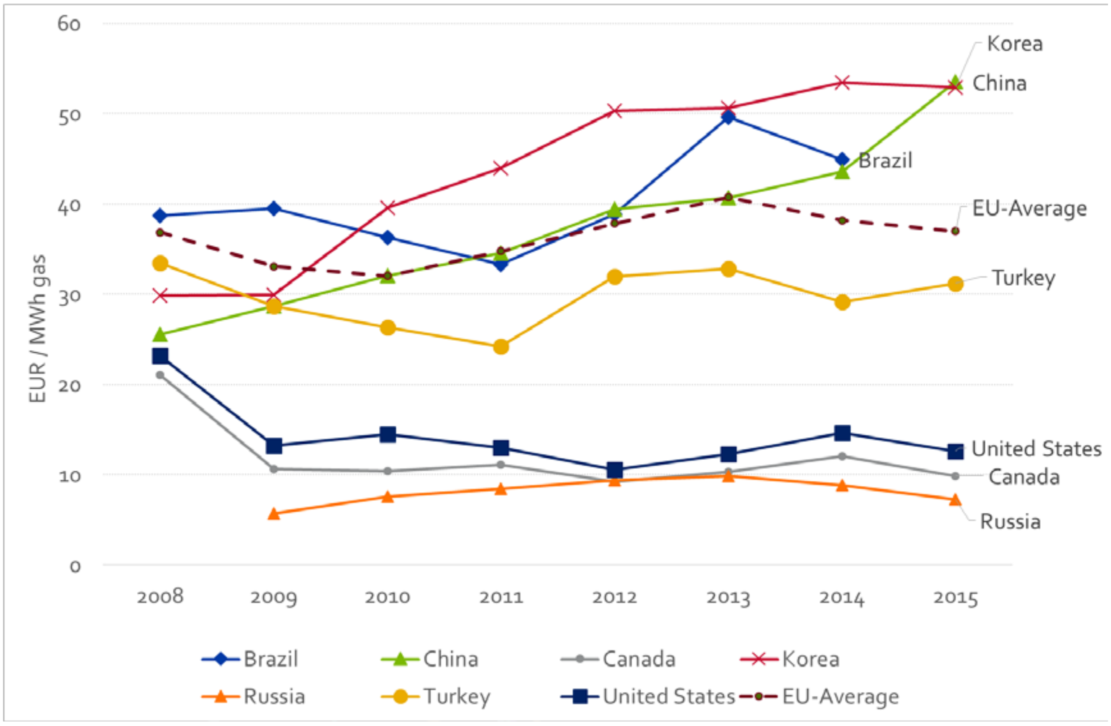

Figure 96: Average natural gas prices paid by industrial consumers in EU major trading partners.

Source: Brazilian National Petroleum Agency, Chinese Price Monitoring Center, NDRC, Russian Federal State Statistics Service, American Energy Information Administration, and for Turkey and Canada EIA data has been used.

Sectors particularly vulnerable to higher gas prices in competitors for the EU are basis chemicals and the minerals-based sectors (glass, refractory products, clay building products and ceramics and porcelain) (section 0).

5.7.2 Energy costs as a share of production cost – international comparison

EU energy cost shares in the sectors we analysed are given in section 5.6.1, to understand the competitiveness impact of energy costs it is useful to put these into an international context to assess if EU energy cost shares are higher (or lower) than international norms and therefore, the impact that changes in energy prices may have on competitiveness.

Approach: The method applied in section 5.6.1 is replicated using data from international sources. To compare across countries an average of available time-series data 2008-2013 is used.

Data sources and limitations: The results from 5.6.1 were used for the EU. For the US, data was sourced from the Annual Survey of Manufacturers published by the US census bureau. For Japan, data was sourced from national statistics from the Census of Manufactures and Current Survey of Energy Consumption. For China, data was sourced from the national statistics tables of Consumption of Energy by Sector and Main indicators of industrial enterprises above designated size by industrial sector.

Data were converted to Euros and using the ECB exchange rates referenced previously.

Data for the United States and Japan is available but only for some years and some sectors. It is unclear from the Japanese data if personnel costs include the non-salary costs included in EU and US data. This could skew the energy cost shares for Japan higher than otherwise would be the case.

The limitations highlighted in section 5.3.2 are important when interpreting these findings, particularly the potential differences in sector definitions, the heterogeneity and product quality variations that exist and differences in statistical method.

Coverage: The calculation was carried out for all countries and sectors for which a full time series 2008-2013 is available, see Table 11 for EU country coverage.

Results: of the analysis at the sector average level are presented in Figure 95 below. This shows that:

- **Subject to the limitations in comparability – due to potential statistical differences (see above and 5.3.2):**
- **EU energy cost shares were on average higher than their Japanese across all sectors,** in some cases (textiles, sawmills, pulp and paper, porcelain and ceramics) EU cost shares were more than double Japanese levels.
- **EU average energy costs shares were on average lower than their US equivalents in most but not all sectors,** the exceptions were basic chemicals, iron and steel and non-ferrous metals.
    - The EU has significantly lower energy cost shares than the US in textiles, pulp and paper, glass and porcelain and ceramics. However, analysis over time suggests that these cost shares are falling more rapidly in the US (Figure 96).
    - These findings are broadly consistent with the European Competitiveness Report, to the extent that the comparison can be made as ratios, sector definitions and time period covered are all different.

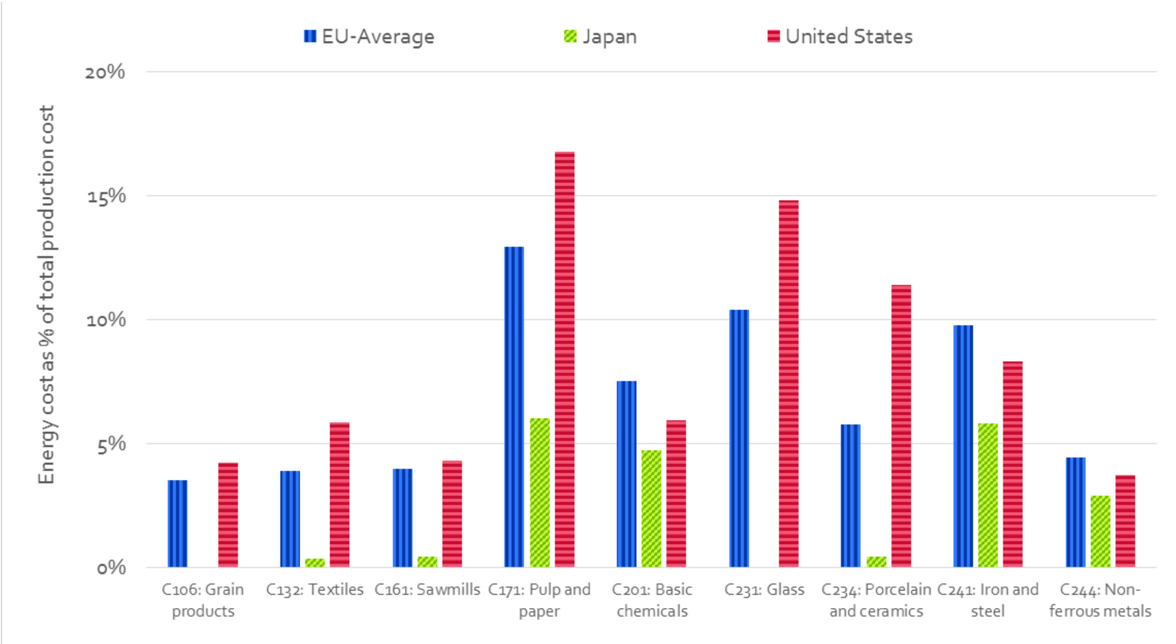

Figure 97: Comparison of [%] average energy cost shares per sector, 2008-2013 averages for available years and sectors. All years for EU, 2008-2010 for Japan, 2008-2011 and 2013 for the United States.

This data suggests that EU industry on average is typically facing higher burdens from energy costs in total production costs than competitors in Japan and sometimes also the US. In a few sectors, the EU average energy cost share is lower than the US equivalent at this level of sector aggregation. As discussed earlier, this may in part relate to structural differences in product mix.

The very low values for Japan probably relate to different definitions of the industrial activity codes and costs.

Taking a closer look at the same data to analyse the EU and US sector trends over time, an interesting overall trend can be observed, namely:

- **Subject to the limitations in comparability – due to potential statistical differences (see above and 5.3.2):**
- **Energy cost shares as a % of total costs have fallen in both the EU and US between 2008-2013,** this is in contrast to the longer terms trends observed in the 2014 European Competitiveness Report which finds energy cost shares for manufacturing as a whole have increased between 1995-2011. It is understood that very low oil prices in the mid-1990's compared to recent years have been a major driver of this longer term trend, therefore, in the period 2008-2013, a time with already high oil prices, the results are consistent with the longer period.

- **US cost shares have fallen faster than EU cost shares** over the 2008-2013 period as would be expected from the development of shale gas. This is the case in 8 of the 11 sectors which can be compared. The following figures are provided as a clear illustration of this trend, full sector figures are provided in Annex 4.

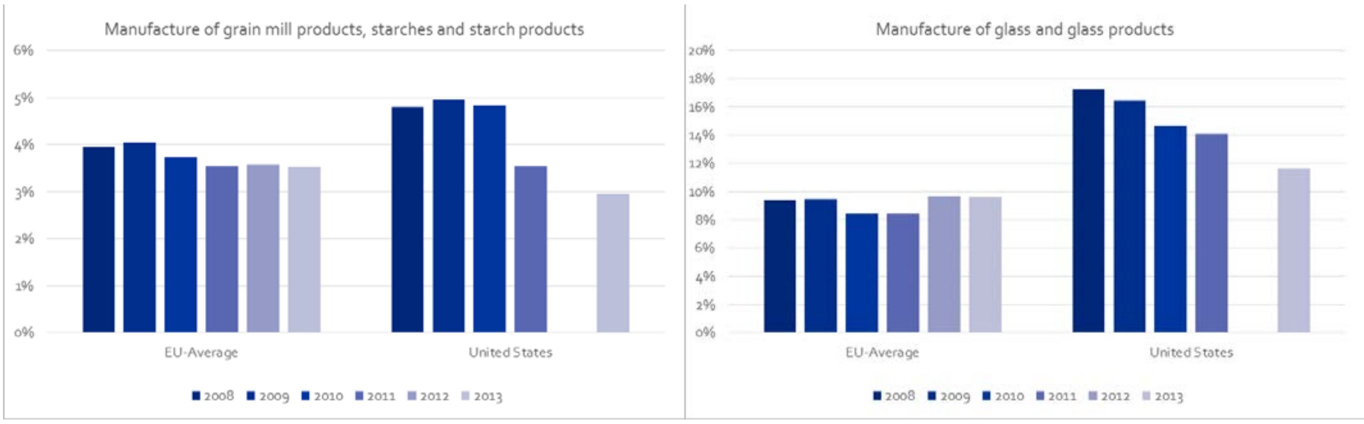

Figure 98: Energy cost shares as a % of cost for selected sectors. Japan excluded as no data available for these sectors.

5.7.3 Comparison of energy intensities

In section 5.4 we presented an analysis of energy intensity for the EU. Although based on just a few data points this showed that energy intensity in the most intensive sectors (pulp and paper, basic chemicals, cement, lime and plaster and iron and steel) has increased between 2008-2013,

Approach: we have replicated the approach used in the analysis presented in section 5.6.

Data sources: The results from section 5.6 were used for the EU. For the US, data was sourced from the Annual Survey of Manufacturers published by the US census bureau. For Japan, data was sourced from national statistics from the Census of Manufactures and Current Survey of Energy Consumption. For China, data was sourced from the national statistics tables of Consumption of Energy by Sector and Main indicators of industrial enterprises above designated size by industrial sector.

Data were converted to Euros in nominal terms and using the ECB exchange rates referenced previously.

Data for the United States, Japan and China is available but only for some years and some sectors. It is unclear from the Japanese data if personnel costs include the non-salary costs included in EU and US data. This could skew the energy cost shares for Japan higher than otherwise would be the case.

The limitations highlighted in section 5.3.2 are important when interpreting these findings, particularly the potential differences in sector definitions, the heterogeneity and product quality variations that exist and differences in statistical method.

Additionally, the role of exchange rates is important, as highlighted in the 2014 European competitiveness report this is particularly relevant for China where exchange rates are understood to be significantly undervalued. This impacts upon the value added variable and skews the energy intensity in China higher, although it is also noted in the 2014 ECR that value added is generally also lower in China. This limitation cannot be adequately corrected for, therefore, it is acknowledged here, with the likelihood that the actual energy intensity of China is lower than presented in Figure 97. An analysis without China is also presented.

Coverage: The calculation was carried out for all countries and sectors for which data is available between 2008-2013. See Table 8 for EU country coverage per sector. Averages of available data is taken.

Limitation: it is important to acknowledge for all energy intensity analysis presented in this section there are significant potential and real statistical differences between the countries that limit the strength of the conclusions that can be drawn. Particularly sector classifications can differ across countries and therefore, it is not always like with like being compared.

Results: are presented in Figure 97. This shows that:

- **China is by far the most energy intensive of all of four economies over this period.** While this is likely to be partly be driven by relative energy inefficiency, it is also subject to the data limitation of an undervalued exchange rate noted above, and statistical errors and relatively low value added.

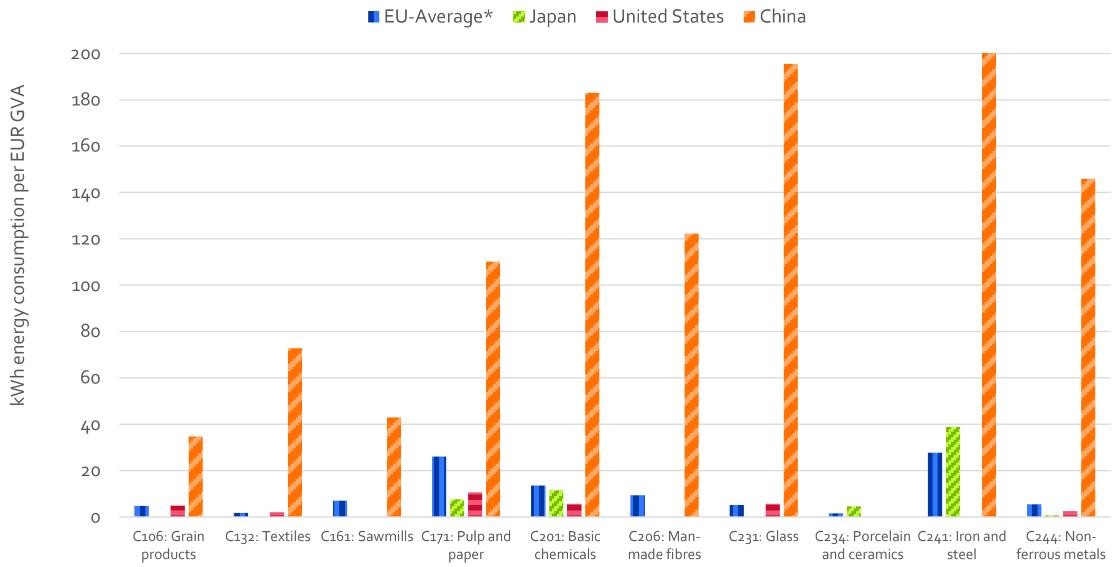

Figure 99: Energy intensity [kWh energy consumption per Euro of GVA generated] per sector, average values for 2008-2013, for EU and Japan typically all years (2008-2013), for US only for 2010, for China 2008-2011. *=EU-average is derived from only limited data points (see Table 8)

Removing China from the figure, given the relatively high values and limitations discussed above, allows for a closer analysis of the EU, Japan and the US, as shown in Figure 98.

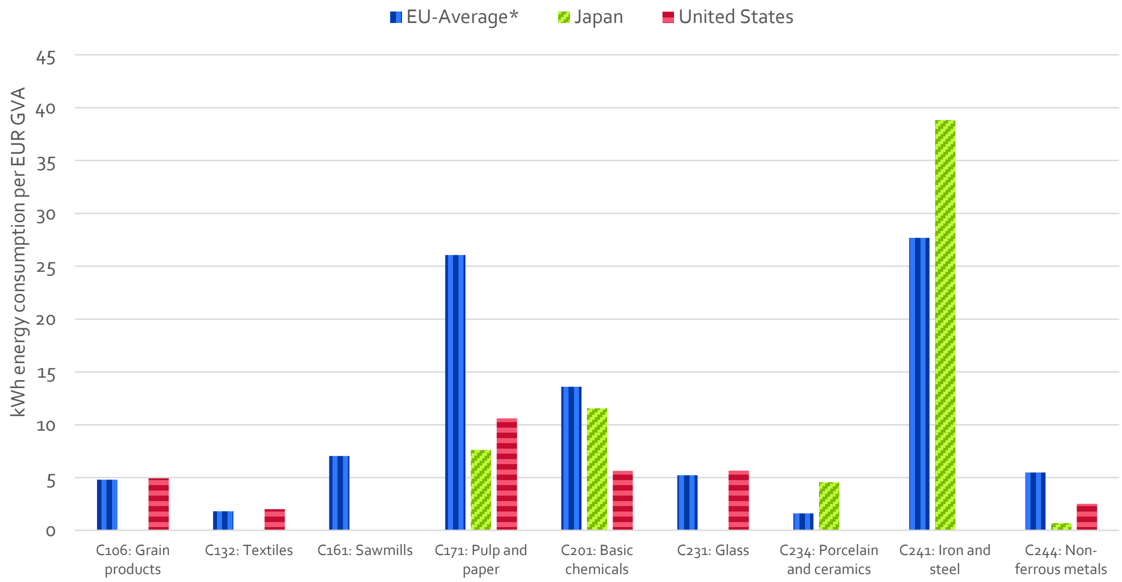

Figure 100: Energy intensity [kWh energy consumption per Euro of GVA generated] per sector, average values for 2008-2013, for EU and Japan typically all years (2008-2013), for US only for 2010. Sectors without data are left out of the figure. *=EU-average is derived from only limited data points (see Table 8)

It can be identified from this that differences per sector are significant:

- **Subject to the limitations in comparability – due to potential statistical differences (see above and 5.3.2):**
- **Comparing the EU and US for these specific NACE categories, the EU is more energy intensive than the US in all but one sector:**
    - The reasons for these differences are unclear and could relate to structural differences, such as product mix. It is difficult therefore, to link conclusions explicitly to relative energy efficiency, and the position that EU industry would be in if energy efficiency policies had not been implemented.
    - These results are counter to findings in previous work, for example the ECR 2014, which found EU industry as a whole was less energy intensive than US. In that paper, similar conclusions were also drawn for certain sectors namely paper, chemicals, non-metallic minerals and basic metals. However, it appears that these are not aligned with the NACE sectors below and the difference relates to sector definition and product mix.
- **Comparing the EU and Japan, the outcomes vary by sector but need to be interpreted carefully because of potential differences in sector definitions.**
    - For pulp and paper, basic chemicals and non-ferrous metals the EU is more energy intensive.
    - For porcelain and ceramics and iron and steel the EU is less energy intensive than Japan.

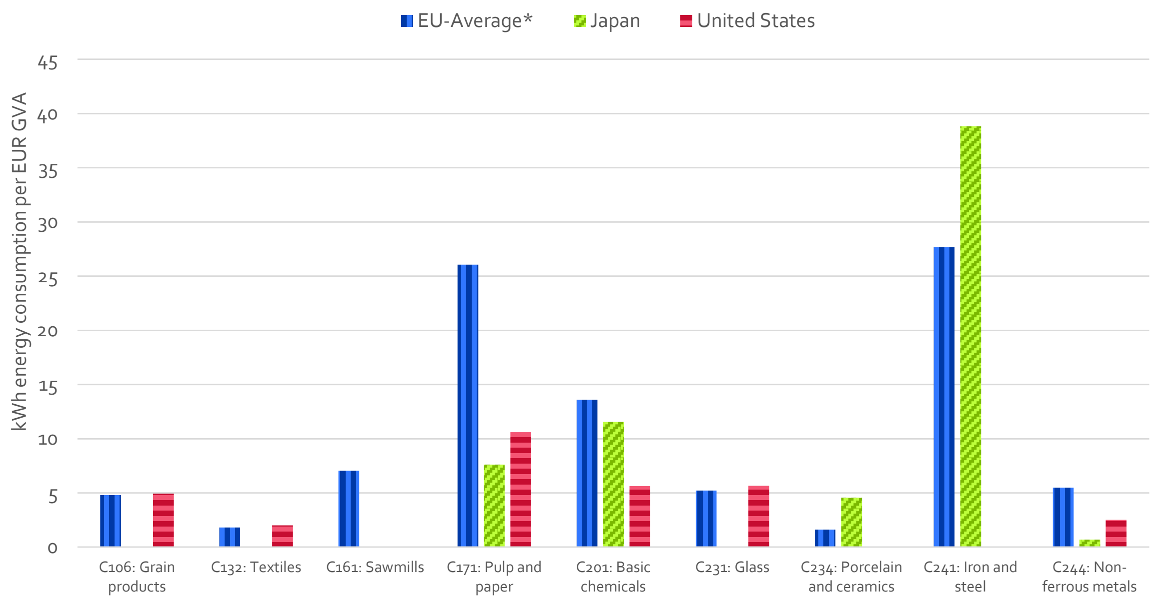

Figure 101: Energy intensity [kWh energy consumption per Euro of GVA generated] per sector, average values for 2008-2013, for EU and Japan typically all years (2008-2013), for US only for 2010. *=EU-average is derived from only limited data points (see Table 8)

Looking at sector trends over time a few key trends can be observed:

- **Energy intensity in China rapidly declined in almost every sector 2008-2011**, as shown in Figure 99. Although as noted above it still remains far above the energy intensities of the EU, US and Japan, but the gap is closing. If an undervalued exchange rate and relatively low value added were able to be factored in then we would expect China to be much more comparable, although still more intense, than the other countries.

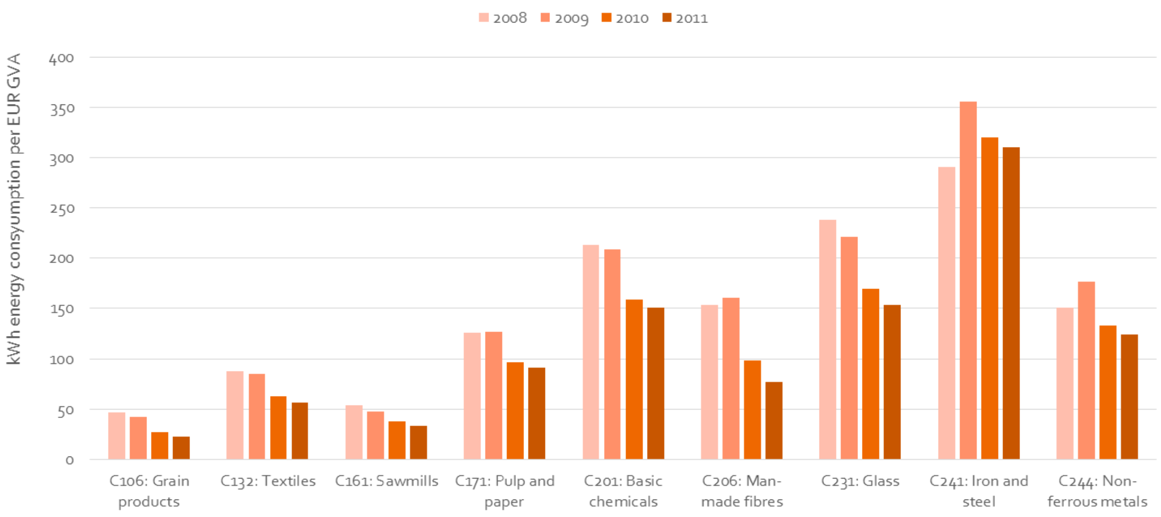

Figure 102: Energy intensity trends in Chinese industry 2008-2011, for sectors with available data.

Energy intensity in the iron and steel sector for EU and Japan has increased over the period 2008-2013 (see Figure 100), driven by declining GVA, which is declining faster than energy consumption. No time series data is available for the US.

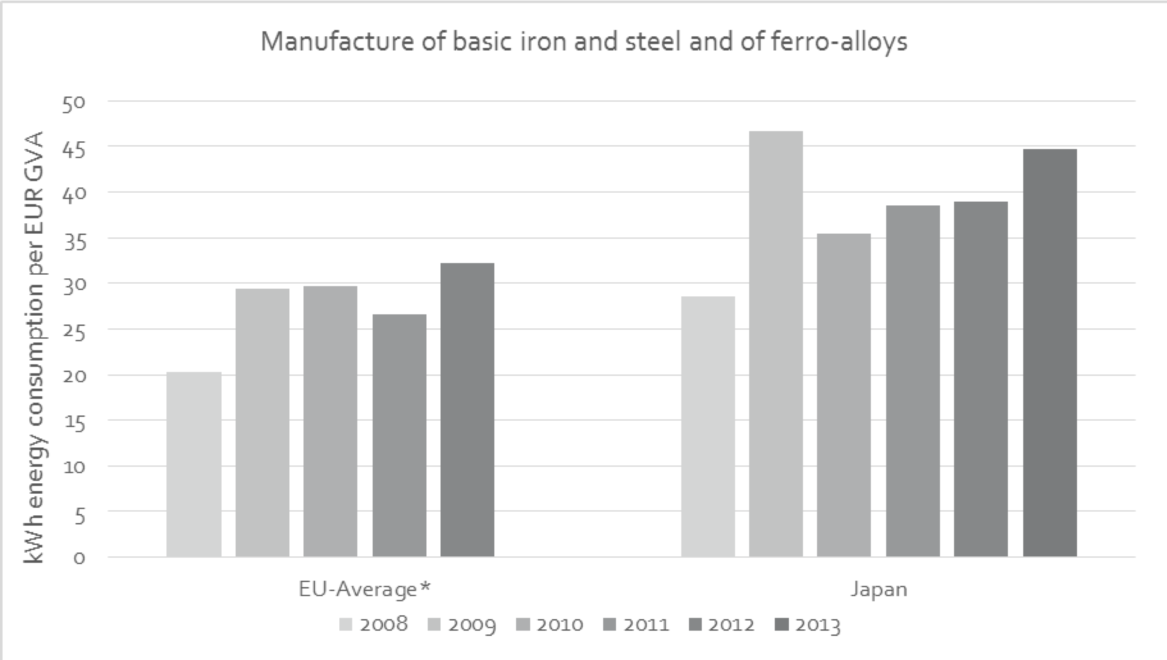

Figure 103: Trends in the energy intensity of the iron and steel sector, comparison of EU-average of (limited number) of data points and Japan, 2008-2013, kWh energy consumption per Euro of GVA. *=EU-average is derived from only limited data points (see Table 8). No data available for the United States, therefore it is excluded from the figure.

Comparing our energy intensity results with other studies

As noted in section 5.4, the 2014 European Competitiveness Study (ECR 2014) only provides an indication of energy intensity for the whole manufacturing industry. The analysis did provide a comparison at this level with the US, China and Japan, which showed that the EU had the lowest energy intensity of all four in 2009, followed by Japan, then the US, then China. Energy intensity decreased in all economies between 1995-2009.

The 2014 study by DG ECFIN into the "Energy Economic Developments in Europe" provides analysis of energy intensities in 2009 across the EU, US and Japan. As noted in section 5.6, there is a mismatch between our 3-digit NACE rev.2 sector based analysis and a 2-digit NACE rev.1 analysis of the ECFIN report. Table 15 provides a comparison of the data that is available. Although there are one or two similarities the results are quite different. In our opinion the differences in sector scope and the statistical inconsistencies across countries highlighted earlier in this section are too great to allow for meaningful comparisons to be made and conclusions to be drawn.

Table 19: Comparison of 2009 energy intensities of this study with closest sector match from 2014 DG ECFIN study 'Energy Economic Developments in Europe', values from the ECFIN study have been converted to kWh/EUR VA for comparison

Sector (NACE rev.2, NACE 3-digit)	2009 Energy intensity [kWh/ EUR VA]			ECFIN 2014 Energy intensity [kWh/EUR VA]			Sector match - NACE rev 1.1, NACE 2-digit level sector
	EU#	US*	JP	EU	US	JP	
C106: Grain products	5.0	4.9	-	2.2	3.0	0.8	Food, beverages and tobacco
C132: Textiles	2.0	2.0	-	1.5	-	1.0	Textiles and textile products
C161: Sawmills	5.3	-	-	4.3	8.1	3.0	Wood and products of wood and cork
C171: Pulp and paper	28.5	10.6	7.2	3.8	5.9	2.9	Pulp, paper, printing and publishing
C201: Basic chemicals	13.8	5.6	12.4	11.5	17.0	13.7	Chemicals and chemical products
C206: Man-made fibres	14.6	-	-	1.8	1.0	0.6	Rubber and plastics
C241: Iron and steel	29.5	-	46.7	5.5	6.0	7.8	Basic metals and fabricated metal
C244: Non-ferrous metals	5.7	2.5	0.6	5.5	6.0	7.8	Basic metals and fabricated metal

EU is based on only limited data points, see Table 8; * 2010 intensities for the United States

Comparison of gross operating surplus

Developing the analysis on value added and gross operating surplus begun in section 5.5 to an international comparison is interesting to discover if international competitors are also facing similar competitive pressures on margins.

Approach: replicates the approach used in section 5.5, with gross operating surplus calculated from GVA minus personnel costs.

Data sources: are the same as those presented for the energy intensity analysis for all countries.

Coverage: is the same as the earlier energy intensity analysis.

Results: we find that the average EU gross operating surplus is lower than those calculated for the United States and Japan in the same period, as shown in Figure 101. This shows that:

- **Subject to the limitations in comparability – due to potential statistical differences (see above and 5.3.2):**
- **Average industrial gross operating surpluses in the United States are in the range 12-17%**, higher than the equivalent EU values. It should be noted that the trend over the period has been for a decline in US operating surplus to 2013, though they remain more than 4 percentage points higher than those in the EU.
- **Average industrial gross operating surpluses in Japan are the highest of the three and are in the range of 24-28%**, more than double the equivalent EU values and also significantly higher than US values. The trend over the full period has been relatively stable.
    - There are some concerns over the labour cost component of total production costs in Japan, this may not include some costs (i.e. social contributions), therefore, margins could in reality be lower.

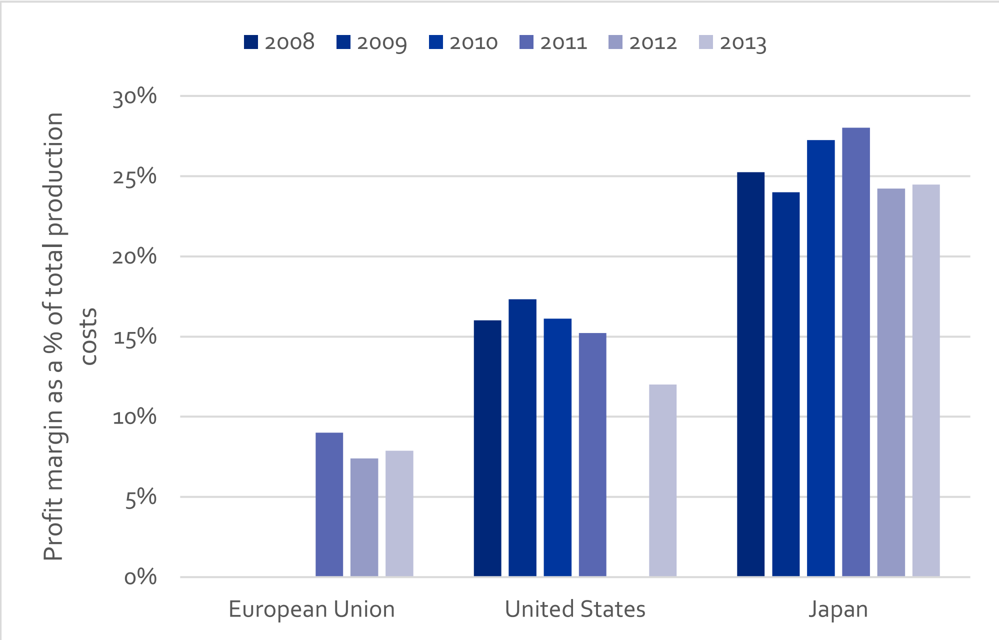

Figure 104: Gross operating surplus as % of total production costs, average across all sectors for the EU28, United States and Japan, 2008-2013.

Looking at the sector level (full results are presented in Annex 4), the average trends noted above are broadly repeated with the exception of:

- **Grain products where the EU has higher average surplus than the US**, 8-9% compared to 5-7%.
- **Sawmills and basic chemicals where EU and US surpluses at 6-7% and 8-10% respectively are broadly the same**.
- **Glass and Cement, lime and plaster where US surpluses are around double EU levels**, although the gap has closed over time.
- **Porcelain and ceramic products where surpluses at 35-45% in Japan are significantly higher than the EU (and US) figures**.
- **In iron and steel, gross operating surpluses are lower than average for all countries** but those for the EU remain lowest as shown in Figure 102.

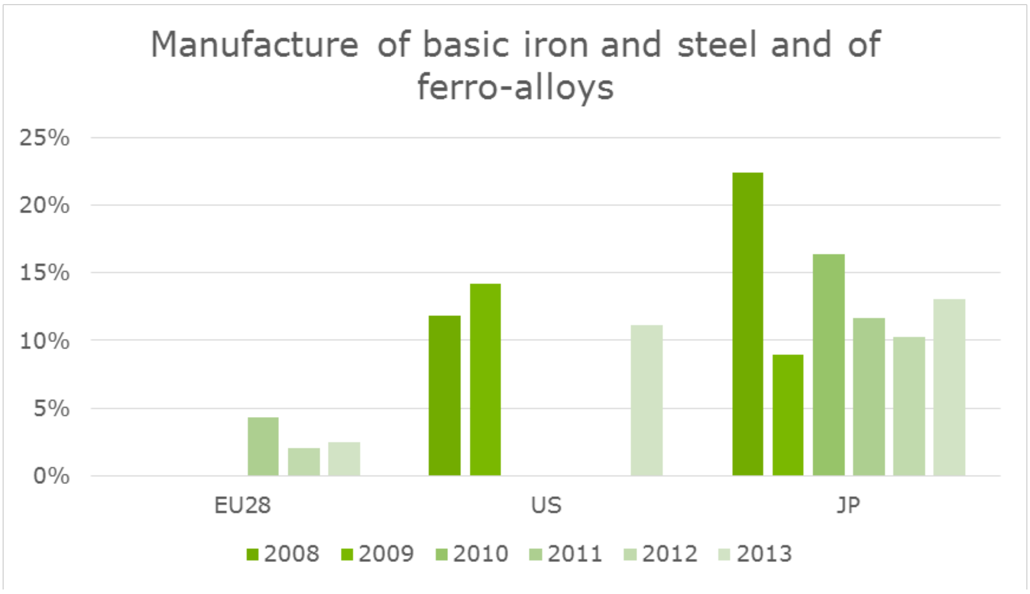

Figure 105: Average industrial gross operating surplus [as % of total production cost] for the EU28, United States and Japan, 2008-2013

International competitiveness from case studies

NACE Rev 2 C2410 - Manufacture of basic iron and steel and of ferro-alloys. EU28 is a net exporter of steel products to the United States and Turkey and a net importer of Chinese and Russian steel products. Until 2014 the EU28 were still net exporters of semi-finished and finished steel products. While long and flat products have been net-exported on average between 2008 and 2014, simple steel products like ingots and semis have been net-imported. Facing global overcapacities, pressure on the European steel industry, especially in the commodity steel sector, has risen. Countries like China, where the steel industry has been supported and overcapacities exist, enter the market with very low prices. A future option for the European steel industry may be to shift more production to more specialized, knowledge-intensive and customized steel products.

NACE Rev 2 C1712 Paper making. Europe produces roughly a quarter of worldwide paper and paperboard. The competitiveness position is different for different types of paper. So far, the European paper industry has succeeded to be among the technological leaders which helped to maintain competitiveness with other regions of the world, despite comparably high production costs (JRC 2015). Major actors in global competition come from Russia, China, India and other Asian regions. These have invested substantially in new capacities and are playing an increasing role in reshaping raw material supply and demand. This is particularly true for China, where around 50 % of the total new capacities over the last five years has been built and were mills reportedly benefitted from subsidised energy prices.

NACE Rev 2 C2442 Aluminium production. Primary aluminium is a globally traded (London Metal Exchange) and consequently highly competitive product. A large share of primary aluminium is imported to Europe, while exports are probably mainly aluminium products. For the aggregate of primary aluminium production and aluminium products Europe's major trading partners are Russia, the United States, Turkey and China. Europe is a net importer especially of Russian and Turkish aluminium products while the United States, Saudi Arabia, Mexico and South Korea are the net importers of European aluminium products.

NACE Rev 2. C2313 Manufacture of hollow glass. Worldwide, Europe is the largest glass producer with roughly one-third of the total global market. Exports of European glass producers towards G20 countries had a value of roughly 8% of production value. This indicates that a major share of production is traded within Europe which can be explained by transport costs generally being high in relation to the sales price. The largest export destinations among the non-EU G20 for hollow glass are the United States followed by Russia.

NACE Rev 2. C2013 Manufacture of other basic inorganic chemicals. Europe's major trading partners are Russia, the United States, and China. Europe is a net importer especially of Russian chlor-alkali products while the United States are the major net importers of European chlor-alkali products.

5.7.4 Discussion on competitiveness of EU industry

The sections above discuss the role of energy expenditures in industry and analyse differences in underlying drivers, such as prices for certain sectors of industry. Annex 5 presents case studies giving more details for individual sectors or products. Drawing on these case studies and the previous analysis we make the following observations:

- EU average electricity prices for industry are in line with the averages of global competitors, with a wide range across the EU Member States. Gas prices for EU industry are higher than for most competitors examined.

- Despite the higher prices, for the limited number of countries with data available (US, Japan) cost shares were lower in the EU than in the US and higher than in Japan. Although energy cost shares are falling in both EU and US, they are in general falling more rapidly in the US and by 2013 approaching similar levels for many sectors. Gross operating surplus as percentage of production costs is smaller in EU industry than Japan and the US.

- Energy intensity in the most intensive sectors (pulp and paper, basic chemicals, cement, lime and plaster and iron and steel) has increased between 2008 and 2013 for the handful of EU Member States for which data was available, driven primarily by pressure on GVA.

- Literature reports long term improvements in energy efficiency for most sectors in the EU, which will reduce the impact of energy price rises. In the period examined in this report though (2008-2014), data suggests energy efficiency improvements have stalled in some sectors probably, due to lack of capital for investment.

- At the level of the investigated NACE 4 sectors, except for glass production, electricity cost intensity per production value is higher than that of gas even in the paper and steel industry where gas consumption is higher than electricity consumption. This indicates the importance of electricity prices to EU industry.

- The largest G20 competitor countries for EU industry were similar for all the sectors in the case studies. The main (net) imports come from China and Russia. For steel South Africa is also very relevant, for paper, India and for aluminium and glass, Turkey is a growing import origin. The USA is the major destination of net exports.

- The EU lost market share particularly to China in certain sectors, including steel, paper and aluminium. Production in the glass sector has remained relatively stable.

- Although as discussed above, European gas prices are high compared to some competitors, particularly the US, Europe is still a net exporter of many products, for example finished steel and aluminium products. As gas prices have been decreasing rapidly in some competitor countries it may be that there is a lag in impact of the decreasing prices.
- Certain energy prices are aimed at supporting competitiveness, for example the low electricity price for aluminium smelters in Norway (around €4ct/kWh) is at or below the level of Russia. It clearly supports the Norwegian competitiveness in primary aluminium production.

- Several industries are suffering from overcapacities and associated market consolidation. New investments are more likely outside Europe and in emerging economies that are experiencing growing markets. If new locations are close to European borders, this may in future challenge domestic suppliers by increasing imports (e.g. glass production in Turkey).

- Commodity products typically face much more international competitive pressure. However, competitiveness depends not only on energy prices and relative personnel and raw material cost but other factors, including proximity to the upstream and downstream markets, economic growth (global and regional) and institutional environment, including the conditions for research and development.

6 Conclusions

There is an ongoing debate in Europe on the impact of expenditure on energy for households and industries and the role of energy prices. In the period between 2008 and 2015, retail prices for electricity and gas have generally increased, with the exception of gas in industry which shows a slight decrease in the statistics. Higher energy costs and prices have been cited as a factor in decreasing competitiveness of industry in many EU Member States. Energy prices in Europe have increased, but there is a large variation in the price changes for final consumers, particularly because of differences in national energy and climate policies.

This report looks at the drivers for developments in energy costs, and how these affect households and European industry. Prices are not however, the only component driving energy expenditure. Total expenditure is also determined by the level of energy consumption, which is influenced by the total level of activities and also efficiency measures. The price discussion is put into the context of these other factors.

This detailed overview of price developments and their drivers provides important information for the discussion about the future energy policy in Europe, in particular about the role of the Energy Union.

Energy retail prices have mostly increased despite some falls in commodity prices

European retail prices rose in the period 2008-2015: for the average electricity price by 15-25%, for the average gas price up to 10%, although there is an exception in gas for industrial users which showed a 1% decline over the period. For globally traded energy carriers like oil and coal, prices were volatile, increasing until 2012, but then decreasing in recent years. This analysis considers three components of retail prices: energy, network, and taxes and levies. On the national level, the average values for these three components often develop in different directions.

The energy component of retail price is determined by wholesale prices and by costs associated with supply (e.g. billing, supplier margins). In the electricity sector wholesale prices are driven by fuel shares in the generation mix, commodity prices and market features: like access to resources, the degree of competition and integration with neighbouring markets. Price decreases are generally caused by competition, cross border exchange of power and a higher share of electricity from renewable energy sources. During the assessed period, (wholesale) pricing of natural gas in the EU underwent large changes: from oil indexed pricing to spot market oriented pricing. In North Western Europe, prices have been significantly affected by both the crude oil price and LNG import prices between 2008 and 2015. In Central Europe the introduction of competitive gas markets has significantly decreased the impact of oil on the border prices for natural gas. As a consequence, Central European Member States were able to profit from the drop of spot gas prices in 2014.

On average, the network component to the retail price for both gas and electricity has remained relatively stable over the period 2008-2015. Increasing shares of electricity production from renewable energy sources are having an impact especially on distribution grids, but connection costs are often covered by special levies, or they are included in renewable energy surcharges. The effect of the network component on total retail prices depends on the consumer category. Large consumers in particular who are connected to the medium voltage or high voltage grids profit from lower network costs as they do not use distribution grids. Tariff structures for industrial consumers often favour demand patterns with little variation over time.

Since 2008, the taxes and levies component has increased for electricity, largely due to support for renewable energies and CHP. These payments add to the energy and environmental taxes that are paid on the use of energy carriers in Europe. In most countries and for most energy uses these excise duties have been constant for the whole period from 2008 to 2015. Value added taxes on household retail prices are applied as percentages of the total retail price, including on the sum added by all other taxes and levies. Their nominal effect increased with increasing total prices. Some countries additionally raised the percentages of the value added tax. The total effect of the taxes and levies component on energy retail prices depends on the energy carrier, the energy use and the consumer group. In electricity prices, there are different rates for consumers depending on total consumption, grid connection, electricity cost intensity and applied processes. Taxes and levies on gas and oil product prices mainly depend on the processes the energy is used for. Some excise tariffs on gas and oil differ by consumer segment, on rare occasions, tariffs are lower for high consumption classes.

Rising prices challenge households with low income

The decrease of 11% in total household energy consumption in Europe between 2008 and 2014 was not sufficient to compensate for the increase in energy retail prices. Hence, annual expenditure on energy for European households in this period has risen in nearly all Member States, with a significant variation between, and even within, countries.

Countries in which household consumption is split amongst a few energy carriers are more exposed to specific price-changes or supply restrictions for these energy products. Heating plays an important role in energy consumption for households, which can be seen especially in cold winters, as in 2010. Depending on the country, residents keep their homes warm using natural gas, heating oil, wood or electricity. Price changes in natural gas, for example, have had a large impact on energy expenditures in the Netherlands, Italy and the UK; while changes in oil prices have mainly affected households in Ireland and Luxembourg.

In some countries, increasing average energy costs have been compensated by increasing average income, thus, mitigating price effects. However, low income households have high shares of residential energy expenditures and are affected most by changes in energy retail prices. A number of countries introduced policies to support households with low income to keep their standards of living, either through issuing allowances to cover costs for heating, or by reduced tariffs per unit of energy. In medium income households, the share of energy costs for transportation is higher.

Changes in retail prices affect industries in different ways

EU average electricity prices for industry are in the range of average prices amongst key competitor countries of the EU. However, national differentiation in the EU is very high. The highest electricity prices in Europe are higher than for all competitors examined and the lowest lower. Gas prices for EU industry are higher than those of most competitors examined.

Energy demand in 2014 by industrial consumers was 12% lower than in 2008, largely due to the financial crisis. For the industry sectors analysed in this study, the decrease in energy consumption exceeded the price increases, so total expenditure decreased between 2008 and 2013. In the energy intensive industries analysed in detail, both the share of energy purchases in total production costs and absolute expenditure on energy declined in the period 2008-2013.

Prices for individual companies vary considerably. The individual energy price depends on the firm's supply strategies, synergies and specific regulations. Additionally, governments provide reduced rates, exemptions or compensation from taxes and levies based on criteria, such as risk of competitiveness, energy costs intensity or energy efficiency status.

Analysing the positioning of EU industry versus key competitor countries is a complex endeavour, because competitiveness is driven by several additional factors beyond the energy price. For the EU sectors examined, the share of energy costs in production was lower than in the US and higher than in Japan. In the US, cost shares are falling more rapidly. Gross operating surplus as percentage of production costs is smaller in the EU industry sectors analysed than Japan and the US.

Despite higher gas (and in some cases electricity) prices compared to some competitors, Europe is still a net exporter of many products, for example finished steel and aluminium products. As gas prices have been decreasing rapidly in some competitor countries it may be that there is a lag effect in this observation. The EU lost market share to particularly China in certain sectors, including steel, paper and aluminium. This is despite higher energy intensity in China and comparable (or higher) gas and electricity prices. Part of this loss in market share can be attributed to government support to industry in China and to undervalued exchange rates.

The changes in energy prices are an important but not the only challenge to the traditional business model of energy intensive industry. In current times of overcapacities and associated market consolidation in energy-intensive sectors, energy prices are one factor in deciding where to pursue production. In the long run, structurally low prices and other structural factors, such as a move to specialised and higher added value products, capacity costs and market proximity are likely to have more impact.

7 Literature

The first section of this literature review focuses on global energy price comparisons, the second section provides recent literature about energy prices in Europe. It is followed by a limited number of national literature sources is presented and full titles and publication information of literatures sources quoted.

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