Study on Energy Prices, Costs and Subsidies and their Impact on Industry and Households

Final report

Trinomics

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Presented by

Trinomics B.V.
Westersingel 34
3014 GS Rotterdam
The Netherlands

Contact person

Mr. Koen Rademaekers
T: (+31) 010-341 45 92
E: koen.rademaekers@trinomics.eu

Authors

Koen Rademaekers, Matthew Smith, Jessica Yearwood, Yamina Saheb, Joris Moerenhout (Trinomics)
Karine Pollier, Nathalie Debrosses, Thierry Badouard, Aurelien Peffen (Enerdata)
Hector Pollitt, Sophie Heald (Cambridge Econometrics)
Matthias Altman (LBST)

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ACER	Agency for the Cooperation of Energy Regulators
AER	Australian Energy Regulator
Bbl	Barrel of oil
CAPEX	Capital expenditures
CEER	Council of European Energy Regulators
CEIC	An international data provider company
CNG	Compressed Natural Gas – in this report considered as a transport fuel (see chapter 3)
DG ENER	European Commission's Directorate-General for Energy
DG JUST	European Commission's Directorate-General for Justice and Consumers
E3ME	E3ME computable general equilibrium model
EBP	Estimated Border Price (natural gas)
EC	European Commission
ECB	European Central Bank
EIA	Energy Information Administration (US)
EMOS	EU Energy Markets Observatory
ERRA	Energy Regulators Regional Association
ETS	(EU) Emissions Trading Scheme
EU	European Union
EU28	28 Member States of the European Union
EUR	Euro
EU SILC	European Union Statistics on Income and Living Conditions
G20	Group of 20
GDP	Gross Domestic Product
GGE	Gallon Gasoline Equivalent
GJ	Gigajoule
IEA	International Energy Agency
IESO	Independent Electricity System Operator (Ontario)
kWh	Kilowatt hour
LCU	Local Currency Unit
LNG	Liquefied Natural Gas – in this report considered as a transport fuel (see chapter 3)
LPG	Liquefied Petroleum Gas
MMBtu	1 Million British Thermal Units
MPI	Market Performance Index
MS	Member State
Mt	Megatonne (1 million tonnes)
MWh	Megawatt hour
NACE	The statistical classification of economic activities in the EU, from the French *Nomenclature statistique des activités économiques dans la Communauté européenne*
NRA	National regulatory authority
OECD	Organisation for Economic Cooperation and Development
OPEC	Organisation of the Petroleum Exporting Countries
PPS	Purchasing Power Standard
RON	Research Octane Number – a standard measure of engine or aviation fuel performance
USD	United States Dollar
VAT	Value Added Tax
WA	Weighted Average
WTI	West Texas Intermediate (crude oil)

Executive summary

Introduction

This report represents one of the key contributions to the biennial report on energy costs and prices that the European Commission is committed to provide. This work builds upon and expands the coverage of the two previous editions of the report carried out in 2014 and 2016. In comparison, this report updates the analysis to include the latest data, and:

- updates and extends the analysis of international energy prices and their evolution and drivers –adding many more prices and wider coverage (including the whole G20);
- updates and extends the analysis of how energy costs influence industrial competitiveness – including through expanding the countries covered (G20), the sectors covered (from 15 to more than 30) and using decomposition analysis to deepen insight into the drivers of impacts;
- provides new insights on the impact of price regulation – not included in previous work; and
- updates and expands the analysis on the evolution of energy subsidies, also covering subsidies to energy products used in transport and agriculture, and providing new econometric analysis of the impact of subsidies on energy prices and costs.

The specific objectives of the study were to:

- (Chapter 3 – Task 1) Analyse the development of wholesale and retail electricity, natural gas and petroleum product prices in the EU28 and major trading partners, as well as the drivers of these prices;
- (Chapter 4 – Task 2) Analyse the effect of energy prices and costs on the production costs and competitiveness of industries in the EU and in major EU trading partners;
- (Chapter 5 – Task 3) Analyse price regulation of electricity and gas in the EU28 and how this impacts on energy prices, quality of service and propensity to invest;
- (Chapter 6 – Task 4) Analyse subsidies on energy products (especially fossil fuels) used in the energy, transport and agricultural sectors in the EU and to evaluate the effect of these subsidies on energy prices on households and industry (particularly energy intensive industries).

Approach

Our approach to every task was based on a 3 step approach:

In summary these steps were: 1. Data collection, collecting, compiling and harmonising data from a wide range of sources; 2. The creation of an Excel-based data tool to analyse the data; 3. Assessment and analysis of the compiled data in this report.

There were also important interactions between the four tasks, for example price data in task 1 being re-used in both tasks 2 and 3.

Price, cost, subsidy and other data has been critical to this work. The team has used a large variety of sources, including the previous energy costs and prices work, existing public databases (national, EU, IEA, OECD, etc.) and private and commercial databases. Furthermore, significant resources have been used during this study to carry out dedicated country level research by experts within the team. This primary data gathering and subsequent validation of much of the Member State data by national regulatory authorities gives confidence in the data that has been used. Stakeholders have also been able to provide inputs through two stakeholder workshops held during the course of the study.

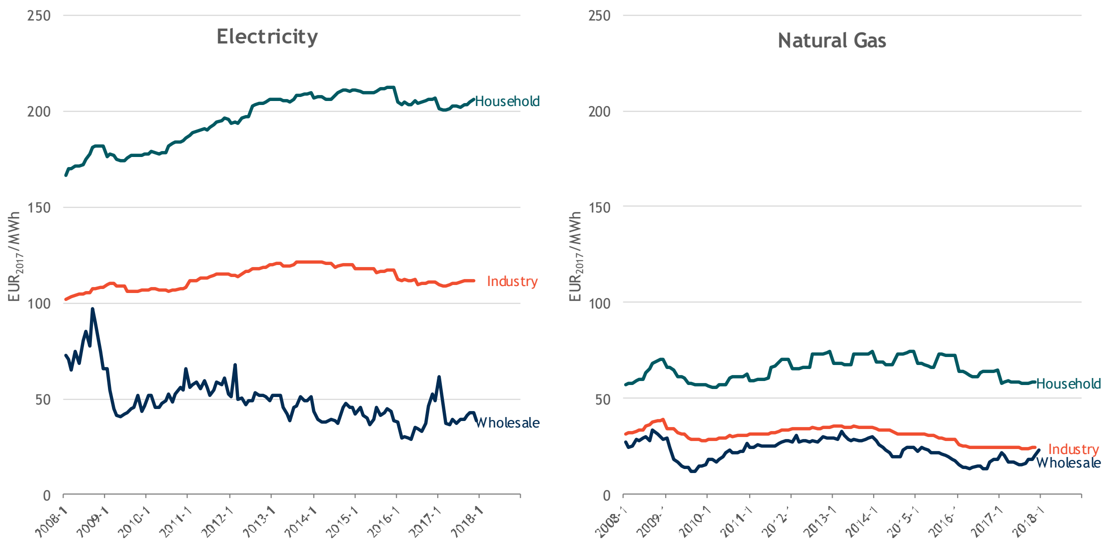
This work has made use of a variety of analytical techniques, particularly statistical and trend analyses. Among the more complex techniques applied were decomposition analyses and econometric analyses using the E3ME model.

Energy prices in the EU and major trading partners

This report has compiled EU and G20 wholesale and retail price data for electricity, natural gas and petroleum (and natural gas) based products. It has used data from multiple international, EU, national and commercial sources to present price trend analyses based on one of the most comprehensive and comparable sets of international price data currently available. See figures 0-1 and 0-2 for summary results for electricity and natural gas. The key trends and conclusions from the analysis include:

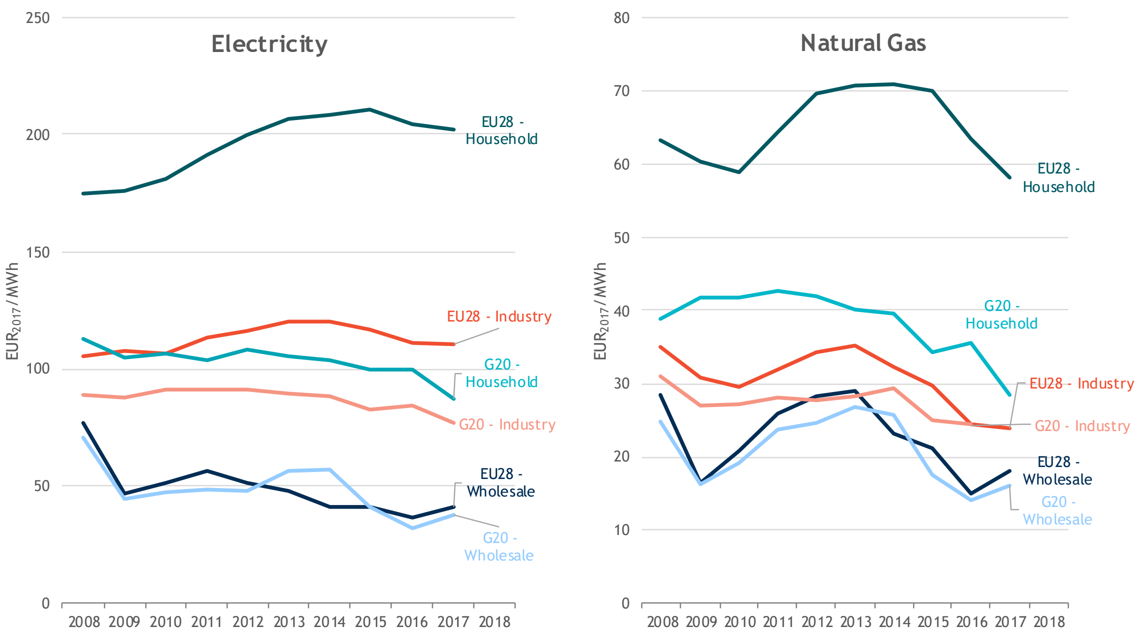
- EU and national energy policies are successful in securing competitive wholesale energy markets at which prices for electricity, natural gas and petroleum products are comparable or lower than many G20 countries;
- Yet EU28 average retail prices for electricity, gas and petroleum products tend to be higher than in the G20, especially for household customers, but also for industry. Although in the case of natural gas EU industry prices for natural gas are similar to, or lower than, those of Asian competitors such as Japan, China and South Korea;
- The main, but not only, driver of the observed differences is the tax regime in the EU28. Whilst a convergence in tax rates may occur if other G20 countries implement similar fiscal measures as the EU as part of their climate mitigation policies, there is as yet little evidence that this is the case;
- Additionally, major energy producers tend to have lower prices than in the EU, most often for natural gas. This has traditionally been the case for countries such as Saudi Arabia and Russia, but these have now been joined by the US and Canada, the latter two supported by shale gas;
- Many of the G20 still implement retail price regulation for households and/or industry. Meaning that retail prices are lower than wholesale prices, with the shortfall being subsidised by the Government.
- The price differences for industry can have an important influence on the relative competitiveness of EU firms, although it should be noted that the impact on energy costs of firms is the result of both the price and consumption, improving the latter through energy efficiency can offset some or all of any price differences; EU Member States also grant tax reductions to energy prices in the case of some energy intensive sectors to mitigate unequal international competition. The analyses in Task 2 (energy costs for industry) and Task 4 (subsidies) address these two matters.

Figure 0-1: EU weighted average[1] Electricity and Natural gas prices, EUR2017/MWh



Source: Own calculations

Figure 0-2: EU28 weighted averages compared to G20 weighted (by trade with EU) average prices[2]



Source: Own calculations

Energy costs for industry in the EU and major trading partners

Assessing energy costs and prices for industry in the EU and major trading partners we found that in the period 2008-2015, energy costs for selected manufacturing sectors typically constituted between approximately 1-10% of total (operational) production costs, although for a handful of sectors the costs significantly exceed 10% (e.g. Cement, lime and plaster [C235]; Clay building materials [C233]), and

[1] The EU weighted average is calculated based on consumption weighted Member State prices for the consumption band with the highest market share in that country, across the EU this is typically (but not always) DC for household electricity, ID for industrial electricity, D2 for household natural gas and I4 for industry natural gas.
[2] It should be noted that individual country prices can vary significantly from the weighted averages, and for example in some EU Member States prices are the same or lower than the G20 average, but also that in some Member States are even higher than the EU weighted average (see task 1 and the annexes for more detail). This is also the case for the G20 with individual countries having prices both higher or lower than the weighted average.

reached up to 40% in one year in the land transport sector (C49). Energy cost shares have fallen in every sector except for the refineries (C192) sector, which has a unique situation as reflected in the corresponding task 2. The largest percentage point decline in cost share can be observed in the cement, lime and plaster (C235) sector with a decline in cost share from around 23% to 16% observed (-7%).

The results from the decomposition analysis in Task 2, show that the drivers of changes in energy costs across different industry sectors are diverse.

- At an aggregate level across all the industry sectors considered, there is around an 8% reduction in current energy costs for EU industry over the period 2010-2015, despite small increases in current energy prices;
- According to the Eurostat SBS data, the only energy-intensive industry sectors which saw increases in energy costs over 2010-2015 were: *Manufacture of abrasive products and non-metallic mineral products n.e.c. (C239)*, *Manufacture of other porcelain and ceramic products (C234)* and *Sawmilling and planing of wood (C161)*. In these cases, energy cost increases were driven by increases in energy prices and gross output, which outweighed cost savings due to energy intensity improvements;
- Increases in current energy costs over the period were more prevalent in less energy intensive industries, such as *Manufacture of other transport equipment (C30)* and *Manufacture of motor vehicles, trailers and semi-trailers (C29)*, although the driver of this effect was, to a large extent, explained by increases in real output within these industry sectors;
- According to Eurostat SBS data, energy costs fell substantially among a number of energy-intensive industries, including in *Manufacture of cement, lime and plaster (C235)*, *Manufacture of basic iron and steel and of ferro-alloys (C241)* and *Manufacture of man-made fibres (C206)*, where energy costs fell by over 25% between 2010-2015;
- While there is some variation across industry sectors in the change in energy costs over the period, the ratio of energy costs to total production costs has fallen among almost all of the sectors included in the analysis over the period 2010-2015.

The impact of regulated end-user prices for electricity and natural gas

Data for 55 indicators over different topics (covering price regulation, competition, quality of services, energy poverty, investments and tariff deficits) was compiled from various sources and controlled by our network of country experts and representatives from the national regulatory authorities (NRAs). The country factsheets provide a detailed assessment of the current situation in each Member State regarding price regulation for household and non-household consumers in both gas and electricity markets. This information, along with the indicators compiled in the database, allowed for an in-depth assessment of the impact of regulated electricity and gas prices in energy markets in each Member State and across the EU.

Member States were categorized into four different groups: Member States without price regulation since 2008 or before, Member States where price regulation was phased out between 2008 and 2016, Member States where less than 50% of households and non-household consumption were under regulated prices, and Member States where more than 50% of those were under regulated prices. This split is the basis for the analysis in this report. Weighted averages for indicators are constructed in order to allow for comparison between groups of Member States. Weightings for indicators are based on the number of consumers, total consumption or the electricity capacity and are indicator, year, sector (households vs non-households) and type specific (electricity vs gas).[3]

The main findings are:

- Many Member States have recently phased out or have plans to phase out energy price regulation;
- However, several Member States still have price regulation in place (mostly for the household sector), but the share of regulated consumers has been decreasing;
- Still, in the household sector, several countries have large shares of consumers underregulated prices. Only a couple of countries, on the other hand, have a large share of non-household consumption under regulated prices:
    - For **electricity**, 7 Member States had regulated prices for more than 95% of **households** in 2016; while only two Member States had 100% of non-household consumption under regulated prices.
    - For **gas**, nine Member States had 100% of the household consumers under regulated prices in 2016; while only two Member States had over 90% of non-household consumption under regulated prices.
- Social tariffs are a common form of regulated energy prices; while the total share of households under regulated prices has decreased, the share of households with social tariffs has increased in several Member States. In 2016, 10 Member States applied social tariffs for electricity; while only 5 Member States did so for gas.
- Tariff deficits are more common in countries with regulated (household) prices: 11 out of the 28 Member States have shown signs of tariff deficit in the assessed time period, and 8 of those 11 still have regulated prices for households.
- No evidence is found for a positive impact of price regulation on energy expenditures (i.e. lower expenditures), energy poverty indicators or energy and supply price components for electricity and gas as compared with de-regulated prices.
- Consumer satisfaction scores are higher in Member States without price regulation and dynamic price offers are almost exclusively available in Member States which phased out price regulation (between 2008 and 2016, or before).
- Member States which phased out household price regulation before 2008 show (both for gas and electricity):
    - More suppliers per capita
    - Larger savings from switching suppliers available to household consumers
    - Higher energy and supply retail price components and higher mark-ups.

There are many factors in play affecting the energy market, besides price regulation. The cross-country analysis presented in this report is based on the comparison of the weighted averages for the different country groups listed above and available country-specific evidence.

Energy subsidies and their impact on prices

The current inventory aims to provide a comprehensive set of information on all forms of financial support to any energy-related purpose in each of the EU28 Member States to obtain a better

[3] The denominator of the weights is calculated as the total of the weight (consumers/consumption/electricity capacity) of all MS for which data was available for a specific indicator in a certain year, sector and type. The denominators of the weights are therefore year, sector and type specific.

understanding of the magnitude of subsidies distributed within the European Union. Information has been taken from an extensive number of official sources and controlled by a network of experts in each of the EU28 Member States. The main findings of the current inventory are:

- Over the 2008-2016 period, the cumulative financial support to energy-related purposes represented around €1,450 bn, in 2017 constant prices. Annual amounts have increased over the nine years covered from €150 bn in 2008 to €168 bn in 2016 (+€18 bn), representing a 12% increase.
- Subsidies supporting the production and the consumption of energy account for close to 90% of the total amounts disbursed in 2016. Subsidies for R&D, investments and energy savings together represent only slightly over 10% of the overall amounts in 2016.
- In contrast to the EU's commitment and intent to phase out fossil-fuels subsidies in the medium term, these have increased by 3% (+1.4 bn) between 2008 and 2016 to €55 bn (in 2017 prices), driven by tax expenditures for consumption of petroleum products in the transport and agriculture sectors (+€1.9 bn and +0.9 bn, respectively, over the period).
- In line with EU's 2020 renewable and climate goals, financial support to renewable energy sources has tripled over the period to €75bn in 2016 (in 2017 prices). However, the increase in financial support has significantly slowed down since 2013, although the installed RES capacity has continued to increase. This seems to mark a reversing trend resulting from cost reductions of RES technologies combined with more cost-efficient policies supporting the development of renewable technologies.

As part of Task 4, the impact of energy subsidies on household and industry gas and electricity prices was estimated using econometric analysis. The results show that, across all Member States, energy-intensive industry, other industry and households have benefitted from energy subsidies to varying degrees.

- In most Member States, the financing burden of subsidies for electricity production is imposed on final electricity consumers, through a tax that is levied on sales of electricity (and/or other instruments). Our estimates suggest that renewables (and other) support costs have led to a net increase in electricity costs over 2008-2016 for most final electricity consumers. This net increase in electricity costs occurs despite reductions in wholesale prices (which were estimated at around €4/MWh for Germany);
- The cost of financing subsidies for electricity producers tended to outweigh the effect of other subsidies in lowering electricity costs for final consumers. When taking account of the combined effect of all electricity subsidies and financing costs, there are only a few cases (households in Latvia, Lithuania, Estonia, Luxembourg, Malta, the UK, the Netherlands, and energy-intensive industry in Sweden and Finland) where consumers experienced net electricity cost savings;
- We estimate that the cost of financing subsidies for electricity production has increased electricity costs for industry by over 25% in some cases (e.g. in Italy, Spain and Denmark). In other cases (e.g. Germany and the UK), energy-intensive industries have been somewhat protected by tax exemptions and other means of support;
- Gas costs for households in Lithuania, Denmark, Luxembourg and the UK are estimated to be around 15-20% lower than they otherwise would have been due to energy subsidies targeted towards households (most notably, the VAT reductions for UK households and energy savings subsidies for Lithuanian households). In the Netherlands, energy tax exemptions for households drive a 30% saving in gas costs;

- In some EU Member States, such as Cyprus and Romania industry and households have not benefitted from energy subsidies at all over the period 2008-2015.

Résumé exécutif

Introduction

Ce rapport représente une contribution importante au rapport biennal sur les coûts et les prix de l'énergie que la Commission Européenne s'est engagée de fournir. Ce travail s'appuie sur deux précédentes éditions réalisées en 2014 et 2016. Le présent rapport représente une mise à jour de l'analyse précédente afin de prendre en compte les dernières données disponibles. De plus, ce rapport :

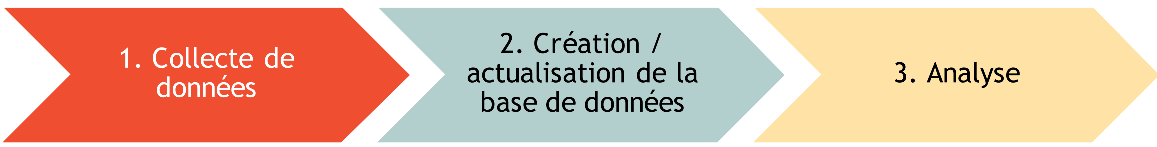
- Actualise et développe l'analyse sur les prix internationaux de l'énergie, leur évolution et leurs déterminants – en ajoutant de plus nombreux prix et une plus grande couverture géographique (notamment le G20) ;
- Actualise et développe l'analyse afin de déterminer comment les coûts de l'énergie influencent la compétitivité industrielle – en intégrant un plus grand nombre de pays dans l'étude (G20), de secteurs (de 15 à plus de 30) et une analyse de décomposition qui offre une meilleure compréhension des facteurs qui influencent les coûts ;
- Fournit de nouvelles perspectives sur l'impact de la régulation des prix – nouvelle partie, non inclue dans le rapport précédent ;
- Actualise et développe l'analyse sur l'évolution des subventions à l'énergie, en intégrant les subventions dans les secteurs du transport et de l'agriculture, ce qui offre une nouvelle analyse économétrique de l'impact des subventions sur les prix et les coûts de l'énergie.

Les objectifs spécifiques de l'étude étaient :

- (Chapitre 3 – Tâche 1) D'analyser le développement des marchés de gros et de détail de l'électricité, du gaz naturel et des produits dérivés du pétrole dans l'UE28 et dans les principaux partenaires commerciaux, ainsi que les facteurs qui influencent ces prix ;
- (Chapitre 4 – Tâche 2) D'analyser les effets des prix et des coûts de l'énergie sur les coûts de production et sur la compétitivité des industries dans l'UE et dans les principaux partenaires commerciaux de l'UE ;
- (Chapitre 5 – Tâche 3) D'analyser la réglementation des prix de l'électricité et du gaz dans l'UE28 et leur influence sur les prix de l'énergie, la qualité des services et la propension à investir ;
- (Chapitre 6 – Tâche 4) D'analyser les subventions par type de fuel (avec un focus sur les combustibles fossiles) utilisés dans les secteurs de l'énergie, du transport et de l'agriculture dans l'UE et d'estimer l'impact de ces subventions sur les ménages et l'industrie (en particulier les industries grandes consommatrices d'énergie).

L'approche

Nous avons abordé chaque tâche selon une approche en trois étapes :



Pour résumer, ces étapes comprennent : 1. La collecte de données, le contrôle, la compilation et l'harmonisation des données venant de différentes sources ; 2. La création d'un outil Excel facilitant l'analyse des données ; 3. L'évaluation et l'analyse des données collectées pour le projet.

Il y a aussi eu des échanges importants entre les quatre tâches, par exemple, les données sur les prix de l'énergie (Tâche 1) ont été utilisées pour les Tâches 2 et 3.

Les données sur les prix, les coûts, les subventions ont joué un rôle important dans notre travail. L'équipe a utilisé des sources très variées pour obtenir tous ces données : des bases de données publiques (données nationales, UE, AIE, OCDE, etc.), ainsi que des bases de données commerciales. Nos équipes ont également mener différentes enquêtes pour compléter ces données et valider les informations collectées par nos soins. Deux ateliers ont été organisés au cours du projet pour présenter les résultats intermédiaires de l'étude.

L'étude a permis de mettre en œuvre différentes analyses statistiques des données. Parmi les techniques utilisées les plus complexes, nous avons mis en œuvre l'analyse de décomposition et des analyses économétriques à partir du modèle E3ME.

Les prix de l'énergie dans l'UE et dans les principaux partenaires commerciaux de l'UE

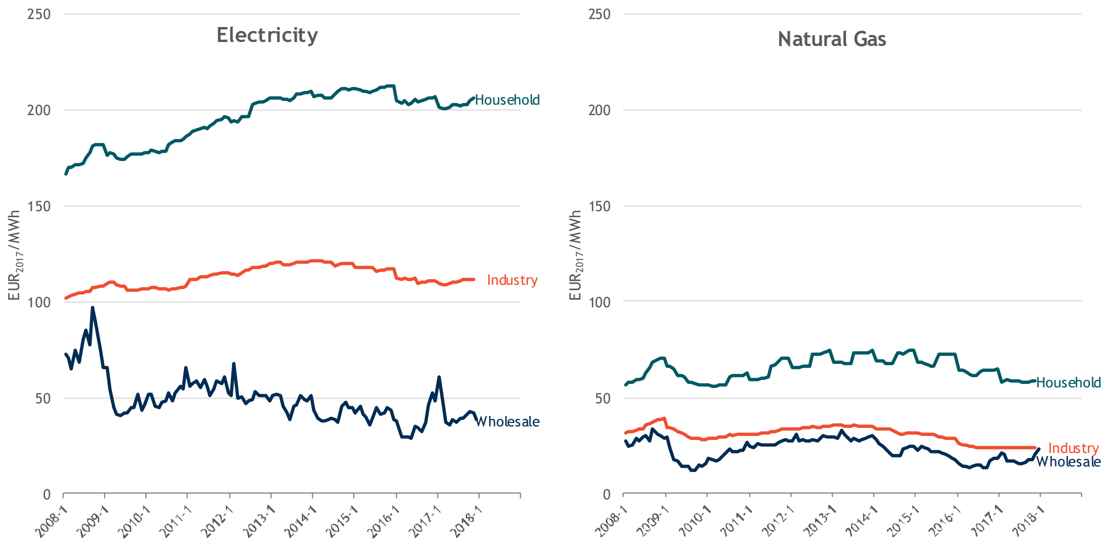
Ce rapport a rassemblé des données sur les prix de gros et de détail de l'électricité, du gaz naturel et des produits dérivés du pétrole (et du gaz naturel) dans l'UE et le G20. Le rapport compile des données venant de multiples sources internationales, européennes, nationales et commerciales afin de pouvoir présenter des analyses de tendance sur les prix basées sur une des plus compréhensibles et comparables bases de données disponibles sur les prix internationaux de l'énergie. Pour un résumé des résultats de l'électricité et du gaz naturel, voir les figures 0-1 et 0-2. Quelques tendances et conclusions principales de l'analyse sont :

- Les politiques énergétiques de l'UE et des États membres réussissent à sécuriser les marchés de gros de l'énergie, sur lesquels les prix de l'électricité, du gaz naturel et des produits pétroliers sont comparables ou inférieurs à ceux de nombreux pays du G20.
- Pourtant, les prix de détail moyens de l'UE28 pour tous les types d'énergie ont tendance à être plus élevés que ceux du G20, en particulier pour les ménages, mais aussi pour l'industrie. En ce qui concerne le gaz naturel, les prix dans l'industrie en UE sont similaires à ceux des concurrents asiatiques tels que le Japon, la Chine et la Corée du Sud.
- Le principal facteur qui influence les différences observées est le régime fiscal de l'UE28. On peut toutefois observer une convergence des taux d'imposition dans certains pays du G20 qui mettent en œuvre des mesures fiscales similaires à celles de l'UE dans le cadre de leurs politiques d'atténuation du changement climatique.
- Les principaux producteurs d'énergie ont tendance à afficher des prix plus bas que dans l'UE, le plus souvent pour le gaz naturel. Cela a toujours été le cas pour des pays comme l'Arabie Saoudite et la Russie, suivi par les États-Unis et le Canada notamment grâce au gaz de schiste.
- Les différences de prix pour l'industrie ont une influence importante sur la compétitivité relative des entreprises de l'UE, mais il convient de noter que l'impact de ces dernières sur les coûts énergétiques des entreprises dépend du prix et de la consommation – l'amélioration de

cette dernière grâce à l'efficacité énergétique peut compenser quelques-unes ou toutes les différences de prix.

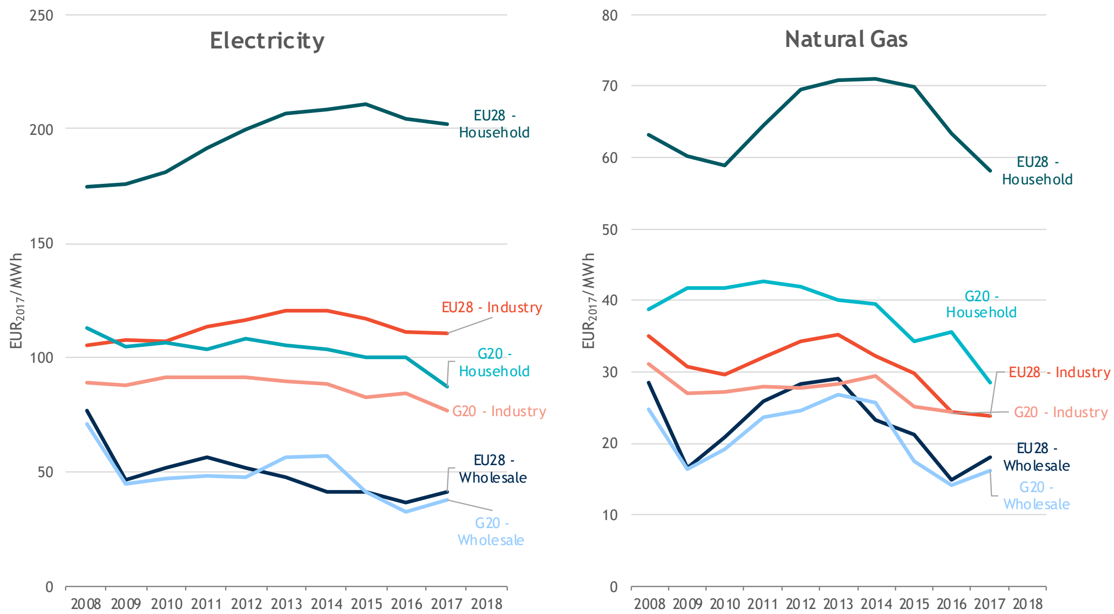
- Un certain nombre de pays du G20 applique toujours la réglementation des prix de détail pour les ménages et/ou l'industrie. Cela signifie que les prix de détail sont inférieurs aux prix de gros, le gouvernement subventionnant le déficit.

Figure 0-1: Moyenne pondérée[4] des prix de l'électricité et du gaz naturel dans l'UE, EUR_{2017}/MWh



Source: Calcul de l'auteur

Figure 0-2: Moyennes pondérées des prix de l'UE28 en comparaison avec les moyennes pondérées des prix du G20 (à travers le commerce avec l'UE)[5]



Source: Calcul de l'auteur

[4] La moyenne pondérée de l'UE est calculée sur la base des prix pondérés de la consommation dans les États Membres pour la bande qui a la part de marché la plus élevée dans le pays. Généralement dans l'UE (mais ce n'est pas toujours le cas), cela veut dire DC pour l'électricité des ménages, ID pour l'électricité de l'industrie, D2 pour le gaz naturel des ménages et I4 pour le gaz naturel de l'industrie.

[5] Il convient de noter que les prix des différents pays peuvent différer sensiblement des moyennes pondérées et, par exemple, dans certains États membres de l'UE, les prix sont identiques ou inférieurs à la moyenne du G20. Dans certains États membres, les prix sont même supérieurs à la moyenne pondérée de l'UE (voir Tâche 1 et les annexes pour plus de détails). C'est également le cas du G20, les pays ayant des prix à la fois supérieurs ou inférieurs à la moyenne pondérée.

Les coûts de l'énergie pour l'industrie de l'UE et de ses principaux partenaires commerciaux

En évaluant les coûts et les prix de l'énergie pour l'industrie dans l'UE et ses principaux partenaires commerciaux, nous avons constaté qu'entre 2008 et 2015, les coûts énergétiques de certains secteurs manufacturiers représentaient entre 1% et 10% des coûts de production même s'ils dépassaient largement les 10% dans quelques cas - par exemple les secteurs Ciment, chaux et plâtre (C235); Matériaux de construction en argile (C233), atteignant même jusqu'à 40% dans le secteur des transports terrestres (C49). Les parts des coûts de l'énergie ont diminué dans tous les secteurs, à l'exception du secteur des raffineries (C192), qui se distingue comme montré dans la Tâche 2. La plus forte baisse en pourcentage est observée dans le secteur Ciment, de la chaux et du plâtre (C235) avec une baisse de la part des coûts observés d'environ 23% à 16% (-7%).

Les résultats de l'analyse de décomposition dans la Tâche 2 montrent que les facteurs qui influencent le changement des coûts de l'énergie des différents secteurs industriels sélectionnés sont relativement variés.

- À un niveau global et en prenant en compte tous les secteurs industriels inclus dans l'étude, nous constatons une hausse d'environ 8% des coûts de l'énergie actuels sur la période 2010-2015, les améliorations de l'intensité énergétique étant compensées par une augmentation des prix de l'énergie.
- Selon les données d'Eurostat, les secteurs qui ont connu des augmentations relativement importantes des coûts de l'énergie sur la période 2010-2015 sont les suivants : fabrication de produits abrasifs et de produits minéraux non métalliques (C239), fabrication d'autres produits en porcelaine et en céramique (C234)) et sciage et rabotage du bois (C161). Dans ces cas, les augmentations des coûts de l'énergie ont été provoquées par les hausses des prix de l'énergie et de la production brute, qui ont été plus importantes que les réductions de coûts dues aux améliorations de l'intensité énergétique.
- Les augmentations des coûts de l'énergie au cours de la période ont été courant dans les industries moins énergivores, telles que la fabrication d'autres équipements de transport (C30) et la fabrication d'automobiles, de remorques et de semi-remorques (C29). Cela s'explique dans une large mesure par l'augmentation de la production réelle de ces secteurs industriels.
- Selon les données d'Eurostat, les coûts de l'énergie ont sensiblement baissé dans un certain nombre d'industries à forte intensité énergétique, notamment dans la fabrication de ciment, de chaux et de plâtre (C235), la fabrication de fer et d'acier de base et de fibres synthétiques (C206), où les coûts énergétiques ont diminué de plus de 25% entre 2010 et 2015.
- Bien que les variations des coûts de l'énergie au cours de la période diffèrent considérablement selon les secteurs d'activité, le rapport entre les coûts de l'énergie et les coûts de production totaux a diminué dans presque tous les secteurs inclus dans l'analyse sur la période 2010-2015.

L'impact de la réglementation des prix de l'électricité et du gaz naturel

Des données pour 55 indicateurs portant sur différents thèmes (couvrant la réglementation des prix, la concurrence, la qualité des services, la pauvreté énergétique, les investissements et les déficits tarifaires) ont été compilées à partir de plusieurs sources et vérifiées par notre réseau d'experts nationaux et des représentants des autorités réglementaires nationales. Ces informations ont été rassemblées dans des fiches pays qui permettent une évaluation détaillée de la situation actuelle de la réglementation des prix pour les ménages et les consommateurs non résidentiels sur les marchés du gaz et de l'électricité. Ces informations, ainsi que les indicateurs compilés dans la base de données, ont permis une évaluation approfondie de la réglementation des prix de l'électricité et du gaz sur les marchés de l'énergie dans chaque État membre de l'UE.

Les États membres ont été classés dans quatre groupes différents : les états membres n'ayant pas de réglementation de prix depuis 2008 ou avant, les états membres où la réglementation de prix a été progressivement éliminée entre 2008 et 2016, les états membres ayant moins de 50% des ménages et des consommateurs non résidentiels sous réglementation et les états membres ayant plus de 50% des ménages et des consommateurs non résidentiels sous réglementation. Cette division des pays est la base de l'analyse du rapport. Les moyennes pondérées des indicateurs sont construites afin de permettre une comparaison entre les différents groupes d'états membres. Les pondérations sont basées sur le nombre de consommateurs, la consommation totale ou la capacité électrique et sont déclinées par années, secteurs (ménages ou consommateurs non résidentiels) ou types de marché (électricité ou gaz).[6]

Les conclusions principales sont les suivantes :

- De nombreux États membres ont récemment éliminé ou envisagent d'éliminer progressivement la réglementation des prix de l'énergie.
- Cependant, plusieurs États membres ont encore recourt à une réglementation des prix (principalement pour le secteur des ménages), mais la part des consommateurs réglementés a diminué.
- Le tarif social est une forme courante de réglementation de prix de l'énergie ; même si la part totale des ménages étant sous réglementation a baissé, la part des ménages destinataires des tarifs sociaux a augmenté dans plusieurs États membres.
- Cependant, dans plusieurs pays une partie importante des ménages a encore des prix réglementés. En contrepartie, seulement deux pays ont une partie importante des consommateurs non résidentiels avec des prix réglementés :
    - Pour l'électricité, 7 États membres avaient des prix réglementés pour plus de 95% des **ménages** en 2016 ; alors que seulement en deux États membres la réglementation des prix touchaient 100% des consommateurs non résidentiels.
    - Pour le **gaz,** 9 États membres avaient 100% des ménages avec des prix réglementés en 2016 ; en contrepartie seulement en deux États membres 90% des consommateurs non résidentiels étaient sujets a la réglementation des prix.
- Outre la régulation des prix, de nombreux facteurs influent sur le marché de l'énergie. L'analyse transnationale présentée dans ce rapport est basée sur une comparaison de moyennes pondérées pour les différents groupes de pays soulignés en haut, ainsi que sur des faits spécifiques aux Etats membres de l'UE. En 2016 10 États membres possédaient des tarifs sociaux pour l'électricité ; alors que pour le gaz cela était le cas pour seulement 5 pays.
- Des déficits tarifaires sont plus communs dans les pays avec des prix réglementés (pour les ménages) : 11 des 28 États membres montrent des signes de déficit tarifaire dans la période recherchée, et 8 de ces 11 États possèdaient des prix réglementés pour les ménages.

[6] Le dénominateur des poids est le total du poids (consommateurs/consommation/capacité électrique) de tous les États membres pour lesquels des données étaient disponibles pour un indicateur spécifique dans une telle année, tel secteur et type de consommateur. Les dénominateurs des poids sont donc spécifiques à l'année, au secteur et au type de consommateur.

- Aucune indication est identifiée d'un impact positif de la réglementation des prix sur les dépenses énergétiques (i.e. des dépenses moindres), sur la pauvreté énergétique ou sur les prix d'énergie et de fourniture d'électricité et de gaz, quand la comparaison est faite avec le l'absence de réglementation.
- Les scores de satisfaction des consommateurs sont plus hauts dans les États membres qui n'ont pas de réglementations de prix, et les offres avec prix dynamiques sont disponibles presqu'exclusivement dans ces États, qu'ils aient éliminé la réglementation avant ou après 2008.
- Les États membres qui ont éliminé la réglementation des prix avant 2008 possèdent (sois pour l'électricité que pour le gaz) :
    - Plus de fournisseurs per capita
    - Des bénéfices pour les ménages provenant du changement des fournisseurs plus importants
    - Des composants de prix d'énergie et de fourniture et des taux de marge plus hauts.

En plus de la réglementation des prix, il y a plusieurs facteurs qui affectent le marché de l'énergie. L'analyse entre pays présentée dans ce rapport est basée sur la comparaison des moyennes pondérées pour les différent groups de pays présentés ci-dessus et information spécifique à chaque pays.

Les subventions à l'énergie et leur impact sur les prix

L'inventaire des subventions à l'énergie a été actualisé et étendu aux secteurs des transport et de l''agriculture afin de mieux déterminer l'ampleur des subsides distribuées au sein de l'Union Européenne. Cet inventaire, établit à partir d'information collectées dans un grand nombre de documents officiels par un réseau d'experts dans chacun des 28 États membres, couvre une multitude de formes d'interventions publiques destinées à soutenir financièrement la production, la consommation ou l'économie d'énergie, ainsi que la R&D et les investissements dans le secteur énergétique. Les conclusions principales de l'inventaire sont :

- Pour la période 2008-2016, le soutien financier cumulé à l'énergie ont représenté environ 1,450 milliards d'euros, en prix constants de 2017. Les montants annuels ont augmenté sur les neuf années de 150 milliards d'euros en 2008 à 168 milliards d'euros en 2016 (+18 milliards d'euros), ce qui représente une hausse de 12%.
- Les subventions pour la production et la consommation d'énergie représentent près de 90% du montant total versé en 2016. Les subventions cumulées pour la recherche et le développement, les investissements et l'économie d'énergie représentent à peine plus de 10% du montant total en 2016.
- Contrairement à l'engagement de l'UE d'éliminer les subventions aux combustibles fossiles à moyen terme, celles-ci ont augmenté de 3% (+1,4 milliards d'euros) entre 2008 et 2016 pour atteindre 55 milliards d'euros (en prix de 2017). Les dépenses fiscales liées à la consommation de pétrole dans les secteurs du transport et de l'agriculture (+1,5 et +0,7 milliards d'euros, respectivement, sur la période) selon la principale source d'augmentation des subventions aux énergies fossiles.
- Conformément aux objectifs climatiques de l'UE, le soutien financier pour les énergies renouvelables a triplé sur la période pour atteindre 75 milliards d'euros en 2016 (en prix de 2017). Toutefois, cette hausse a significativement ralenti depuis 2013 alors même que les capacités de production de ces technologies ont continué de croitre. Cela semble marquer un inversement de tendance conséquence de la réduction des coûts des technologies de

production d’énergies renouvelables et de l’adaptation des politiques de soutien à leur développement.

Dans le cadre de la Tâche 4, l’impact des subventions en matière d’énergie sur les prix du gaz et de l’électricité pour les ménages et l’industrie a été estimé à l’aide d’une analyse économétrique. Les résultats montrent que dans tous les États membres, les industries grandes consommatrices d’énergie, les autres industries et les ménages ont bénéficié des subventions énergétiques à des degrés divers.

- Dans la plupart des états membres, le poids financier des subventions en matière de production d’électricité se fait ressentir par le consommateur final notamment par le biais d’une taxe prélevée sur la vente d’électricité. Nos estimations montrent que les politiques de soutien aux énergies renouvelables ont conduit à une augmentation nette des coûts de l’électricité sur la période 2008-2016 pour la plupart des consommateurs finaux d’électricité. Cette augmentation nette des coûts de l’électricité se produit malgré des réductions dans les prix de gros (qui ont étés estimés en environ €4/MWh pour l’Allemagne).
- Le coût du financement des subventions destinées aux producteurs d’électricité a tendance à largement compenser l’effet des autres subventions quant à la diminution des coûts d’électricité pour les consommateurs finaux. Si nous prenons en compte l’effet combiné de toutes les subventions en matière d’électricité et les coûts de financement, il y a très peu de cas (ménages en Lettonie, Lituanie, Estonie, Luxembourg, à Malte, au Royaume Uni, aux Pays Bas, et les industries grandes consommatrices d’énergie en Suède et Finlande) où les consommateurs ont ressenti des économies nettes de coûts d’électricité.
- Nous estimons que le coût des subventions pour la production d’électricité a accru les coûts d’électricité pour l’industrie de près de 25% dans certains cas (par exemple, Espagne et Italie). Dans d’autres cas (par exemple, Allemagne et Royaume Uni), les industries grandes consommatrices d’énergie ont été en partie protégées par les exonérations fiscales et d’autres politiques de soutien.
- Les coûts de gaz pour les ménages en Lituanie, Danemark, Luxembourg et le Royaume Uni sont inférieurs de 20% par rapport à ce qu’ils auraient été sans les subventions, parce que les subventions en matière d’énergie visent les ménages (un exemple marquant étant les réduction de TVA pour les ménages dans le Royaume Uni et les subventions en matière d’économie d’énergie pour les ménages en Lituanie). Aux Pays-Bas, les exonérations fiscales en matière de taxe sur l’énergie pour les ménages entraînent une baisse de 30% dans les coûts de gaz.
- En Chypre et en Roumanie, l’industrie et les ménages n'ont bénéficié d'aucune subvention énergétique entre 2008 et 2015.

1 Introduction

This is the final report of the study on Energy prices, costs and subsidies and their impact on industry and households.

1.1 The objectives of the study

The EC is committed to present an analysis of the prices and costs of energy every two years. This study represents a major input for the third energy prices and costs report in 2018 (along with other inputs prepared by the Commission Services, for example on household energy expenditure and energy poverty, energy price drivers and bottom-up data on energy prices and costs paid by energy intensive industry or evidence on impact of price setting mechanisms). Compared to previous editions of the costs and prices report in 2014 and 2016, this report:

- Updates and extends the analysis of international energy prices and their evolution and drivers;
- Updates and extends the analysis of how energy costs influence industrial competitiveness;
- Provides new insights on the impact of price regulation; and
- Updates and expands the analysis on the evolution of energy subsidies, also covering subsidies to energy products used in transport and agriculture.

The specific objectives of the study were to:

- Analyse the development of wholesale and retail electricity, natural gas and petroleum product prices in the EU28 and major trading partners, as well as the drivers of these prices;
- Analyse the effect of energy prices and costs on the production costs and competitiveness of industries in the EU and in major EU trading partners;
- Analyse price regulation of electricity and gas in the EU28 and how this impacts on energy prices, quality of service and the propensity to invest;
- Analyse subsidies on energy products (especially fossil fuels) used in the energy, transport and agricultural sectors in the EU and to evaluate the effect of these subsidies on energy prices for households and industry (particularly energy intensive industry).

By gathering data to update or create these analyses for the EU28 countries and major trading partners, this study aims to increase transparency on energy prices, costs and subsidies, to support market integration, and to identify factors that distort the internal market.

1.2 The scope of this study

This study aims to build upon the work carried out in the 2016 (second) energy prices and costs report and in the 2014 energy costs and subsidies report. The table below provides an overview of the scope of the previous studies and the extended scope taken into account in this assignment. It notes the countries covered, the period of time considered, and – per task – the energy carriers or sectors included.

Table 1-1: Overview of the scope

Task	2014 energy costs & subsidies study	2016 energy prices & costs study	Current assignment
1. International energy prices	Not covered	• Several G20 countries	• EU28 + all non-EU G20 countries
		• 2008-2015	• 2008-latest available
		• Electricity and gas - retail prices only	• Electricity, gas and petroleum products – retail and wholesale prices
2. Industry energy costs	Not covered	• EU28, China, USA, Japan	• EU28 + all non-EU G20 countries
		• 2008-2014	• 2008-2016
		• NACE 3: 15 energy intensive manufacturing sectors	• NACE 2 [A-H]: 15 sectors • NACE 3: 15 energy intensive manufacturing sectors plus 15 other manufacturing sectors[7]
3. Regulated end-user prices	Not covered	Not covered	• EU28
			• 2008-2016
4. Subsidies for energy products	• EU28	Not covered	• EU28 + Norway and Switzerland
	• Up to 2012		• Up to 2016
	• Energy sector		• Energy, transport and agriculture sector

[7] Specifically this refers to the 15 energy intensive manufacturing sectors: 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 - Clay building materials; C234 - Porcelain and ceramics; C235 - Cement, lime and plaster; C237 – Stone; C241 - Iron and steel; C244 - Non-ferrous metals.
The 15 other manufacturing sectors are: C103 - Fruit and vegetables; C11 – Beverages; C172 - Articles of paper; C21 - Pharmaceutical products; C222 - Plastics products; C239 - Abrasive products; C245 - Casting of metal; C25 - Fabricated metal products; C26 - Computer and electronics; C27 - Electrical equipment; C28 - Machinery and equipment; C29 - Motor vehicles; C30 - Other transport equipment; C32 - Other manufacturing; C33 - Repair of machinery.

2 Methodology

2.1 Overall approach

The overall approach to this work has been structured by four tasks, and an inception phase which was used to clarify the key definitions, scope, objectives and data to be used in the work. The four tasks each correspond to a specific and distinct aspect of energy prices and costs as requested in the original terms of reference of the work, namely:

- **Task 1: Analysis of energy prices in EU and major trading partners (G20)** - the goal of this task was to gather and assess energy prices in both the EU28 and non-EU G20 countries, to compare levels and trends over time and provide analysis of the key movements and drivers of these. This constituted around 10% of the work.

- **Task 2: Analysis of energy costs for industry in the EU and major trading partners (G20)** – the goal of this task was to gather and assess the energy costs for industry in the EU and non-EU G20 countries, including energy costs, energy prices, energy consumption and energy efficiency. This constituted around 20% of the work.

- **Task 3: Analysis of the impact of regulated end-user prices on electricity and gas markets** – the goal of this task was to assess the impact of regulated end-user prices on gas and electricity retail markets in the EU28. Specifically, it was to provide analysis of the price evolution per type of consumer/customer group, the evolution of the quality of service and the investments/ potential propensity to invest. This constituted around 20% of the work.

- **Task 4: Analysis of energy subsidies and their impact on prices** – the goal of this task was to assess the impact of energy subsidies on prices in the EU, clearly quantifying them and identifying the fossil fuel subsidies. By using econometric analysis and modelling this task was to provide estimates of the direct and indirect impacts of energy subsidies on power markets, both through the impact of production subsidies and energy efficiency subsidies on industrial energy demand. As a result, it would be possible to provide insights into the influence of these on both wholesale and retail prices. This constituted around 50% of the work.

All four tasks were structured in the same way, comprising three distinct sub-tasks: 1) data collection; 2) database update/creation; and, 3) assessment. These are reflected in the following sections, which provide an overview of our approach to each. It should be noted that the task-specific approaches are presented in the appropriate chapters of this report.

It should also be noted that there was some interaction between the tasks, for example the international price data gathered in task 1 was used in task 2 for estimating energy costs of industry in other G20 countries. Also from task 1, EU28 energy prices have been utilised in task 3. The work in task 4 to analyse the relationship between wholesale and retail prices has also had relevance for task 3.

2.2 Data collection

This work has been highly data intensive and has drawn upon a variety of approaches and sources to complete the work. Among the key sources have been the following:

- **Previous Energy costs and prices work** – the previous iterations of this study provided a starting point for many tasks in this work. This data was reviewed and discussed with the European Commission, in most cases being used to inform our specific approach, rather than being directly reused. For task 3, no data was available from previous versions of the Energy costs and prices series, the data for task 1 was also highly limited;
- **Existing public databases** – key national, EU and international data sources such as Eurostat, OECD and IEA have been major sources for this work.;
- **Private and commercial databases** – working with the European Commission and other relevant administrations, agencies, associations and providers, it has been possible to access and use unpublished and/or commercially available data. Of particular importance was a dataset provided by CEER[8] on various issues related to price regulation, prices and quality service, and which was a highly valuable sources for task 3 (chapter 5) of this report. In addition we would like to acknowledge data provided through the EMOS (Energy Market Observatory) database by Commission Services which has been particularly valuable to task 1 (chapter 3);
- **Primary research from country experts** – a major part of the project, particularly relevant to task 4, has been primary research carried out per EU28 Member State by national experts. Desk research of data and contact with national administrations, statistical offices, energy agencies or other sources, has enabled update, improvement and validation of the subsidy estimates per Member State;
- **Stakeholder interaction** – our work has included a stakeholder workshop, held in Brussels in March 2018, at which the approach to each task and preliminary results were presented to an audience of highly relevant stakeholders. This provided an opportunity to share data and improve our approach. A second workshop was held in June 2018 at which we presented the draft final results of this work and received additional feedback from stakeholders.

Please see the task chapters to find the specific sources used.

2.3 Database update and creation

Our work on the creation or update of existing Excel databases has been based on the principles of:

- Traceability (of data);
- Simplicity & functionality;
- Consistency;
- Improvement (for updating of databases);
- Smart design (for creation of new database);

The databases that have been created for this work are supplied as accompanying deliverables to the work. These were developed in close cooperation with counterparts at the European Commission to ensure they provide relevant information and incorporate the (future) user perspective.

[8] The Council of European Energy Regulators - https://www.ceer.eu/

2.4 Analysis

This work has made use of a variety of analytical techniques, particularly statistical and trend analysis. Among the more complex techniques applied are:

- Decomposition analysis;
- Econometric analysis using the E3ME model.

A detailed description of the former and its specific application to this work can be found in chapters 4 & 6. A detailed description of the econometric modelling can be found in chapter 6 and Annex E of this report.

3 Task 1 - Analysis of prices in EU and major trading partners

3.1 Methodology and data

3.1.1 Objective and scope

The aim of this task was to gather and assess energy price data of EU trading partners and compare them to EU prices.

The geographical scope of the work was agreed as the EU28 and (non-EU) G20[9]. The period 2008-2018 was the main focus of the work. In the accompanying Excel deliverables, longer datasets are also included in some cases where extended time series were easily available. Data frequency is primarily annual or monthly, although in some cases less or more frequent data is used. For example, in wholesale markets daily (or weekly) price data have been converted to monthly averages.

The scope of prices to be covered was discussed and agreed at inception and is summarised in Table 3-1 below. This presents a comprehensive list of prices. It was noted already at this stage that for some prices, for example biofuels (wholesale), LNG and CNG (both retail), there was likely to only be very limited data availability – this has proved to be the case, particularly for retail LNG, for which no usable data was found.

Table 3-1: Scope of task 1 - prices and source types.

	Electricity	Natural Gas	Petroleum products (new)
Wholesale	• EU28 – using national market prices • G20 – using national market prices	• EU28 – using national hub prices, estimated border prices or specific LNG prices • G20 – using hub prices, border prices or LNG import prices	• Crude oil – based on main global price indices (Brent, WTI, Nigeria, Dubai) • Biofuels (wholesale) – main US and EU prices

Retail	• Industrial (split by consumption bands as defined in Eurostat)
	• Household (split by consumption bands as defined in Eurostat)
		• Industrial (split by consumption bands as defined in Eurostat)
		• Household (split by consumption bands as defined in Eurostat)
			• Petrol (gasoline)
			• Diesel
			• LPG motor fuel
			• Heating oil
			• High sulphur fuel oil
			• Low sulphur fuel oil
			• Natural gas based fuels
			  ○ CNG
			  ○ LNG

Note: In addition to the listed prices, a selection of wholesale coal price time series is also included in the petroleum products dataset. This data was used for task 2 as coal is an important input to industrial processes and/or auto-generation by large industrial facilities.

[9] Please see Annex C for the list of countries and the abbreviations for them used in this project.

3.1.2 Data gathering

Our first step was to evaluate the data and outputs contained in the existing tool (from the 2016 prices and costs study) with two objectives relevant to the data gathering:

1. Identifying which data was already available and could easily be updated, and how the data could best be structured;
2. Analysing how the analytical capabilities of the existing tool could be improved.

The assessment of the previous tool found that very little data could be reused. It was in fact better to start again as the scope of the work had multiplied significantly since the previous study, from 2 price analyses to 16 price analyses, with many more new sub-levels to the analysis (such as price bands and components). As a result, it was also necessary to create a new and significantly different Excel tool to handle the data. The final tools accompanying this report were developed with feedback from the EC.

In terms of the data gathering, a variety of sources have been used, but key sources included those extracted by the team, and those provided or advised by the European Commission, including:

- Eurostat and EC analyses – includes standard published price data sets for electricity, natural gas and petroleum products and also non-published data shared by the EC[10], the latter primarily for EU28 electricity and natural gas prices and their breakdowns per consumption band and/or component;
- IEA Energy Prices and Taxes – this was among the primary sources for retail prices for petroleum products, electricity and gas, particularly for G20 members of the IEA (Australia, Canada, Japan, South Korea, Mexico, Turkey and the United States);
- CEIC[11] which provides prices and price indices for electricity and natural gas for many G20 countries, compiled from various national and other sources;
- VaasaETT[12] which provides price data for household natural gas and electricity prices for the EU28, split by component;
- ERRA (Energy Regulators Regional Association) – household, industrial and wholesale electricity and gas prices for a range of central European and Asian countries, including Russia and Saudi Arabia;
- Platts – data for wholesale electricity and natural gas prices in Europe, and international biofuel prices;
- World Bank Commodities Price Data (The Pink Sheet) – for global oil and coal wholesale prices.
- National statistics websites;
- Other fuel specific websites such as: cngeurope.com

Full tables of the sources for each figure in task 1 are provided as an Annex to this report.

The following table, Table 3-2, provides a summary of the data per price type that has been compiled and used for this work. LNG as a transport fuel is not presented in the table as no data was found for this fuel, despite contact with associations and requests to commercial data providers, and therefore it is not included in the analysis. LNG as a natural gas delivery method is included within the natural gas prices for countries for which this is particularly relevant, e.g. Japan, China, South Korea. Similarly,

[10] A large part of the data used in this task (including the following bullets) has been provided by Commission Services through EMOS (Energy Market Observatory) database
[11] https://www.ceicdata.com/en
[12] http://www.vaasaett.com/

wholesale prices for Crude oil, Biofuels and Coal are not listed in the table as these are compiled from a handful of globally significant prices. Please refer to the specific sections for the sources used for these prices.

It should be noted that some price data is provided as price indices; these have been used for analysis and comparison with EU trends over the same time period, but do not allow for comparison of price levels. Price indices are shown in the table as an underlined I.

The data is also not without its limitations, with the following points of note:

- Data coverage is quite comprehensive for the EU28 countries. There are a handful of gaps for particular fuels or in some cases where a fuel is simply not used for a particular purpose (e.g. residential natural gas in Finland) or a market does not exist (e.g. electricity wholesale in Cyprus);
- Data coverage for the G20 was mixed: although coverage for electricity, natural gas and retail petrol and diesel was good, there were significant gaps for other petroleum products;
- In South Africa and India price indices were sometimes available but started too late (after 2014) to be of much use in the analysis. These instances are indicated by the # symbol in the table below;
- For wholesale electricity and natural gas prices we have used for some G20 countries a proxy price to estimate the price, this is often based on a price index for wholesale or producer prices. The exact proxies used and reasoning can be found in the tables in Annex D;
- Since 2017 the EU28 industrial retail price data for electricity and natural gas changed to a non-household price basis. Therefore, the industrial prices for the EU for 2017 and later, may include other non-household consumers.

Table 3-2: Summary of price data and key:

Complete or near complete price data	M = Monthly data	Q = Quarterly data
Partial price data	B-A = Bi-annual (every 6 months) data	1 = 1 data point only
No data	A = Annual data	I = Price index data
Not applicable	(P) = Proxy data	# = Partial (unusable) data

Country	Electricity			Natural Gas			Petroleum products (new)						
	Retail		Wholesale	Retail		Wholesale	Retail						
	Households	Industry		Households	Industry		Petrol	Diesel	LPG motor fuel	Heating oil (HH)	High sulphur fuel oil	Low sulphur fuel oil	CNG
Austria	M	M	M	M	M	M	M	M		M		M	Q
Belgium	M	M	M	M	M	M	M	M	M	M		M	A
Bulgaria	M	M	M	M	M	M	M	M	M	M	M	M	Q
Croatia	A	B-A	Q	B-A	B-A	P, M	M	M	M	M		M	A
Cyprus	M	M	N/A	N/A	N/A	N/A	M	M		M	M	M	
Czech Republic	M	M	M	M	M	M	M	M	M	M	M	M	A
Denmark	M	M	M	M	M	M	M	M		M		M	1
Estonia	M	M	M	M	M	M	M	M	M	M		M	
Finland	M	M	M	N/A	B-A	M	M	M		M		M	1
France	M	M	M	M	M	M	M	M	M	M	M	M	Q
Germany	M	M	M	M	M	M	M	M	M	M		M	1
Greece	M	M	M	B-A	B-A	M	M	M		M	M	M	B-A
Hungary	M	M	M	M	M	M	M	M	M	M		M	1
Ireland	M	M	M	M	M	M	M	M		M		M	1
Italy	M	M	M	M	M	M	M	M	M	M		M	A
Latvia	M	M	M	M	M	M	M	M	M	M	M	M	1
Lithuania	M	M	M	M	M	M	M	M	M	M	M	M	1
Luxembourg	M	M	M (P)	M	M	(P) M	M	M	M	M		M	1
Malta	M	M	M (P)	N/A	N/A	N/A	M	M		M		M	
Netherlands	M	M	M	M	M	M	M	M	M	M		M	B-A
Poland	M	M	M	M	M	Q	M	M	M	M	M	M	B-A
Portugal	M	M	M	M	M	M	M	M	M	M		M	A

Country	Electricity			Natural Gas			Petroleum products (new)						
	Retail		Wholesale	Retail		Wholesale	Retail						
	Households	Industry		Households	Industry		Petrol	Diesel	LPG motor fuel	Heating oil (HH)	High sulphur fuel oil	Low sulphur fuel oil	CNG
Romania	M	M	M	M	M	M	M	M	M	M		M	1
Slovakia	M	M	M	M	M	M	M	M	M	M		M	1
Slovenia	M	M	M	M	M	M	M	M	M	M		M	1
Spain	M	M	M	M	M	M	M	M	M	M		M	A
Sweden	M	M	M	M	M	M	M	M		M		M	1
UK	M	M	M	M	M	M	M	M		M		M	Q
Argentina	#	I, M	I, M	A	A	(P) M	A	A					
Australia	A	I, Q	Q	I, Q	I, Q	Q	A	A	A				
Brazil	A	A	A	A	A	(P) M	A	A					
Canada	A	A	M	A	A	M	A	A	A	A	A		
China	M	M	P, M	M	M	M	A	A					
India	#	I, M	I, A	#	#	(P) M	A	A	#	#			
Indonesia	A	A	A			M	A	A					
Japan	A	A	M	A	A	M	A	A	A	A	1	A	
Mexico	A	A	A	A	I, M	(P) M	A	A			A		
Russia	M	Q	Q	Q	Q	Q	A	A					1
Saudi Arabia	Q	Q	#	Q			A	A					
South Africa	A	#	#	N/A			A	A					
South Korea	M	A		A	A	M	A	A	A	A	A	A	
Turkey	Q	Q	Q	B-A	B-A	Q	A	A	A	A	A		1
USA	M	M	M	A	A	M	M	M	Q	A	A		Q

Partial index or other data was available but this series or data was not sufficient for the analysis, i.e. the price index only begins in 2014 or 2016

3.1.3 *Approach and methodological notes*

This section sets out our approach to key methodological issues in working with the data and production of the time series graphs.

Definitions

Whilst some fuels are rather self-explanatory it is important to be clarify the uses and customers which fuel each covers:

- Electricity – power traded (wholesale) or consumed by industry or households;
- Natural gas – natural gas traded (wholesale) through pipelines or by ship in liquefied natural gas (LNG) form. Consumed by industry to generate own power or heat, and/or to use in production processes. Consumed by households, primarily for space and water heating;
- Petroleum products:
    - Petrol (or gasoline): unleaded automotive fuel for household use, we use 95 RON / Euro-super prices for comparison or closest available price in countries where 95 RON is non-standard;
    - Diesel: automotive diesel gas oil for on-road use. Prices shown are those charged at filling stations with public access;
    - LPG motor fuel: Liquefied Petroleum Gas consists mainly of propane and butane. LPG is normally liquefied under pressure for transportation and storage. Prices shown refer to LPG used as engine fuel only;
    - Heating oil: or light fuel oil in IEA terminology, this comprises light distillate fuel oils and is mainly used for heating in household or industrial settings;
    - High sulphur fuel oil: refers to fuel oil for commercial purposes and with a sulphur content >1%. It is primarily used as a maritime transport fuel;
    - Low sulphur fuel oil: refers to fuel oil for commercial purposes and with a sulphur content <1%. It is primarily used as a maritime transport fuel or as fuel for power generation;
    - CNG: Compressed Natural Gas used for automotive transport purposes only.

We also looked at LNG as an automotive fuel but found no relevant price data.

Energy units

The raw datasets were often denominated in different energy units. To make the data comparable, a conversion factor was applied to bring all data into a single comparable unit. IEA conversion factors were used whenever possible. The selected units for the analysis are presented below:

- Electricity - all (MWh);
- Natural Gas - all (MWh);
- Petroleum products:
    - Petrol, Diesel, LPG, High sulphur fuel oil, Low sulphur fuel oil, Heating oil (litre);
    - CNG (kg);
    - Crude oil (bbl);
    - Biofuel – ethanol and biodiesel (Mt);
- Coal (GJ);

The units are selected for internal consistency in the analysis but different volume/weight or energy units are also commonly used including MMbtu (Natural gas), cubic metre / m^3 (natural gas, gallon (fuels), GGE (fuels) tce (coal), klitre (LPG, fuel oils, heating oil).

Inflation and constant prices

To remove the effects of inflation from the analysis, currency deflators were applied to the prices so that **all values are presented in constant 2017 euros**. World Bank currency GDP deflators from the World Development Indicators[13] were used for all currencies, except for the Euro Zone, where the European Central Bank (ECB) euro area deflator was applied. As deflators were not yet published for 2017 or 2018 an assumption was made that values for 2017 and 2018 were equal to 2016 values. Deflators were applied prior to currency conversion (see next paragraph).

Currency

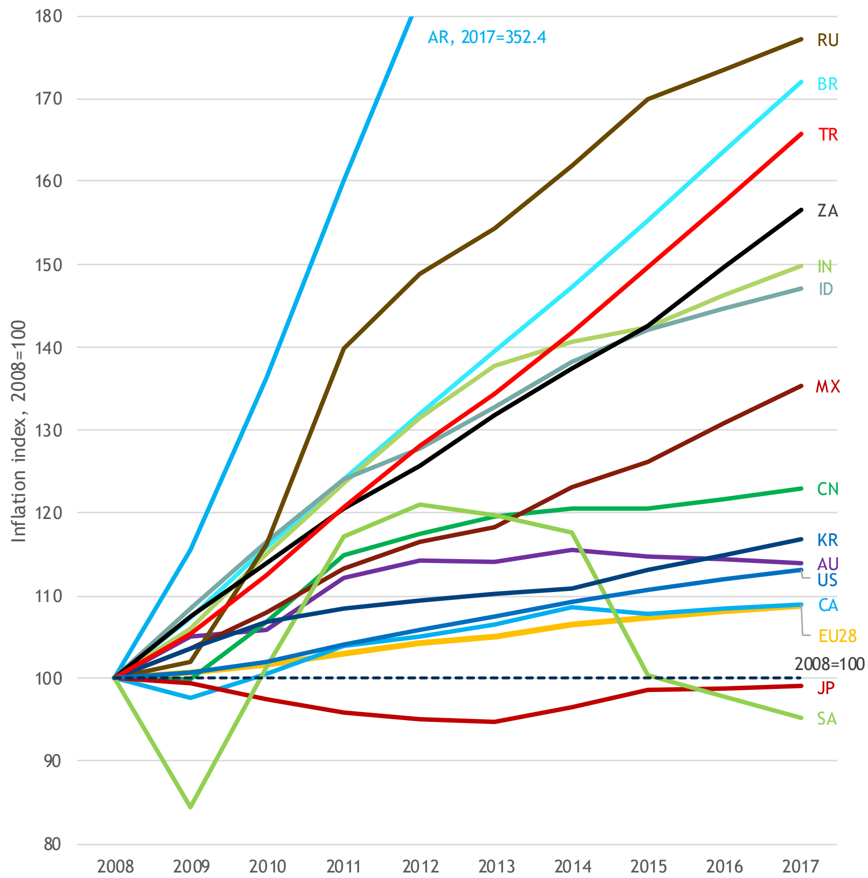
The raw data was also often denominated in local currency units (LCUs) or US dollars (USD), these were then converted to Euros for comparability. Monthly average exchange rates for each currency from the ECB were used for these conversions. For 2018 prices, exchange rates from Dec 2017 were used as exchange rates for 2018 were not yet published.

Analysing the role of inflation and exchange rates

Inflation plays an important role in observed price movements. As noted above, in this study we typically produce price analyses based on constant (or real) prices, e.g. priced in 2017 euros, where we use deflators to remove the inflation effect from past prices. Yet nominal prices and their inflation remain an important factor, particularly within the context of national markets and investment decisions. It is useful therefore to reflect on the role inflation has played in the EU (Euro zone) and each of the G20 countries included in the analysis, as differences between the two can play a part in explaining diverging trends with EU prices. Figure 3-1 presents an inflation index for the EU and G20 countries since 2008. This shows that inflation in Argentina (AR) has been very high (+252%) in this period and therefore when considering changed in energy prices we should expect to see a large increase in prices solely due to this effect. High (>40%) inflation is also an issue for Russia (RU), Brazil (BR), Turkey (TR), South Africa (ZA), India (IN) and Indonesia (ID) and to a lesser extent Mexico (MX). Inflation in the EU was around 9% over this period, this is closely comparable to changes in Canada (CA), the United States (US), Australia (AU), South Korea (KR) and, to a lesser extent, China (CN). For these countries inflation is likely to only play a minor role in explaining price differences. The differential with Japan (JP) and Saudi Arabia (SA) is also relatively small, but these are notable for having experienced a slight deflation over the period. Table 3-3 presents the same index values but with a calculated annual average compound rate of inflation, this is equivalent to more 15% per year in Argentina, but only 0.9% per year in the EU28 between 2008-2017.

[13] NY.GDP.DEFL.KD.ZG.AD

Figure 3-1: Inflation indices for the EU (euro zone) and G20 countries, 2008=100



Source: Own chart derived from World Bank deflators, and ECB deflators for the EU28 (Eurozone)

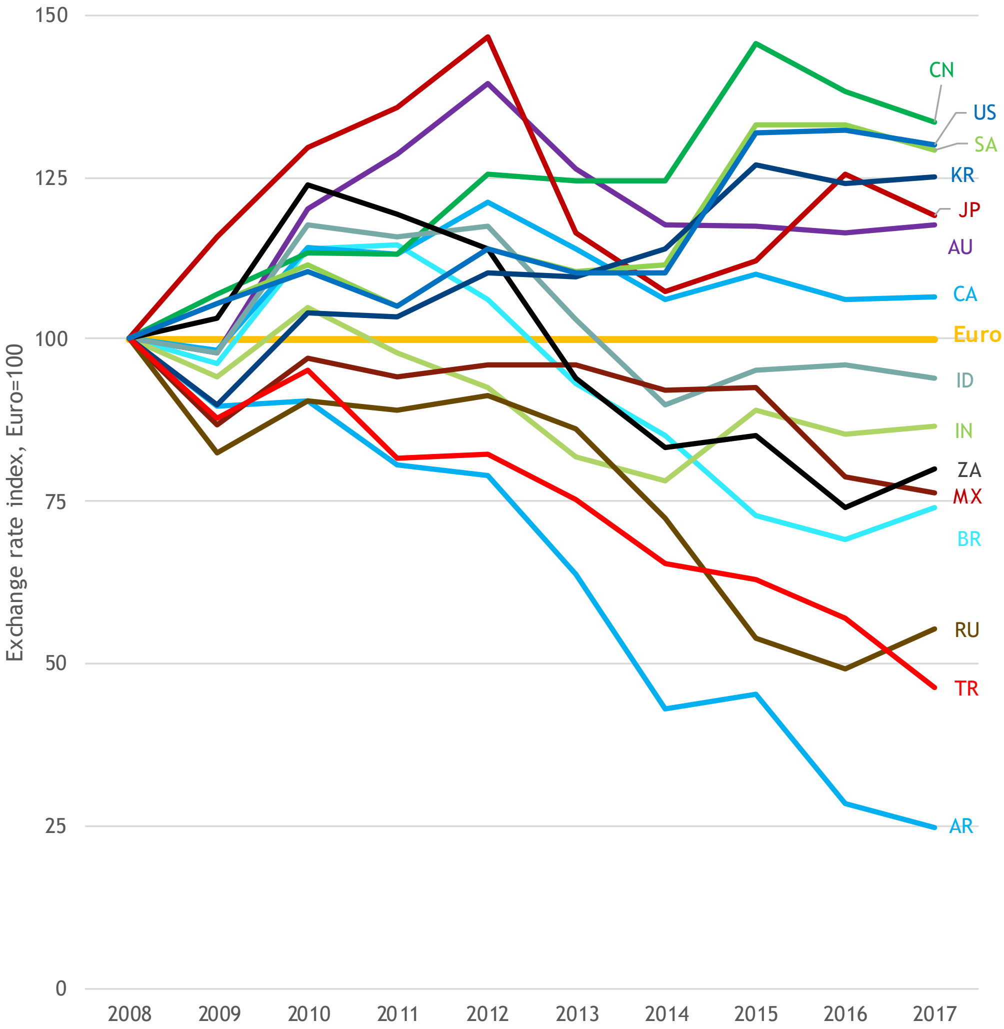
Table 3-3: Annualised compound average inflation rate

Country	2017 index value	Equivalent to annual average change of
EU28	108.8	0.9%
AR	352.4	15.0%
AU	113.9	1.5%
BR	171.9	6.2%
CA	109.0	1.0%
CN	122.9	2.3%
IN	149.8	4.6%
ID	147.1	4.4%
JP	99.0	-0.1%
MX	135.3	3.4%
RU	177.2	6.6%
SA	95.3	-0.5%
ZA	156.6	5.1%
KR	116.8	1.7%
TR	165.7	5.8%
US	113.1	1.4%

Source: Own table derived from World Bank deflators, and ECB deflators for the EU28 (Eurozone)

Inflation is not the only factor of this type, **exchange rates** are also important factors which may mask interesting movements in nominal prices denoted in the national currency, e.g. a price decrease in national currency may be presented as an increase in Euros due to an appreciation of the national currency. Understanding the presence or not of these types of effects is also relevant to understanding the national markets and investment decisions. Figure 3-2 presents an exchange rate index for the G20 countries charting the evolution of their exchange rates against the euro since 2008. This shows that many of the other developed economies, plus China and Saudi Arabia, have seen their currency appreciate against the Euro since 2008. In China (CN), the United States (US), Saudi Arabia (SA) and South Korea (KR) the effect is greater than 25%. In these countries the impact of exchange rates on their own could lead to observed price increases in euros even if national prices have declined. National currencies in Indonesia (ID), India (IN), South Africa (ZA), Mexico (MX) and Brazil (BR) all experienced a depreciation of up to around 25% against the euro over this period. But the biggest exchange rate movements were experienced in depreciations of the currency in Russia (RU), Turkey (TR) and, especially, Argentina (AR). In these countries the impact of exchange rates on their own could lead to observed price decreases in euros even if national prices have increased. Table 3-4 presents the same index data, with a calculated annual average compound rate of change.

Figure 3-2: Exchange rate index, Euro=100, 2008-2017



Source: Own chart derived from ECB exchange rates

Table 3-4: Annualised compound average exchange rate change, local currency vs. Euro

Country	2017 index value (2008=100	Equivalent to annual average change of
EU28	100.0	
AR	24.7	-14.4%
AU	117.7	1.8%
BR	74.0	-3.3%
CA	106.4	0.7%
CN	133.3	3.2%
IN	86.4	-1.6%
ID	93.9	-0.7%
JP	119.1	2.0%
MX	76.4	-2.9%
RU	55.4	-6.4%
SA	129.2	2.9%
ZA	80.1	-2.4%

KR	125.1	2.5%
TR	46.2	-8.2%
US	129.9	2.9%

Source: Own table derived from ECB exchange rates

The combined impact of both these effects is included in the results presented in constant prices in euros throughout this chapter (unless stated otherwise). It is useful therefore to understand these drivers and the effect that they have.

Indices

Price indices were used for a handful of G20 countries. These were rebased to a new starting period of (Jan) 2008 to enable the best comparison with existing data. In the case that price indices did not overlap with this period, if values were available within 1 year of the period, these were assumed also for Jan 2008 to enable their inclusion. If such values were unavailable and data was only from much later, e.g. 2012, 2014, 2016, as was the case for a few series for Argentina, India and South Africa, then these were not included in the analysis.

Local currency GDP deflators were applied to price indices to allow for fair comparison. Price indices were also calculated for countries with absolute price data.

In this report, we only present the comparison of the used indices and the EU28 weighted average equivalent.

Proxy data

In some cases, proxy data has been used, for example in the EU this involves assumptions of proxies for Luxembourg and Malta for wholesale electricity or natural gas prices[14]. Proxies have also been used for a handful of international prices, particularly in wholesale natural gas markets, the main proxy used is an adjusted global LNG price. Specific details on proxies can be found in the tables in Annex D.

Data frequency

To aid the readability of graphs and simplify an already complex analysis, data provided at daily (e.g. wholesale market prices) or weekly (EU Oil Bulletin data for petroleum products) frequency was averaged to monthly data.

Price bands

For non-EU countries, it was not possible to find prices per consumption band as provided by the EU. For comparability, a single price band per EU Member State was selected as the price for international comparison. This was selected in discussion with Commission Services, most often aligning with the band known for having the highest share of consumption within a country to provide a representative price. Other factors in the selection included a consistency check with IEA data (see also below in the limitations section) to select the band with the lowest variance with IEA data. Finally, in the absence of clear indications from other sources, default bands were selected, namely electricity household (DC),

[14] For Luxembourg wholesale electricity prices Germany was used as a proxy, for Malta, Italy was used. For Luxembourg wholesale natural gas prices, a combined proxy from Germany and Belgium was used.

electricity industry (ID), natural gas household (D2) and natural gas industry (I4). Full data on the band selection can be found in the tables in Annex D.

Price components

Whilst some datasets provided data split by price components, e.g. energy and supply, network charges, taxes and levies; this was far from always the case. Prices analysed in this chapter, unless stated, represent a total price, including taxes and levies. The exceptions to this include industrial prices which exclude VAT and recoverable taxes and levies, and petroleum products for which price excluding tax data is available. Additionally wholesale prices are compared against retail prices and provide an indication on the existence of subsidies / tariff deficits. Finally, the additional component level data has been used in other tasks in this report.

EU28 weighted averages

EU28 weighted averages of the member state level price data were calculated. These were calculated on the following basis:

- Final energy consumption data for each MS per year (2008-2016) was taken from Eurostat, with residential consumption used to weight household prices, industrial consumption for industrial prices and total consumption for wholesale prices;
- This was used to calculate for each MS and each year a % of the EU total. Values for 2017 were assumed to be equal to 2016 as 2017 consumption data was not yet available. The annual % was also applied to each month in a year;
- The actual price data was checked and the sum of the consumption % for all available prices was calculated to provide a consumption coverage value. Coverage values fell into the following ranges, leading to high confidence in the robustness of the weighted average:
    - Electricity – household: >99% in every period;
    - Electricity – industrial: >99% in every period;
    - Electricity – wholesale: 87-93% up to September 2009, thereafter >93% in every period;
    - Natural gas – household: >99% in every period;
    - Natural gas – industrial: >97% in every period;
    - Natural gas – wholesale: 79-83% up to April 2010, thereafter >93% in every period.
- This value was used to calculate a multiplier to ensure that the available data would sum to 100%;
- The multiplier and percentage were then applied to the actual price for each country and period to calculate an EU28 weighted average.

For the petroleum products (petrol, diesel, LPG, heating oil, low-sulphur fuel oil, high sulphur fuel oil), the Oil Bulletin produced by the European Commission already calculates consumption-weighted EU averages, these have been used directly. For other petroleum (or natural gas) products for which no consumption data is available e.g. CNG, a simple average of all values is presented.

Limitations

The data presented in the following sections represents the best data the team has been able to access, with much of the data coming from Eurostat, European Commission or IEA datasets. Yet it is also the case that data from other less transparent sources has been used; and therefore, the methodology applied, validation carried out and other quality assurance of that data is unclear. This is an important factor that the reader should take into account when interpreting the results. Please refer to the source list per price in Annex D to check the original source per country.

The data mixes annual, quarterly and monthly data, therefore some series will show greater volatility than others, reflecting a higher frequency of data. Series that use only annual averages will show lower volatility and therefore the peaks and troughs in the data will not be as high, this could mask interesting short term changes. This should be kept in mind when interpreting the graphs.

Comparability of Eurostat and IEA data for EU energy prices

Eurostat and IEA data form the two key sources of EU (Eurostat) and international (IEA) energy price data used in this report. To make relevant comparisons it is important that the data is prepared on a similar basis and represents, as far as possible, the same thing across countries. As noted previously within the Eurostat data there are multiple consumption bands and different prices. Consumption data per band is patchy and therefore it was not possible to make a consumption weighted average for each EU country. A specific band was therefore selected for each country to be used for the international comparison (see previous section).

To check the comparability of IEA and Eurostat data we carried out an analysis of an EU sample, using prices from France, Germany and the United Kingdom (these three typically represent around 50% of total EU energy consumption). We also contacted IEA staff that attended the first stakeholder workshop carried out as part of this work to get further insights into their methodology for energy prices and looked in detail at the country notes accompanying the data. From this we found that IEA prices for France, are provided by the French Government and are consumption weighted prices based on the bands and prices used by Eurostat, for Germany the prices correspond to bands DC, ID and I4, and for the UK the reported prices are based on surveys of major electricity and gas suppliers. The band selection criteria we used is explained above in the 'Price bands' sub-section and the final selected bands can be found in Annex D of this report.

Our analysis of the differences between IEA and Eurostat shows (see table 3-3) that whilst differences between IEA data and some Eurostat bands can be large, the differences in some bands were very low and generally +/- 6% in the bands with the closest match. That these bands correspond to those selected as the default in this work, or those that have the highest share in the market, was reassuring. It was notable that there are differences between countries and that variation in the selection of band per MS as comparator is therefore useful and appropriate. Indeed, these results were used to inform (but not determine) the selection of price band comparators for these countries.

Table 3-5: Comparison of Eurostat prices with IEA prices, average of % differences per band[15] 2008-2016

Electricity household				Electricity industrial*				Key
	FR	DE	UK		FR	DE	UK	Closest match between IEA and Eurostat data
Band DA	-88%	-52%	-21%	Band IA	-47%	-85%	-46%	
Band DB	-21%	-10%	-13%	Band IB	-16%	-34%	-26%	If different to closest match with IEA - the band selected in the analysis based on band
Band DC	-6%	0%	-4%	Band IC	6%	-15%	-12%	
Band DD	3%	5%	7%	Band ID	17%	-2%	-2%	
Band DE	7%	9%	13%	Band IE	23%	10%	2%	

15 For details on band definitions please see Box 2 in chapter 4

				Band IF	33%	18%	4%	with largest market share
				Band IG	56%	#N/A	8%	

Natural Gas household				Natural Gas industrial*			
	FR	DE	UK		FR	DE	UK
Band D1	-88%	-51%	-23%	Band I1	-40%	-44%	-80%
Band D2	2%	6%	1%	Band I2	-17%	-32%	-29%
Band D3	16%	12%	12%	Band I3	0%	-20%	-14%
				Band I4	21%	-1%	0%
				Band I5	27%	10%	14%
				Band I6	52%	12%	36%

* Prices excluding recoverable taxes and levies

Source: Own calculation, using data from IEA Energy Prices and Taxes (2018)

As a conclusion of this comparison, we acknowledge that there remain discrepancies between the IEA and Eurostat data, but that these are – with the appropriate comparator band – typically in the range of +/- 6%. Therefore, although the 'fit' isn't perfect, data from the two sources can be compared in the same analysis with good confidence of comparing almost the same things across countries.

3.2 Analysis of price data and preliminary findings

Note: Within this section all prices are presented in constant 2017 euros unless otherwise stated.

3.2.1 Electricity prices

This section presents preliminary results for electricity price trends in the EU28 and G20.

Wholesale

Wholesale electricity prices have relatively complete datasets. The figures below present time series of available price data for the EU28 countries and G20 from 2008-2018.

Specific explanations relating to this dataset include:

- As there are no wholesale markets for electricity in CY, it was excluded from the EU28 dataset;
- In cases where electricity wholesale price data was not available, such as for LU and MT, proxy prices were used, DE and IT prices were used respectively;
- In China, Brazil and Indonesia, in the absence of actual wholesale market prices, final consumer price data for large industrial customers has been used as a proxy for wholesale prices. For these countries, the results are presented as dotted lines to underline that these are not fully representative of wholesale prices (which are likely to be lower than the proxy levels) and therefore greater caution should be exercised in interpreting these prices.

Conclusions that can be drawn from this data include:

- Since 2009, wholesale prices in the EU have typically moved in a band between 20-80 EUR/MWh, with the weighted average moving in a narrower 30-60 EUR/MWh band. Among notable movements is the peak in prices in 2008, with the average moving up to almost 100

EUR/MWh. A large part of this increase was driven by higher (largely oil indexed) prices for natural gas as oil prices increased significantly in 2008-2009 and to a much lesser extent by high prices (around 30 EUR/tonne) in the EU-ETS. After falling after this peak in 2009 and slowly creeping up again, the trend has changed and since 2012 a price decline can be observed, being driven by a decline in energy demand prompted by the financial crisis and increasing impact of energy policy, increasing shares of renewable energy in the power supply and declining prices for coal and natural gas. Since 2016 upturns in coal and gas prices wholesale prices have also begun to trend upwards. Box plots and line charts for each EU country are presented in Annex D2;

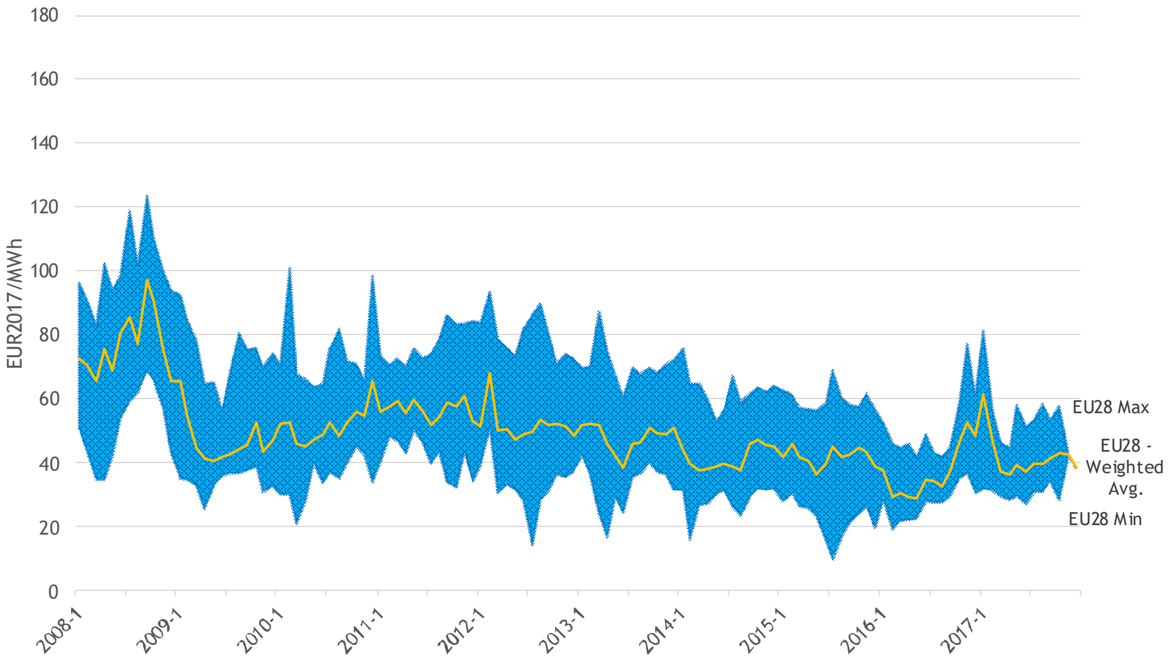
- Wholesale electricity prices in the USA have tended to vary within a similar price range to the EU28 weighted average price, but generally slightly below, declining natural gas prices in the US driven by shale gas playing an important role in this price development, and with renewable energy also playing a role, but less influential than in the EU. Prices in Japan, previously comparable to the EU average and US, show the dramatic impact of the Fukushima nuclear disaster in March 2011, with prices more than doubling within one year from around 70 EUR/MWh to 160 EUR/MWh as the entire nuclear power capacity of the country was forced to close. Prices have since fallen as some plants have been permitted to re-open and replacement renewable and fossil fuel plants have come online. Whilst they returned to their pre-2011 levels by 2016, they remain 20-40 EUR/MWh higher than EU28 and US average prices as electricity generation is mainly based on more expensive imported LNG. The proxy for wholesale prices in China[16] shows a slow but steadily decreasing price trend over time. The proxy price level is relatively high, but in reality, the wholesale price is likely to be much lower, as suggested in other studies, but for which price data was not usable[17];
- Prices in other G20 countries (TR, ID, BR, MX, AU, RU, CA) display a variety of trends. Prices in Canada have shown a declining trend and are the lowest of all G20 countries, in the last years moving in a band of 5-20 EUR/MWh. The Australian price development highlights seasonal price peaks coinciding with summer heat, with particularly acute problems with the grid resulting in load shedding in early 2017 and a coinciding sharp peak in wholesale electricity prices. Prices in Australia have been trending upwards since around 2009 and are now typically higher than the EU28 average. Russian prices are among the lowest of the G20, but have been steadily increasing over time, although declined during 2014-15. Prices in Turkey are amongst the highest of all G20 countries. Prices in Mexico have declined between 2010-2015, driven by an energy reform introduced in 2013 and declining natural gas import prices (from the US) for power generation and fuel switching in the power sector from fuel oil to natural gas[18]. In Brazil, the price proxy shows some volatility year-to-year but prices have not significantly changed since 2009. In Indonesia, the proxy price has shown an increase between 2014-16. In the case of both proxy prices (industrial prices used) the wholesale prices are likely lower than these levels;
- Information from price indices for countries without absolute price information (AR, CN, IN) is also presented. This shows that prices in Argentina have declined to around 25% of 2008 levels. In nominal terms the price index increased by around 300% over this period. However, taking inflation into account means that, in real terms, there was a significant decline as shown in the index. Furthermore, the equivalent price in Euros will have substantially decreased due to

[16] Used industrial price as proxy, this dataset from CEIC: CN: Purchasing Price Index: Fuel and Power (China).
[17] https://eta.lbl.gov/sites/all/files/publications/ced-9-2017-final.pdf
[18] IEA (2016) Mexico Energy Outlook: Special Report

the significant deterioration of the exchange rate between the Argentinian Peso and Euro. The price index for China, the producer price index: power, an alternative to the proxy presented in figure 3-5 sets out that wholesale prices in China have remained quite flat since 2008 in real terms. Similarly small variations in real prices can be observed for Indian electricity prices. As actual price information is unavailable for these indices, it is unclear how the price levels relate to EU levels;

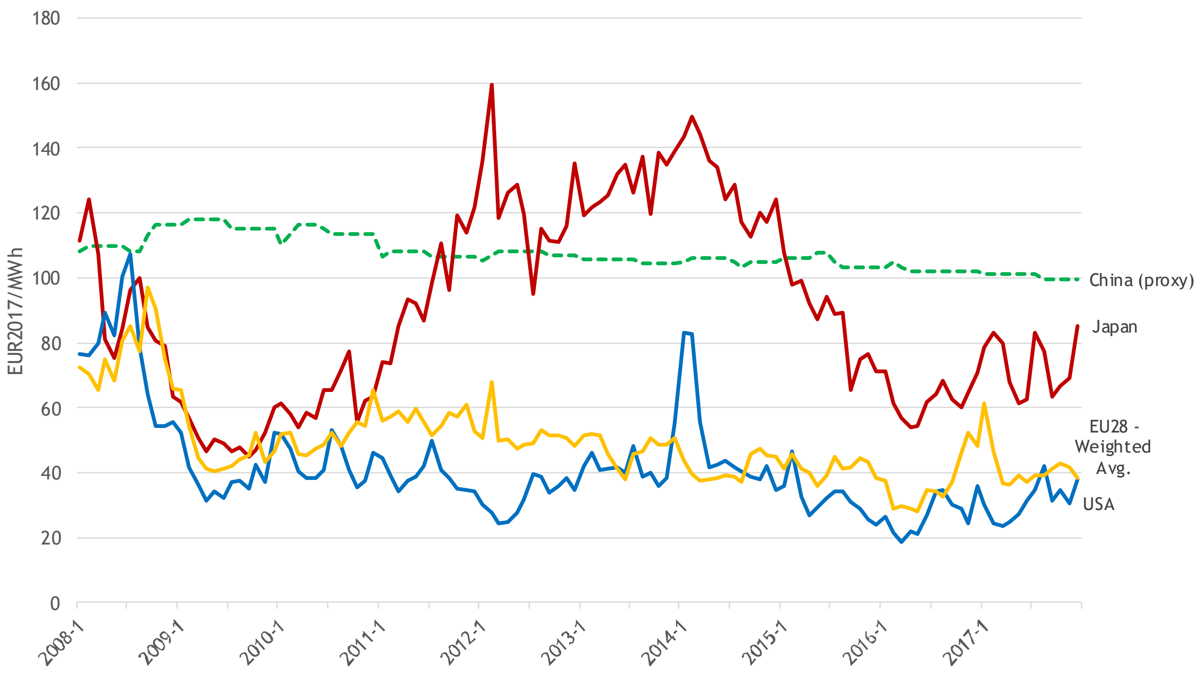
- Analysis of the evolution of price differentials in euros (see Table 3-6) in 2017 constant EUR prices shows that price developments across 8 of the 10 countries have been positive compared to the EU average. In 2008 four countries (AU, CA, ID, RU) had lower prices than the EU average, this had fallen to three countries by 2017 (CA, RU, US), with Australia and Indonesia becoming more expensive than the EU and the US becoming cheaper. The development in the US was negative for the EU. The only other country with a price change negative for the EU was Turkey which narrowed the price gap slightly, but still has much higher prices than the EU average;
- In Table 3-7 we present a more detailed presentation of the observed (nominal) price changes with the breakdown of some of the key factors in these changes, namely inflation, national price and exchange effects. Looking at the national price effects we see that EU28 weighted average prices decreased by more than 51% between 2008 and 2017. This change compares very favourably with the other G20 countries, with only Canada and the US experiencing greater price declines. Inflation had a significant effect on prices in Brazil and Turkey. It is notable that prices only increased in national currency in real terms in Indonesia, Russia and Turkey, although in the case of Indonesia proxy data was used. Exchange rates had an important influence on prices in China and Turkey, with prices appreciating due to this effect in the former, and depreciating in the latter.

Figure 3-3: Electricity prices, wholesale, EU28 (weighted) average, 2000-2017, EUR_{2017}/MWh



Sources: Own calculation, based on data from Platts, EMOS

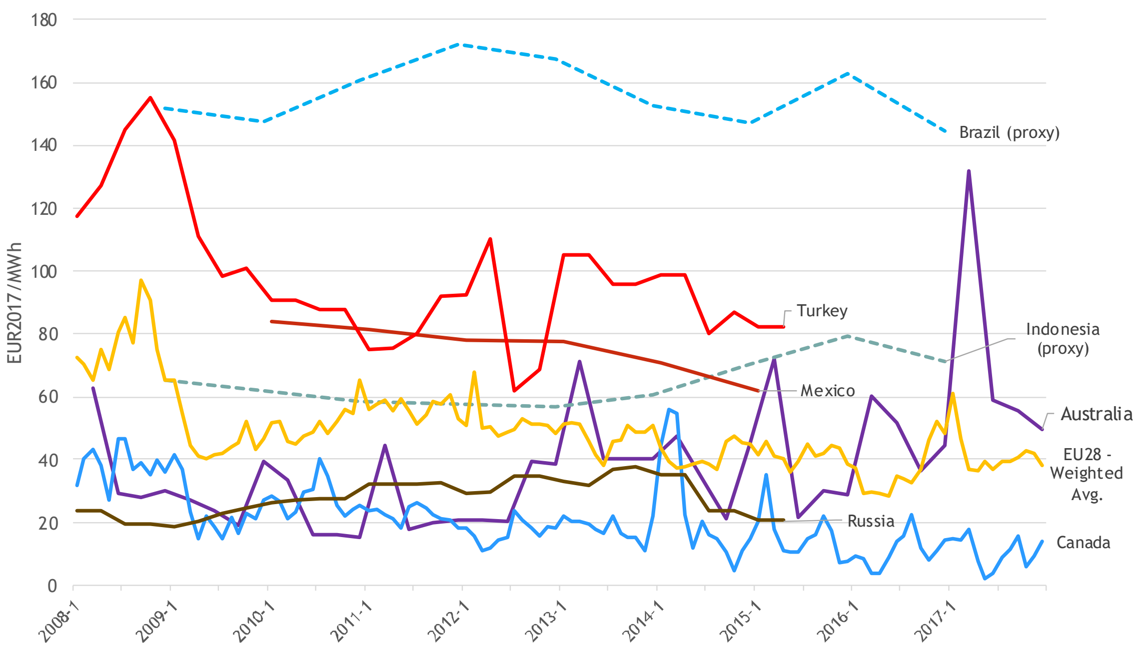
Figure 3-4: Electricity prices, wholesale, EU28, China, Japan and USA, 2000-2017, EUR_{2017}/MWh



Sources: Own calculation, based on data from US EIA, Japan Electric Power Exchange, CEIC, Platts, EMOS

Note: the Chinese wholesale price is an assumed proxy price based on Usage Price: 36 City Avg: Electricity for Industry: 35 kV & Above (China). Actual wholesale prices, to the extent they exist in China, are likely to be lower.

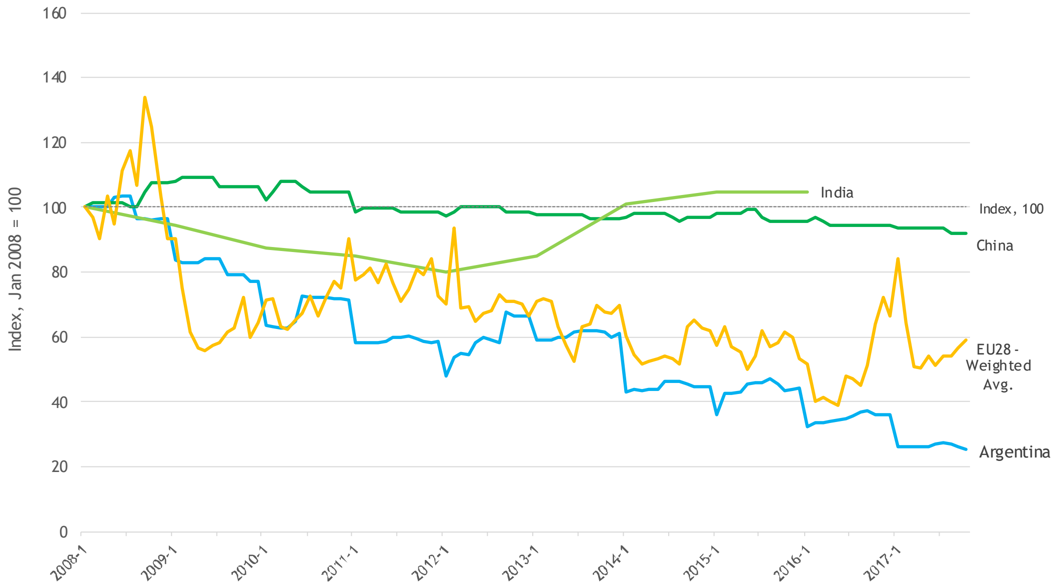
Figure 3-5: Electricity prices, wholesale, EU28 and other G20, 2000-2017, EUR_{2017}/MWh



Sources: Own calculation, based on data from ERRA, AER, CEIC, IESO, Platts

Note: Price proxies are used for Brazil and Indonesia, these are based on prices for large industrial consumers. Further details can be found in the annexes.

Figure 3-6: Electricity price indices, wholesale, EU28, AG, CN, IN, 2008=100, constant prices



Sources: Own calculation, based on data from *CEIC*

Table 3-6: Comparison of changes in wholesale electricity prices differential compared to the EU average price, constant 2017 euros per MWh

Country	Start price [EUR2017]	End price [EUR2017]	Change EUR	Change %	Start Gap [EUR]	End Gap [EUR]	Difference [EUR]	Impact for EU
EU28	**72.54**	**38.38**	-34.16	-47.1%				
Argentina								
Australia	**62.99**	**49.56**	-13.43	-21.3%	-9.55	11.18	20.73	Positive
Brazil	**151.51**	**144.48**	-7.03	-4.6%	78.97	106.09	27.13	Positive
Canada	**31.69**	**14.07**	-17.62	-55.6%	-40.85	-24.31	16.53	Positive
China	**108.19**	**99.65**	-8.54	-7.9%	35.65	61.27	25.62	Positive
India								
Indonesia	**65.01**	**71.30**	6.29	9.7%	-7.53	32.92	40.45	Positive
Japan	**111.38**	**85.20**	-26.17	-23.5%	38.84	46.82	7.98	Positive
Mexico	**84.07**	**61.76**	-22.31	-26.5%	11.53	23.38	11.85	Positive
Russia	**23.75**	**20.70**	-3.05	-12.9%	-48.79	-17.68	31.10	Positive
Saudi Arabia								
South Africa								
South Korea								
Turkey	**117.32**	**82.05**	-35.26	-30.1%	44.78	43.67	-1.11	Negative
USA	**76.83**	**38.10**	-38.74	-50.4%	4.30	-0.29	-4.58	Negative

Source: own calculations.

Note: a positive impact for the EU is recorded if the price gap has improved over time, e.g. that if a country had lower prices initially the gap is now smaller or prices are higher than the EU average, or if a country had higher prices, that the gap has increased. A negative impact is recorded if a country had lower prices than the EU, and that the gap has now increased, or if the country had higher prices than the EU but this gap has narrowed or the country now has lower prices.

Table 3-7: Factors in observed wholesale electricity price changes per country, nominal prices, EUR per MWh

Country	Start date	End date	Nominal Start price EUR	Change due to inflation [EUR]	Change due to price change in national currency [EUR]	Exchange rate effect [EUR]	Total change [EUR]	Nominal End price EUR	Change due to inflation [%]	Change due to real price change in national currency [%]	Exchange rate effect [%]	Total change [%]
EU28	2008-1	2017-12	**66.43**	5.87	-33.92	0.00	**-28.05**	**38.38**	8.8%	-51.1%	0.0%	**-42.2%**
Argentina	No data											
Australia	2008-3	2017-12	**48.32**	6.73	-11.50	3.59	**-1.18**	**47.14**	13.9%	-23.8%	7.4%	**-2.4%**
Brazil	2008-12	2016-12	**111.68**	71.01	-15.02	-14.87	**41.12**	**152.80**	63.6%	-13.4%	-13.3%	**36.8%**
Canada	2008-1	2017-12	**28.60**	2.56	-17.30	-0.23	**-14.97**	**13.64**	9.0%	-60.5%	-0.8%	**-52.3%**
China	2008-1	2017-12	**61.93**	14.21	-4.83	26.03	**35.41**	**97.34**	22.9%	-7.8%	42.0%	**57.2%**
India	No data											
Indonesia	2008-12	2016-12	**40.72**	18.18	9.96	5.56	**33.70**	**74.41**	44.6%	24.5%	13.7%	**82.8%**
Japan	2008-1	2017-12	**89.82**	-0.86	-20.95	12.74	**-9.07**	**80.75**	-1.0%	-23.3%	14.2%	**-10.1%**
Mexico	2010-1	2015-1	**84.07**	14.07	-40.45	4.07	**-22.31**	**61.76**	16.7%	-48.1%	4.8%	**-26.5%**
Russia	2008-1	2015-4	**16.00**	11.19	6.10	-12.15	**5.14**	**21.14**	69.9%	38.1%	-75.9%	**32.1%**
Saudi Arabia	No data											
South Africa	No data											
South Korea	No data											
Turkey	2008-1	2015-4	**79.02**	39.14	20.91	-55.26	**4.79**	**83.81**	49.5%	26.5%	-69.9%	**6.1%**
USA	2008-1	2017-12	**51.75**	6.79	-29.32	7.12	**-15.41**	**36.35**	13.1%	-56.7%	13.8%	**-29.8%**

Source: own calculations.

Explanation: this table shows the different components of the observed nominal price change, decomposed into inflation, price change and exchange rate effects. By summing the components between the Nominal start price EUR and Total change [EUR] the total change can be calculated, this corresponds to the difference between the Nominal Start price EUR and the Nominal End price EUR. For example, in the USA, prices started at EUR 51.75 in 2008 (USD 76.17), over the period prices increased by EUR 6.79 due to inflation (of 13.1%), whilst over the same period prices in national currency decreased by EUR 29.32 (-56.6%). Finally, due to an appreciation in the value of the USD compared to the EUR, the EUR denominated price increased by a further EUR 7.12, leading to a total change of EUR -15.40 between Jan-2008 and Dec-2017, a change of -29.8%. This is constructed from 51.75 (nominal start price) + 6.79 (inflation) - 29.32 (national price effect) + 7.12 (exchange rate effect) = 36.35 (nominal end price)

This table presents nominal prices, differences can be observed with the previous table which used constant prices, the start prices differ due to application of the currency deflator for the constant price calculation. Whilst the end prices differ as we deflate to a particular year (2017) using an annual average exchange rate, as opposed to the monthly average exchange rate used for the nominal price calculation. This can result in small differences, for example in the USA in 2017-12(Dec) the nominal price of USD 43.02 / MWh is recorded, using the nominal approach the exchange rate for 2017-12 of 1.1836 USD=1 EUR was applied, resulting in the price of EUR 36.35 / MWh, whilst for the constant price approach the average annual exchange rate for 2017 as a whole, of 1.1292 USD=1 EUR was applied for the resulting price of EUR 38.10, both are correct in the context of their approach, but the difference in monthly and annual average exchange rates leads to these differences in EUR terms. This difference is typically less than +/- 5% of the price.

Retail - households

Retail electricity prices for households have relatively complete datasets. The figures below present time series of available price data for the EU28 and G20 countries from 2008-2018.

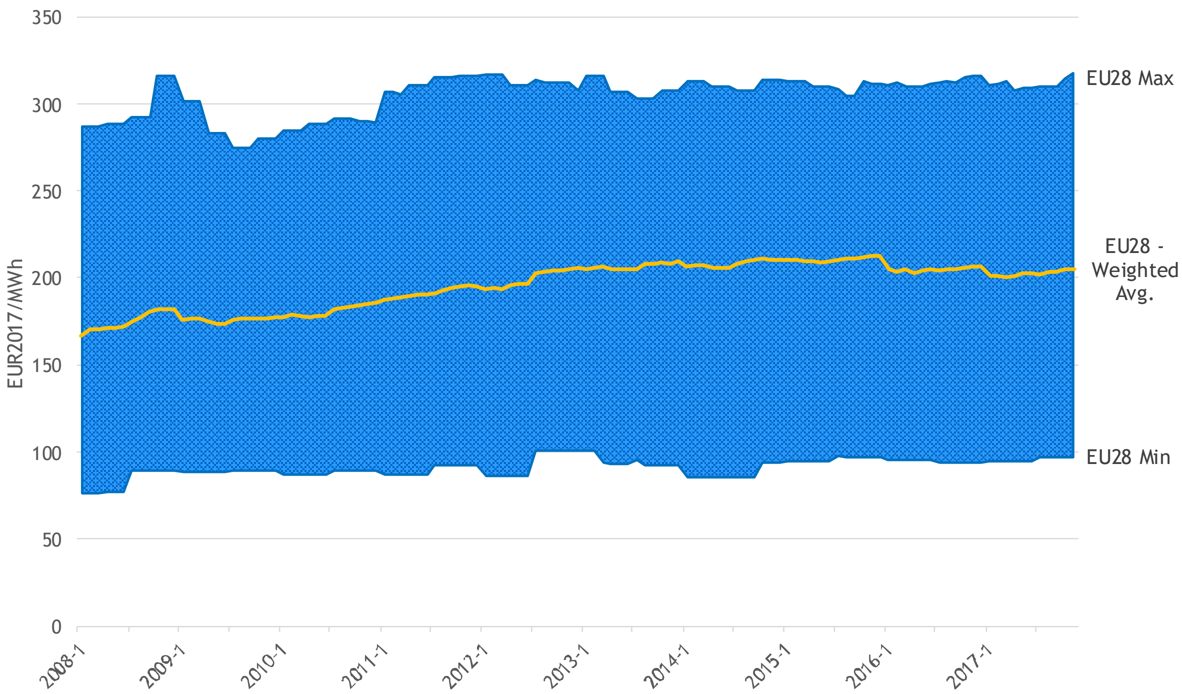
Conclusions that can be drawn from this data include:

- EU28 average prices have increased from around 165 EUR/MWh in 2008 to more than 205 EUR/MWh in 2017. Although it is notable that average prices increased to more than 210 EUR/MWh in 2014 they then began to decline back to 200 EUR/MWh in 2016. Box plots and line charts for each EU country are presented in Annex D2;
- Chinese prices are around 1/3 of the EU28 average, and US prices are around ½ of the EU28 average. US prices have, subject to seasonal variations, remained at around the same level between 2008 and 2018. Chinese prices, which are subsidised, have been flat in nominal terms, therefore the observed decline is driven by inflation and exchange rate effects. Prices in Japan started higher than the EU average in 2008 and increased up to 2012 (likely linked to Fukushima), but since 2012 have declined significantly and were lower than the EU28 average in 2016;
- Amongst other G20 countries, prices in Saudi Arabia, Russia and Indonesia are lowest and have generally shown a flat trend between 2008 and 2018, prices are subsidised in all 3. Prices in Mexico are below cost, subsidised by the government (previously through the state-owned energy company), and these have nearly halved over this period to join this low-price group, driven by the decline in wholesale prices observed in the previous section[19]. Prices in Canada (CA) and Korea (KR) are typically less than 100 EUR/MWh, with prices in KO showing a significant seasonal variation and also an increasing trend over time. Prices in TR are lower than the EU28 average and have been diverging from it since 2013 as prices decline. Prices in AU and BR, formerly higher than the EU average, have declined below the EU average in 2014-15, with a depreciation in the value of the USD (in which Australian prices were listed) against the EUR of around 20% at this time, among the main drivers of the observed fall in Australia. This effect is also visible to a lesser extent in some of the other price series;
- Since 2016, the EU28 average price for households is the highest of all G20 countries for which data is available. As one example of the driver of this, it is instructive to compare the USA and the EU. The similarity of EU28 and US wholesale prices (see Figure 3-5) but large divergence in retail prices for households, highlights differences in other costs between the two. Network costs and, especially, taxes and levies drive prices higher for household electricity in the EU28. This difference is analysed further later in this section;
- Analysis of the evolution of prices (see Table 3-8) in 2017 constant EUR prices shows that price developments across all countries have been of relative negative impact for the EU. Although this does not affect the competitiveness of the EU, it does signal a worsening of the relative price paid by the average EU household. The starting position was already that only 3 (AU, BR, JP) of the 13 countries had higher prices than the EU average in 2008, and in 2017 none have, with the gap worsening or widening in all countries. This is unsurprising as the biggest price increase was recorded for the EU, whilst prices only increased in 3 of the other countries (CA, KR, US) in this period;
- In Table 3-9 we present a more detailed presentation of the observed (nominal) price changes with the breakdown of some of the key factors in these changes, namely inflation, national

[19] IEA (2016) Mexico Energy Outlook: Special Report

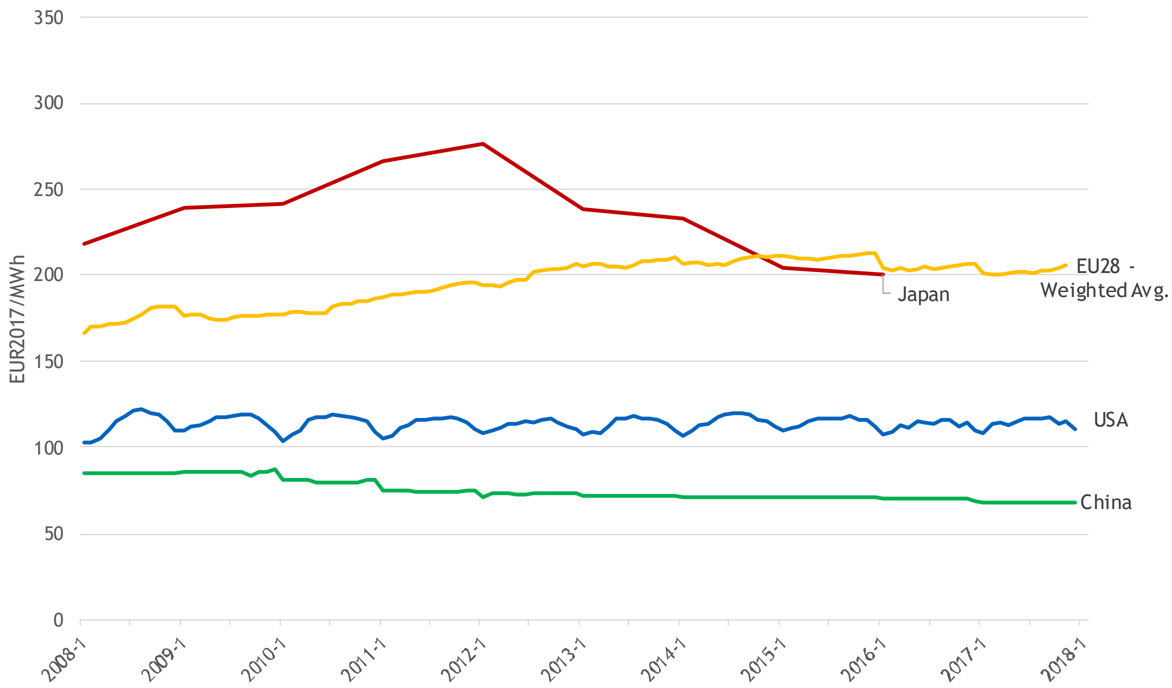
price and exchange effects. Inflation had a significant effect on prices in Brazil, Mexico, Russia and Turkey. Looking at the national price effects we see that the EU weighted average price increased by almost 40 EUR/MWh (26%) between 2008 and 2017. Only in Turkey could a higher price change be observed, although large price increases could also be observed in Canada and South Africa and prices also increased in Australia, Japan, Russia, South Korea and the USA. Exchange rates had an important influence on prices in Turkey, with prices depreciating significantly due to this effect. In percentage terms it is notable that prices did increase by more than the EU average in many of the other G20 countries (CA, CN, ID, JP, KR, US), but from lower starting points in most cases, therefore with lower impacts on totals.

Figure 3-7: Electricity prices, household retail, EU28 (weighted) average, min and max, 2008-2018, EUR2017/MWh



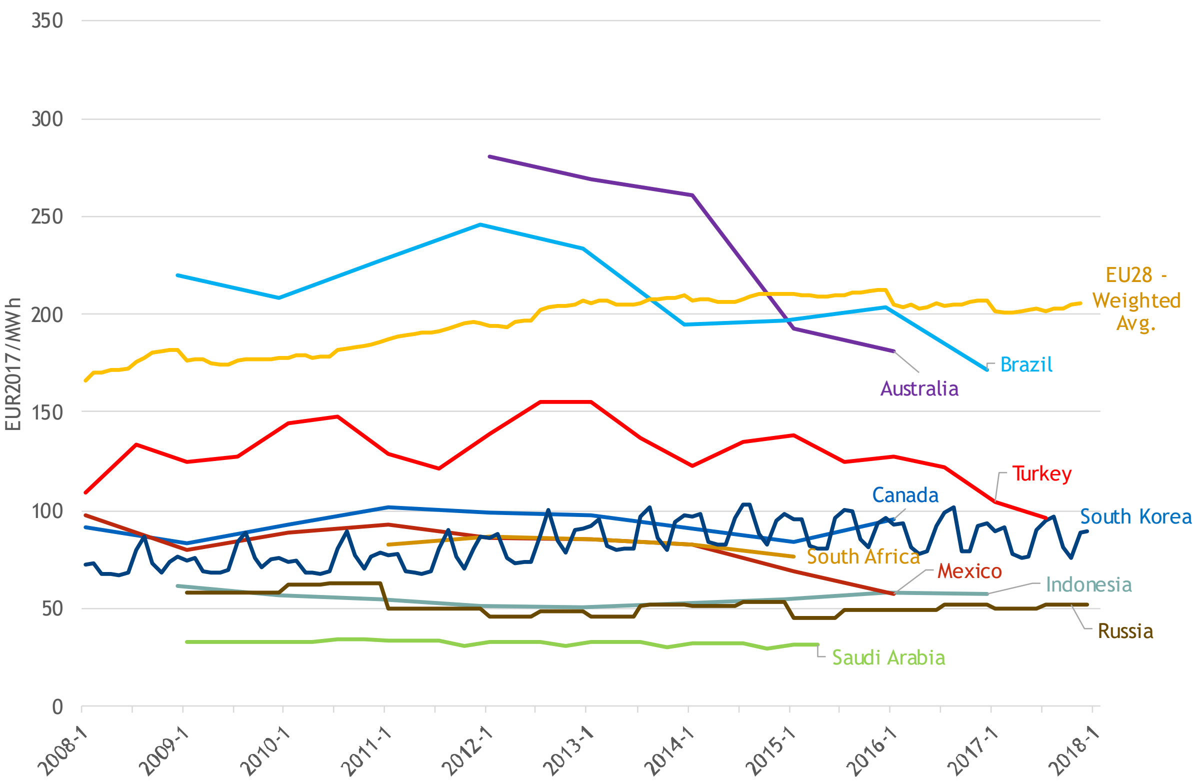
Sources: Own calculation, based on data from Eurostat

Figure 3-8: Electricity prices, household retail, EU28, Japan, USA, China, 2008-2018, EUR_{2017}/MWh



Sources: Own calculation, based on data from Eurostat, CEIC, IEA

Figure 3-9: Electricity prices, household retail, EU28, other G20, 2008-2018, EUR_{2017}/MWh



Sources: Own calculation, based on data from Eurostat, CEIC, IEA, ERRA

Table 3-8: Changes in retail household electricity prices compared to EU prices, constant 2017 EUR/MWh

Country	Start price [EUR2017]	End price [EUR2017]	Change EUR	Change %	Start Gap [EUR]	End Gap [EUR]	Difference [EUR]	Impact for EU
EU28	**166.25**	**205.61**	39.36	23.7%				
Argentina								
Australia	**280.63**	**181.19**	-99.44	-35.4%	114.38	-24.42	-138.80	Negative
Brazil	**220.32**	**171.43**	-48.88	-22.2%	54.06	-34.18	-88.24	Negative
Canada	**91.09**	**95.35**	4.26	4.7%	-75.16	-110.26	-35.10	Negative
China	**85.24**	**68.18**	-17.06	-20.0%	-81.01	-137.43	-56.42	Negative
India								
Indonesia	**61.45**	**57.19**	-4.26	-6.9%	-104.80	-148.42	-43.62	Negative
Japan	**218.21**	**200.26**	-17.95	-8.2%	51.96	-5.35	-57.31	Negative
Mexico	**96.89**	**57.16**	-39.73	-41.0%	-69.36	-148.45	-79.09	Negative
Russia	**57.95**	**51.84**	-6.11	-10.5%	-108.31	-153.77	-45.47	Negative
Saudi Arabia	**32.84**	**31.49**	-1.35	-4.1%	-133.41	-174.13	-40.71	Negative
South Africa	**82.85**	**76.84**	-6.02	-7.3%	-83.40	-128.77	-45.38	Negative
South Korea	**72.92**	**89.35**	16.44	22.5%	-93.33	-116.26	-22.92	Negative
Turkey	**108.97**	**95.80**	-13.17	-12.1%	-57.28	-109.81	-52.53	Negative
USA	**102.29**	**110.69**	8.40	8.2%	-63.97	-94.92	-30.96	Negative

Source: own calculations.

Note: a positive impact for the EU is recorded if the price gap has improved over time, e.g. that if a country had lower prices initially the gap is now smaller or prices are higher than the EU average, or if a country had higher prices that the gap has increased. A negative impact is recorded if a country had lower prices than the EU, and that the gap has now increased, or if the country had higher prices than the EU but this gap has narrowed or the country now has lower prices.

Table 3-9: Factors in observed household retail electricity price changes per country, nominal prices, per MWh

Country	Start date	End date	Nominal Start price EUR	Change due to inflation [EUR]	Change due to price change in national currency [EUR]	Exchange rate effect [EUR]	Total change [EUR]	Nominal End price EUR	Change due to inflation [%]	Change due to real price change in national currency [%]	Exchange rate effect [%]	Total change [%]
EU28	2008-1	2017-11	**152.26**	13.46	39.90	0.00	**53.35**	**205.61**	8.8%	26.2%	0.0%	**35.0%**
Argentina	No data											
Australia	2012-1	2016-1	**228.54**	0.31	3.75	-46.57	**-42.51**	**186.04**	0.1%	1.6%	-20.4%	**-18.6%**
Brazil	2008-12	2016-12	**162.40**	103.26	-66.70	-17.64	**18.92**	**181.32**	63.6%	-41.1%	-10.9%	**11.7%**
Canada	2008-1	2016-1	**61.35**	5.12	35.28	-3.85	**36.55**	**97.90**	8.3%	57.5%	-6.3%	**59.6%**
China	2008-1	2017-12	**48.80**	11.20	-11.20	17.81	**17.81**	**66.60**	23.0%	-23.0%	36.5%	**36.5%**
India	No data											
Indonesia	2008-12	2016-12	**38.49**	17.18	-0.44	4.46	**21.20**	**59.69**	44.6%	-1.1%	11.6%	**55.1%**
Japan	2008-1	2016-1	**146.98**	-1.80	21.10	39.34	**58.64**	**205.62**	-1.2%	14.4%	26.8%	**39.9%**
Mexico	2008-1	2016-1	**65.26**	20.04	-13.68	-12.93	**-6.57**	**58.69**	30.7%	-21.0%	-19.8%	**-10.1%**
Russia	2009-1	2017-12	**44.52**	32.82	3.35	-31.48	**4.69**	**49.21**	73.7%	7.5%	-70.7%	**10.5%**
Saudi Arabia	2009-1	2015-4	**24.78**	4.71	-1.57	4.25	**7.39**	**32.16**	19.0%	-6.3%	17.2%	**29.8%**
South Africa	2011-1	2015-1	**64.00**	11.80	29.96	-32.96	**8.80**	**72.80**	18.4%	46.8%	-51.5%	**13.8%**
South Korea	2008-1	2017-12	**56.79**	9.54	15.83	6.67	**32.04**	**88.83**	16.8%	27.9%	11.7%	**56.4%**
Turkey	2008-1	2017-7	**99.80**	65.60	61.46	-131.07	**-4.01**	**95.80**	65.7%	61.6%	-131.3%	**-4.0%**
USA	2008-1	2017-12	**68.90**	9.05	6.99	20.68	**36.72**	**105.61**	13.1%	10.1%	30.0%	**53.3%**

Source: own calculations.

Explanation: this table shows the different components of the observed nominal price change, decomposed into inflation, price change and exchange rate effects. By summing the components between the Nominal start price EUR and Total change [EUR] the total change can be calculated, this corresponds to the difference between the Nominal Start price EUR and the Nominal End price EUR. A worked example is provided in the notes to Table 3-7.

This table presents nominal prices, differences can be observed with the previous table which used constant prices, the start prices differ due to application of the currency deflator for the constant price calculation. Whilst the end prices differ as we deflate to a particular year (2017) using an annual average exchange rate, as opposed to the monthly average exchange rate used for the nominal price calculation. An example of this effect is presented in the notes to Table 3-7. As noted there, the observed difference is typically less than +/- 5% of the price.

Box 3-10: Purchasing power standard (PPS): the example of household retail electricity prices

The prices presented in the previous section are unadjusted for purchasing power differences, e.g. the differences in income and living costs between countries. It is interesting to look at these differences when considering the relative impact on households in each country to get a keener understanding of the actual impact of the differences. In this box-text we provide a snapshot and analysis of the differences that result from using purchasing power standard (PPS) prices based on IEA data, and with the United States as the PPS reference point.

As shown in Table 3-11, the lowest nominal prices are found in Mexico, the US, Canada and Norway, and the highest prices in Portugal, Germany, Spain and Poland. But when relative purchasing power is taken into account these rankings change, especially for countries with lower income relative to the US. This is due to the fact that although incomes may be significantly lower (or higher) relative to the base country (the USA in this analysis) that prices levels are also different. Using PPS adjusts the prices in national currency to allow comparison on the basis of purchasing the same amount of goods and services, removing the price level effect. This means that countries with lower incomes than the USA experience lower prices in PPS terms, and vice-versa for those with higher incomes.

Table 3-11: Comparison of 2016 retail household electricity prices, nominal and PPS, USD/MWh

Country	Nominal price (USD/MWh)	PPS price (USD/MWh)	Difference	Nominal Rank	PPS Rank	Rank change
	2016	2016				
Austria	245.50	222.87	-9%	16	9	7
Belgium	315.60	292.18	-7%	7	3	4
Czech Republic	292.00	155.97	-47%	11	21	-10
Denmark	298.60	329.95	10%	10	1	9
Estonia	212.30	130.54	-39%	19	24	-5
Finland	164.90	169.38	3%	23	20	3
France	200.00	182.22	-9%	20	13	7
Germany	376.30	328.76	-13%	2	2	0
Greece	284.20	190.15	-33%	12	12	0
Hungary	265.70	125.70	-53%	14	25	-11
Ireland	257.20	242.87	-6%	15	7	8
Italy	332.80	276.01	-17%	5	4	1
Latvia	326.60	182.08	-44%	6	14	-8
Luxembourg	184.10	181.02	-2%	22	15	7
Netherlands	193.00	175.61	-9%	21	17	4
Poland	340.00	155.26	-54%	4	22	-18
Portugal	394.80	256.99	-35%	1	6	-5
Slovak Republic	307.10	169.82	-45%	8	19	-11
Slovenia	266.50	177.10	-34%	13	16	-3
Spain	360.00	268.31	-25%	3	5	-2
Sweden	164.60	174.19	6%	24	18	6
United Kingdom	212.90	198.78	-7%	18	11	7
Norway	91.30	104.47	14%	30	29	1
Switzerland	158.10	203.28	29%	25	10	15
Canada	113.50	106.32	-6%	29	28	1
Japan	231.10	223.30	-3%	17	8	9
Korea	157.60	119.05	-24%	26	27	-1
Mexico	142.80	63.74	-55%	27	30	-3
Turkey	307.00	132.44	-57%	9	23	-14
United States	125.50	125.48	0%	28	26	2

Source: Own calculation, based on data from IEA Energy Prices and Taxes 2017Q3 (2018)

For example we see Portugal fall 5 places in the ranking, as PPS prices are 35% lower than nominal prices. The effect is even more pronounced for Poland, which falls 18 places in the ranking, as its PPS prices are 54% lower than nominal. Similar large changes are notable for the Czech Republic, Hungary, Latvia, Slovakia and Turkey.

On the other hand, although only a handful of countries have PPS prices higher than their nominal prices, namely Denmark, Finland, Norway, Sweden and Switzerland, the relative PPS adjustment also leads to interesting adjustments. Whilst Norway, Canada, Mexico and the United States remain in the bottom 5 in PPS prices, the top 5 prices change to include Denmark (up 9), Germany (unchanged), Belgium (up 4) and Italy (up 1). Other big movers in PPS prices include Switzerland (up 15), Japan (up 9), Ireland (up 8), France (up 7), the UK (up 7) and Austria (up 7), as these have relatively high incomes and move up the rankings.

Overall, we can draw from this that in an international comparison of household retail electricity prices the use of PPS has little effect on the overall international comparison between the EU average and G20 countries such as the US, Canada, Mexico, Korea which all continue to have lower prices than the EU in both PPS and nominal terms. For Japan and Turkey there is an impact that should be borne in mind, that actual impacts in Turkey are lower than the nominal prices suggest, and that the impacts in Japan may be higher. PPS also provides additional insight into the impact of prices within the EU, and the differences in Member States with lower incomes relative to the PPS, mainly in Central and Eastern Europe, although even in these cases prices remain higher than the other G20 countries.

Retail – industry

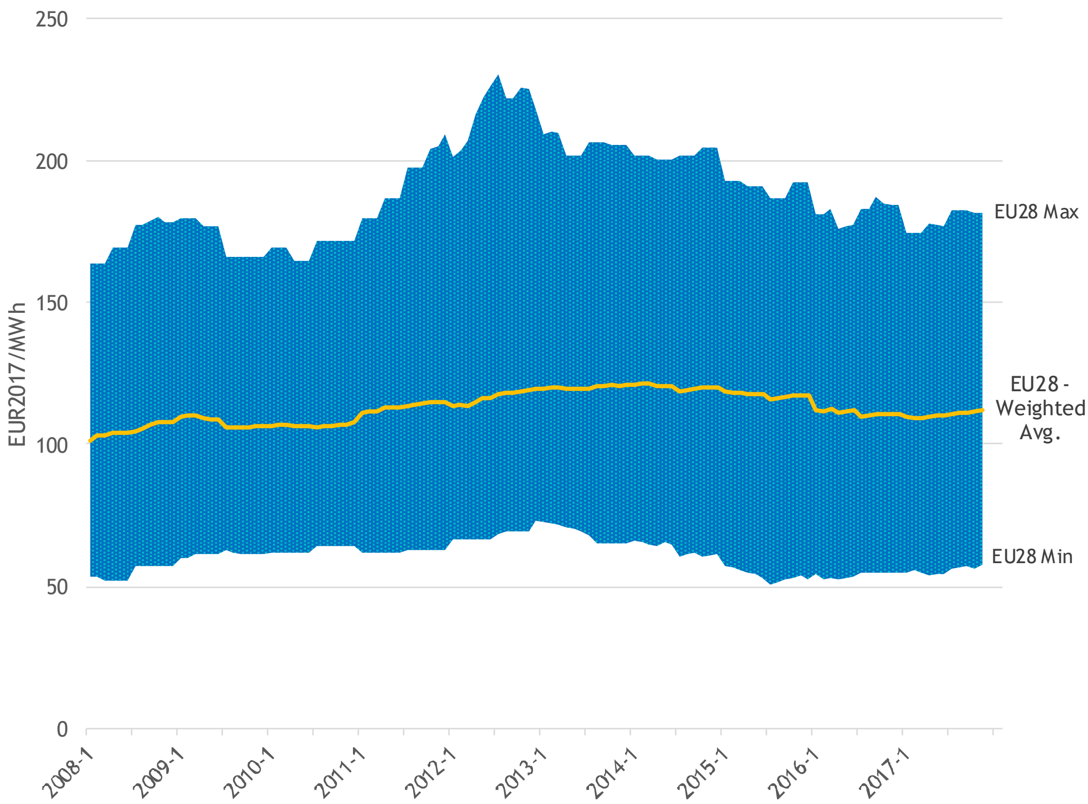
Retail electricity prices for industry have relatively complete datasets. The following figures, present time series of available price data for the EU28 and G20 countries from 2008-2018. Prices in this section are exclusive of VAT and recoverable taxes and levies but include relevant (non-recoverable) excise taxes and levies. From 2017 onwards EU prices are for non-household consumers, not just industry.

Conclusions that can be drawn from this data include:

- The EU28 industrial electricity prices have spanned a range of 50-270 EUR/MWh between 2008 and 2018. EU28 average prices increased from around 100 EUR/MWh in 2008 to 120 EUR/MWh by 2013-2014, but since then prices have slowly declined to around 110 EUR/MWh. Box plots and line charts for each EU country are presented in Annex D2;
- EU28 prices are based on consumption band assumptions, which for the majority of which correspond to consumption band ID (see Annex D1 for specific information). No consumption band data is available for international countries;
- US prices are around half the EU average levels and have not changed significantly between 2008 and 2018. Prices in CN began at a comparable level to EU prices but have diverged since 2011 as Chinese prices have declined. Prices in Japan were higher than the EU28 average but have converged in 2015-2016 to a broadly similar level;
- Most other G20 countries (CA, ID, RU, MX, KR, SA, TR) also have lower prices than the EU average. Only BR has higher prices. Prices in KR may be slowly converging with EU levels, whilst prices in MX, already below cost, are diverging, as they have significantly decreased since 2014, as a result of the factors highlighted in the section on wholesale prices;

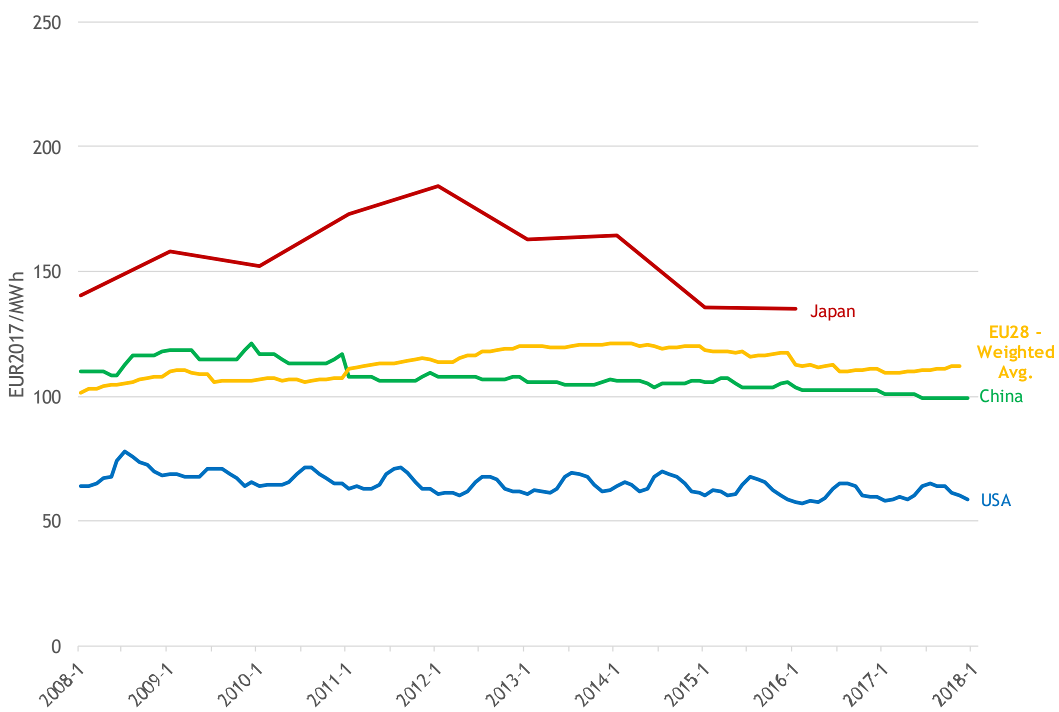
- Information from price indices for countries without absolute price information (AG, AU, IN) is also presented (Figure 3-13). This makes clear that whilst EU average prices have increased by around 10% since 2008 (around 1.1% annual average growth), that by contrast the real price indices in Argentina (AR) especially, but also India (IN) have declined. The Australian price index has increased in real terms by more than 60% over the period, moving in a similar direction to the observed increase in wholesale prices;
- Analysis of the evolution of prices (see Table 3-12) in 2017 constant EUR prices shows that price developments across all countries except South Korea have been of relative negative impact for the EU. This can have important implications for the competitiveness of EU industry, signalling a worsening of the relative price paid, and additional pressure on energy costs for firms. The starting position was already that only 4 (BR, CN, JP, MX) of the 11 countries had higher prices than the EU average in 2008, and in 2017 only two still did (BR, JP), with the gap worsening or widening in the other countries. This is unsurprising as the price increase recorded for the EU, was only surpassed in South Korea, and prices only increased in one of the other countries (ID) in this period;
- In Table 3-13 we present a more detailed presentation of the observed (nominal) price changes with the breakdown of some of the key factors in these changes, namely inflation, national price and exchange effects. Inflation had a significant effect on prices in Brazil, Mexico, Russia and Turkey. Looking at the national price effects it is notable that prices increased not only in the EU but also in CA, ID, JP, RU, KR and TR, and only in ID was the increase lower that in the EU. Exchange rates had an important influence on prices in Russia and Turkey, with prices depreciating significantly due to this effect, whilst in China and Japan there was also a significant but appreciating impact on prices from the exchange rate. In percentage terms it is notable that prices increased by more than the EU average in many of the other G20 countries (BR, CA, CN, ID, JP, KR, RU, SA, US), but from lower starting points in most cases, therefore with lower impacts on total prices and relative competitiveness.

Figure 3-10: Electricity prices, industry retail (exc. VAT and recoverable taxes and levies), EU28 (weighted) average, min and max, 2008-2018, EUR2017/MWh



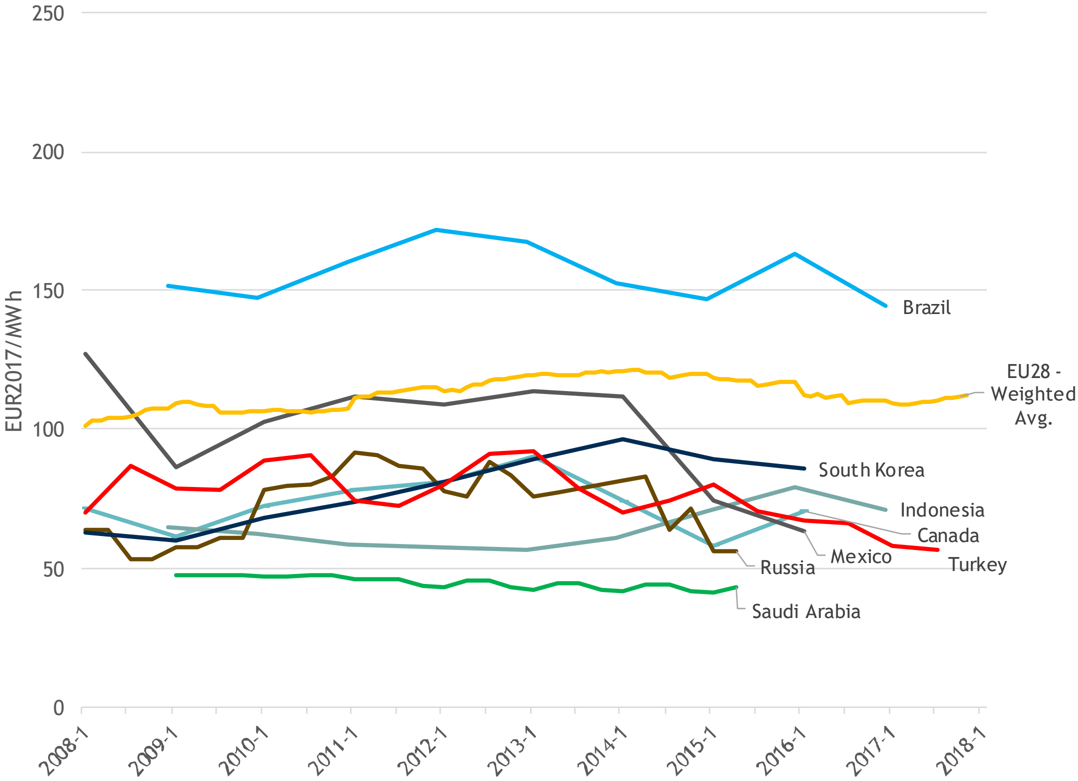
Sources: Own calculation, based on data from Eurostat

Figure 3-11: Electricity prices, industry retail, EU28, USA, China, Japan, 2008-2018, EUR2017/MWh



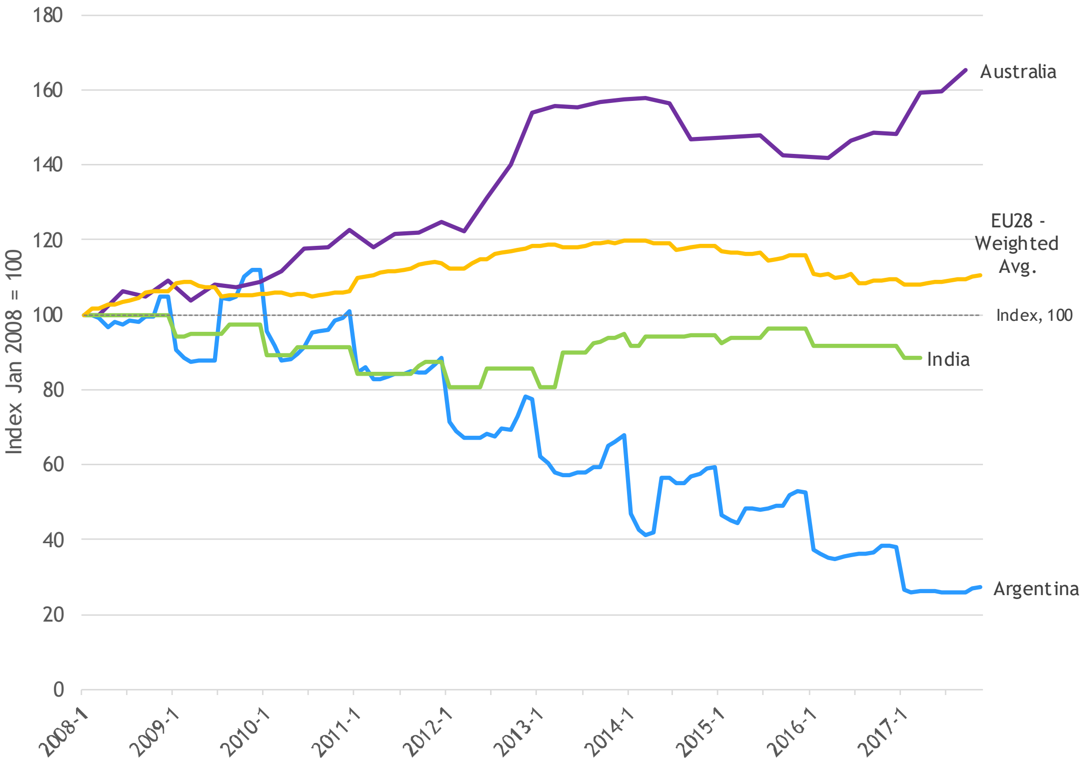
Sources: Own calculation, based on data from Eurostat, CEIC, IEA

Figure 3-12: Electricity prices, industry retail, EU28, other G20, 2008-2018, EUR2017/MWh



Sources: Own calculation, based on data from Eurostat, CEIC, IEA, ERRA

Figure 3-13: Electricity price indices, industrial retail, EU28, AR, AU, IN, 2008=100, constant prices



Sources: Own calculation, based on data from Eurostat, CEIC

Table 3-12: Changes in retail industrial electricity prices compared to EU prices, constant 2017 EUR/MWh

Country	Start price [EUR2017]	End price [EUR2017]	Change EUR	Change %	Start Gap [EUR]	End Gap [EUR]	Difference [EUR]	Impact for EU
EU28	101.33	112.05	10.72	10.6%				
Argentina								
Australia								
Brazil	151.51	144.48	-7.03	-4.6%	50.18	32.43	-17.75	Negative
Canada	71.53	70.66	-0.87	-1.2%	-29.80	-41.39	-11.59	Negative
China	109.83	99.65	-10.18	-9.3%	8.50	-12.40	-20.90	Negative
India								
Indonesia	65.01	71.30	6.29	9.7%	-36.32	-40.75	-4.43	Negative
Japan	140.15	134.58	-5.57	-4.0%	38.82	22.53	-16.29	Negative
Mexico	127.10	63.20	-63.90	-50.3%	25.77	-48.85	-74.62	Negative
Russia	64.00	56.33	-7.67	-12.0%	-37.33	-55.72	-18.39	Negative
Saudi Arabia	47.25	43.60	-3.66	-7.7%	-54.08	-68.46	-14.38	Negative
South Africa								
South Korea	62.94	85.82	22.88	36.3%	-38.39	-26.23	12.16	Positive
Turkey	70.21	56.80	-13.41	-19.1%	-31.12	-55.25	-24.13	Negative
USA	63.85	58.71	-5.14	-8.1%	-37.48	-53.34	-15.86	Negative

Source: own calculations.

Note: a positive impact for the EU is recorded if the price gap has improved over time, e.g. that if a country had lower prices initially the gap is now smaller or prices are higher than the EU average, or if a country had higher prices that the gap has increased. A negative impact is recorded if a country had lower prices than the EU, and that the gap has now increased, or if the country had higher prices than the EU but this gap has narrowed or the country now has lower prices.

Table 3-13: Factors in observed industrial retail electricity price changes per country, nominal prices, EUR/MWh

Country	Start date	End date	Nominal Start price EUR	Change due to inflation [EUR]	Change due to price change in national currency [EUR]	Exchange rate effect [EUR]	Total change [EUR]	Nominal End price EUR	Change due to inflation [%]	Change due to real price change in national currency [%]	Exchange rate effect [%]	Total change [%]
EU28	2008-1	2017-11	**92.80**	8.20	11.05	0.00	**19.25**	**112.05**	8.8%	11.9%	0.0%	**20.7%**
Argentina	No data											
Australia	No data											
Brazil	2008-12	2016-12	**111.68**	71.01	-15.02	-14.87	**41.12**	**152.80**	63.6%	-13.4%	-13.3%	**36.8%**
Canada	2008-1	2016-1	**48.18**	4.02	23.20	-2.86	**24.36**	**72.55**	8.3%	48.2%	-5.9%	**50.6%**
China	2008-1	2017-12	**62.87**	14.43	-5.98	26.03	**34.48**	**97.34**	23.0%	-9.5%	41.4%	**54.8%**
India	No data											
Indonesia	2008-12	2016-12	**40.72**	18.18	9.96	5.56	**33.70**	**74.41**	44.6%	24.5%	13.7%	**82.8%**
Japan	2008-1	2016-1	**94.40**	-1.15	18.50	26.44	**43.79**	**138.19**	-1.2%	19.6%	28.0%	**46.4%**
Mexico	2008-1	2016-1	**85.61**	26.29	-32.71	-14.30	**-20.72**	**64.89**	30.7%	-38.2%	-16.7%	**-24.2%**
Russia	2008-1	2015-4	**43.11**	30.16	17.35	-33.08	**14.43**	**57.54**	70.0%	40.2%	-76.7%	**33.5%**
Saudi Arabia	2009-1	2015-4	**35.65**	6.78	-3.78	5.89	**8.89**	**44.53**	19.0%	-10.6%	16.5%	**24.9%**
South Africa	No data											
South Korea	2008-1	2016-1	**42.40**	6.35	34.28	5.09	**45.72**	**88.12**	15.0%	80.9%	12.0%	**107.8%**
Turkey	2008-1	2017-7	**64.30**	42.27	27.94	-77.71	**-7.50**	**56.80**	65.7%	43.5%	-120.9%	**-11.7%**
USA	2008-1	2017-12	**43.01**	5.65	-3.61	10.97	**13.01**	**56.02**	13.1%	-8.4%	25.5%	**30.2%**

Source: own calculations.

Explanation: this table shows the different components of the observed nominal price change, decomposed into inflation, price change and exchange rate effects. By summing the components between the Nominal start price EUR and Total change [EUR] the total change can be calculated, this corresponds to the difference between the Nominal Start price EUR and the Nominal End price EUR. A worked example is provided in the notes to Table 3-7.

This table presents nominal prices, differences can be observed with the previous table which used constant prices, the start prices differ due to application of the currency deflator for the constant price calculation. Whilst the end prices differ as we deflate to a particular year (2017) using an annual average exchange rate, as opposed to the monthly average exchange rate used for the nominal price calculation. An example of this effect is presented in the notes to Table 3-7. As noted there, the observed difference is typically less than +/- 5% of the price.

Households - comparing retail prices to wholesale prices

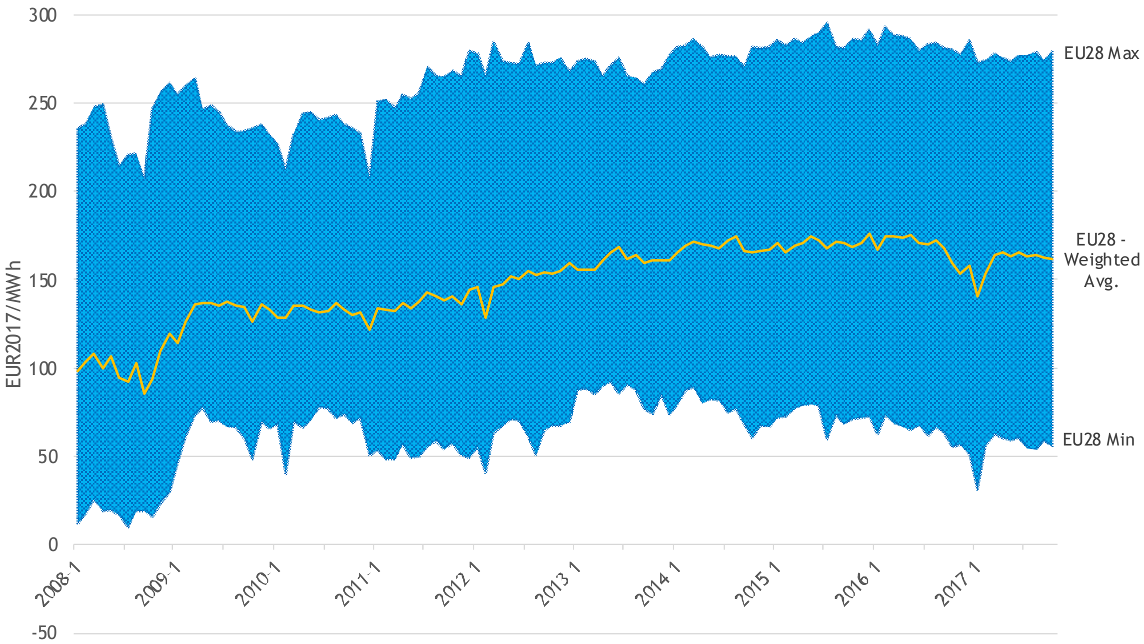
For the international comparison it is interesting to reflect on the role that different price components play in the retail prices paid by consumers and how these differ across countries. Unfortunately, corresponding price data (energy and supply, network charges, taxes and levies) is not available for non-EU countries. As a proxy for this analysis we provide in this section a comparison of the difference between the retail prices paid by consumers and the observed wholesale prices. Wholesale prices representing a proxy for the energy and supply component, and the difference between wholesale and retail prices illustrating the other components in the price such as network charges, mark-ups and non-recoverable taxes and levies. This can also illustrate where price regulation and/or tariff deficits exist in other countries.

Analysis of the difference between retail electricity prices for households and electricity wholesale prices are presented in the figures below (they show time series of this difference for the EU28 and G20 countries from 2008-2018).

Conclusions that can be drawn from this data include:

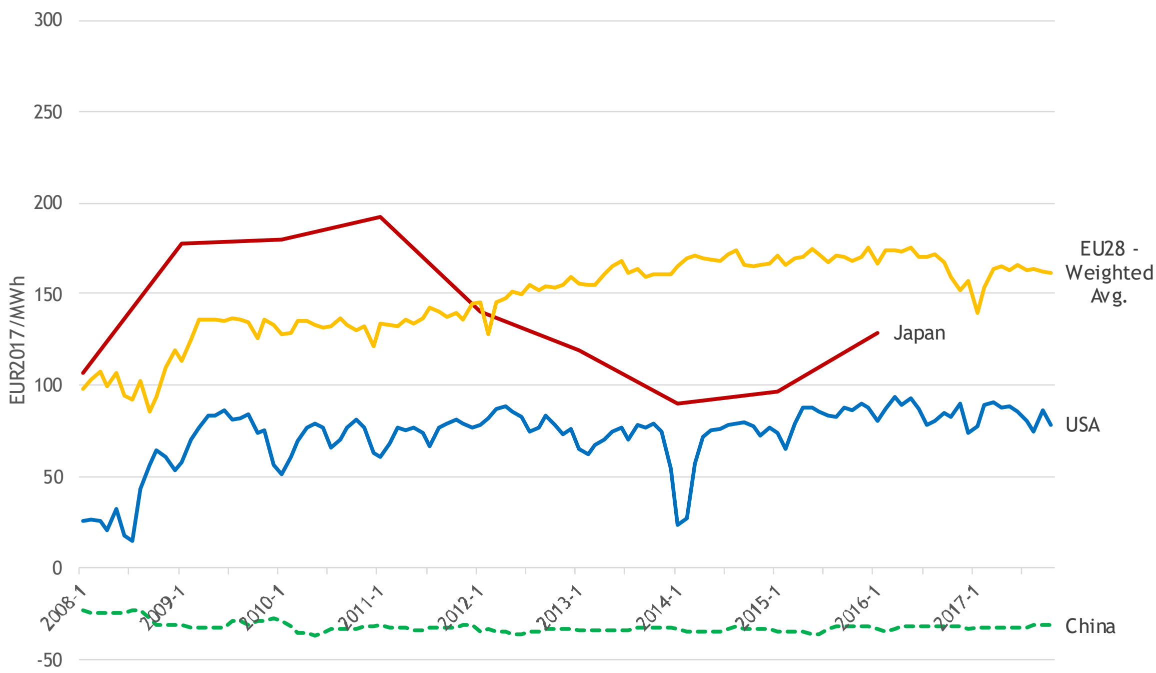
- The EU28 average difference between household retail prices and wholesale prices has increased from around 100 EUR/MWh in 2008 to more than 160 EUR/MWh in 2017. This difference touched as high as 175 EUR/MWh in 2016. It is also notable that with wholesale prices averaging around 30-60 EUR/MWh over this period the difference between the two, equating broadly to network charges and taxes and levies, is by far the most important component in, and driver of, retail price increases in the EU28;
- The same analysis using the wholesale proxy for China shows a negative outcome of 30-40 EUR/MWh, this highlights that household consumers in China are not paying the full cost of their electricity use. The difference in the US is lower than in the EU28 at around 80-90 EUR/MWh but has increased since 2008. The difference in Japan has varied considerably over the period, with the Fukushima effect on wholesale prices likely to have played an important role in the 2011 peak;
- For the other G20 countries the difference is also much lower than the EU28 average. In Mexico (MX), Indonesia (ID) and Russia (RU) there is only a small difference between the two prices, highlighting also that retail prices are held low in these countries. In Canada (CA), Turkey (TR) and Brazil (BR) the difference is greater, but still significantly smaller than the EU28.

Figure 3-14: Difference between household retail electricity prices and electricity wholesale prices, EU28 (weighted) average, min and max, 2008-2018, EUR_{2017}/MWh



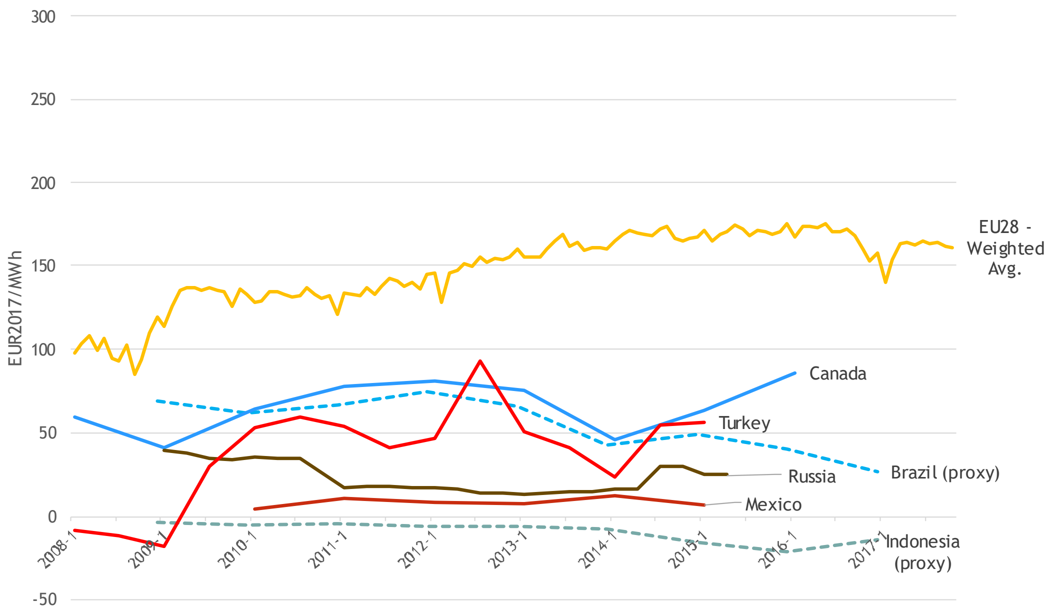
Sources: Own calculation, based on data from Eurostat

Figure 3-15: Difference between household retail electricity prices and electricity wholesale prices, EU28, US, CN, JP, 2008-2018, EUR_{2017}/MWh



Sources: Own calculation, based on data from Eurostat, CEIC, EIA

Figure 3-16: Difference between household retail electricity prices and electricity wholesale prices, EU28 and other G20 countries, 2008-2018, EUR_{2017}/MWh



Sources: Own calculation, based on data from Eurostat, CEIC

Industry – comparing retail prices to wholesale prices

Carrying out a similar international comparison of the difference but now for retail industrial electricity and wholesale prices brings the results presented in Figure 3-17, Figure 3-18 and Figure 3-19 (which present time series of this difference for the EU28 and G20 countries from 2008-2018).

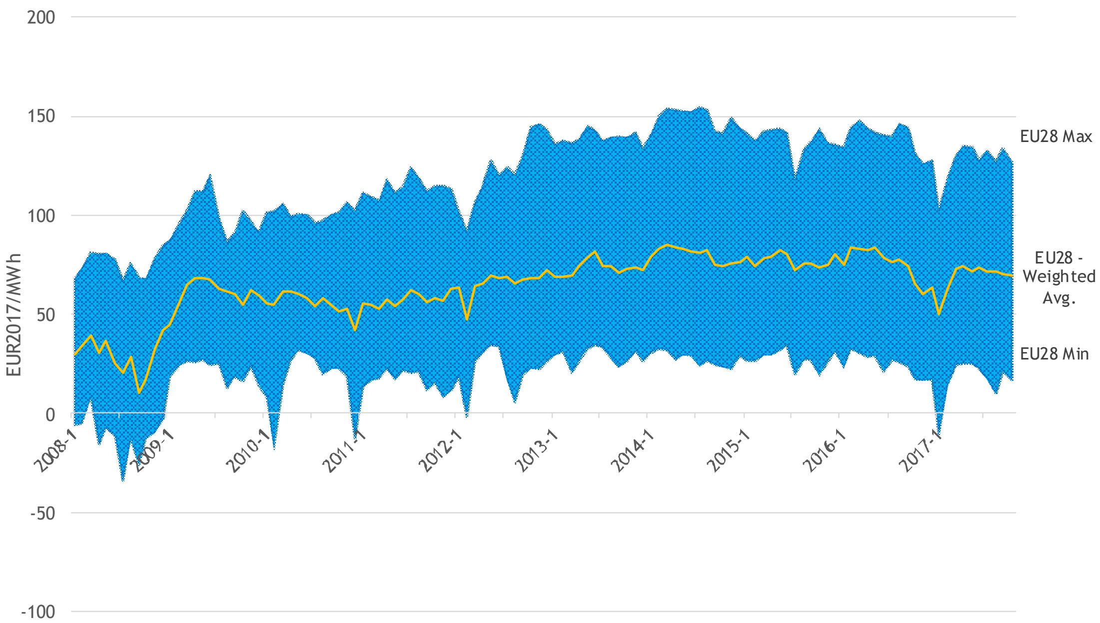
Conclusions that can be drawn from this data include:

- The EU28 average difference between household retail prices and wholesale prices has increased from around 30 EUR/MWh in 2008 to around 70 EUR/MWh in 2017, more than doubling over the period and generally trending up over time. Although the weighted average always stays above zero, it is notable from the min of the range that in some EU member states (EL, FI, FR, HU, RO, SE, SI, UK) there has been a negative difference between the two at specific points in time, particularly when the wholesale price has spiked, as for example in January 2017 (in HU, RO and SI). These short lived spikes in wholesale prices highlight that day-to-day or month-to-month volatility in day ahead wholesale prices is not matched by corresponding short-term flexibility in industrial retail prices, at least in some Member States, this can lead to (so far only) short term negative differences. The relative effect of the two factors, wholesale prices and other cost components in the retail price has been relatively equal over time. Although with a slowly declining wholesale price and slowly increasing difference, the role of these other (network and tax) costs is becoming more influential as a component in, and driver of, retail prices in the EU28;
- The difference in the US is lower than in the EU28 at around 15-40 EUR/MWh, over the period, ending around 30 EUR/MWh in 2017, but the trend is for a slow increase since 2008. As in the EU the difference turned negative at 2 points in time when the wholesale price spiked. At least part of the reason for these spikes is that wholesale prices in the EU vary on a much shorter timeframe than retail prices, which are often fixed annually. Usually the retail price is set by suppliers at a level high enough to cover the wholesale price plus a mark-up, but shocks to supply or other factors can lead to temporary jumps in wholesale prices, and negative

differences such as those observed. The difference in Japan is in the same order of magnitude as the EU28 average and US levels, but has varied considerably over the period, with the annual frequency of the data playing a role, and the Fukushima effect on wholesale prices likely to have played an important role in the 2011 peak. The same analysis using the wholesale proxy for China shows virtually no difference, likely due to the proxy being similar to the industrial price, it is an interesting contrast to household prices, pointing towards energy policy priorities and price interventions in favour of households rather than industry;

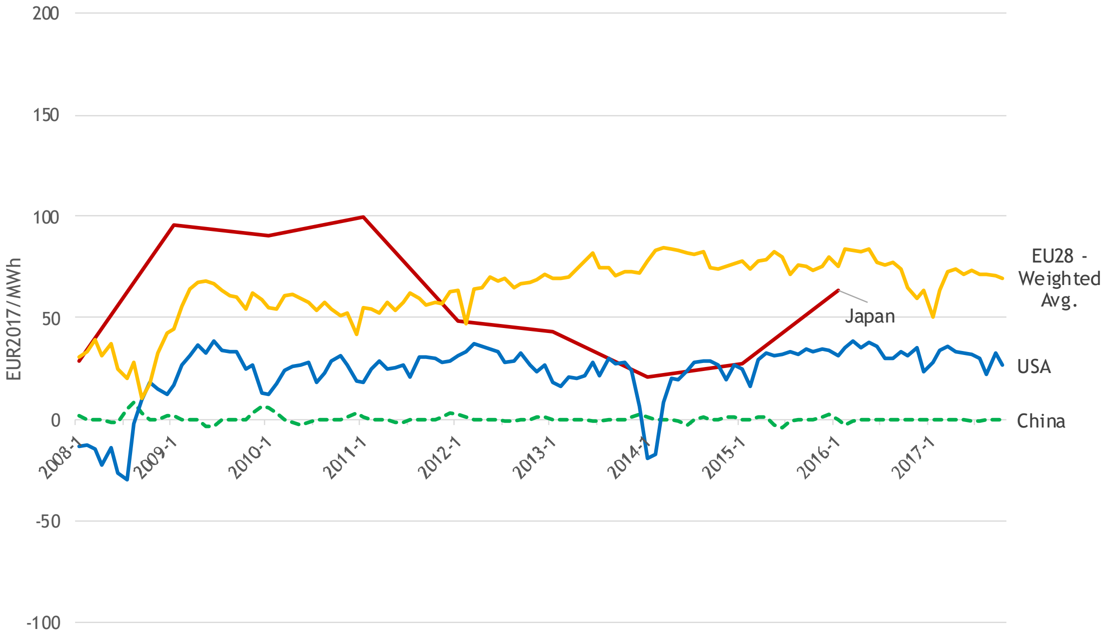
- For the other G20 countries the difference with the EU28 average is typically lower, although the difference in Canada (CA) has generally been similar to the EU. We can observe a small divergence in Mexican (MX) and Russian (RU) prices as the there is only a small difference between the two prices, as EU prices increase and these remain at a similar or lower level. In Turkey (TR) the difference in prices has often been negative highlighting that retail prices are held low, although this difference has reduced considerably and was around zero in 2015, implying that industry roughly pays wholesale prices for electricity in Turkey.

Figure 3-17: Difference between industrial retail electricity prices and electricity wholesale prices, EU28 (weighted) average, min and max, 2008-2018, EUR_{2017}/MWh



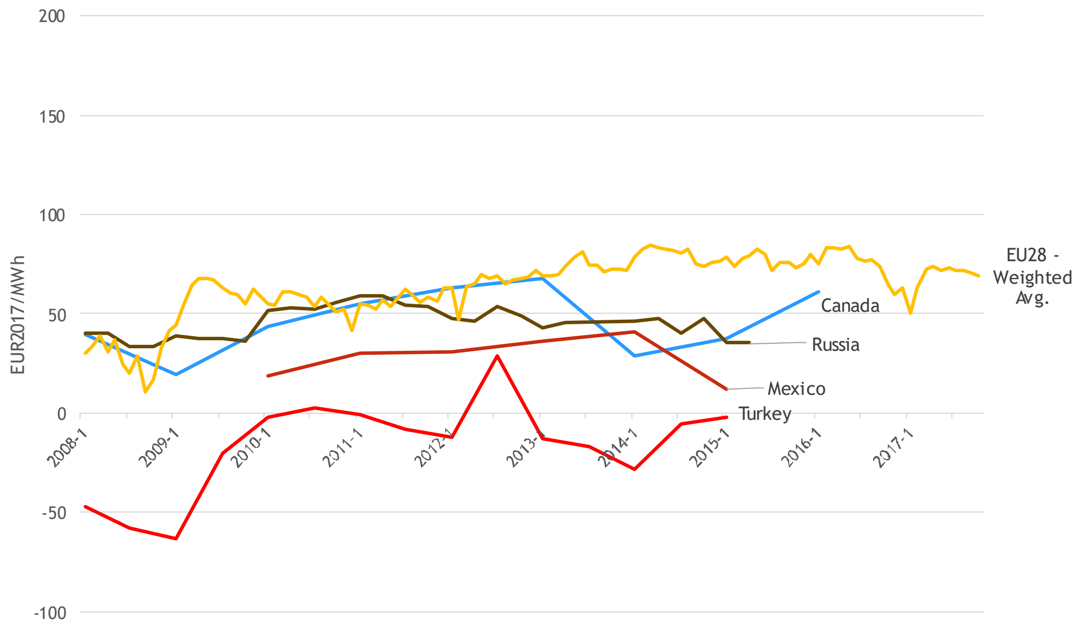
Sources: Own calculation

Figure 3-18: Difference between industrial retail electricity prices and electricity wholesale prices, EU28, US, CN, JP, 2008-2018, EUR2017/MWh



Sources: Own calculation

Figure 3-19: Difference between industrial retail electricity prices and electricity wholesale prices, EU28 and other G20 countries, 2008-2018, EUR2017/MWh



Sources: Own calculation

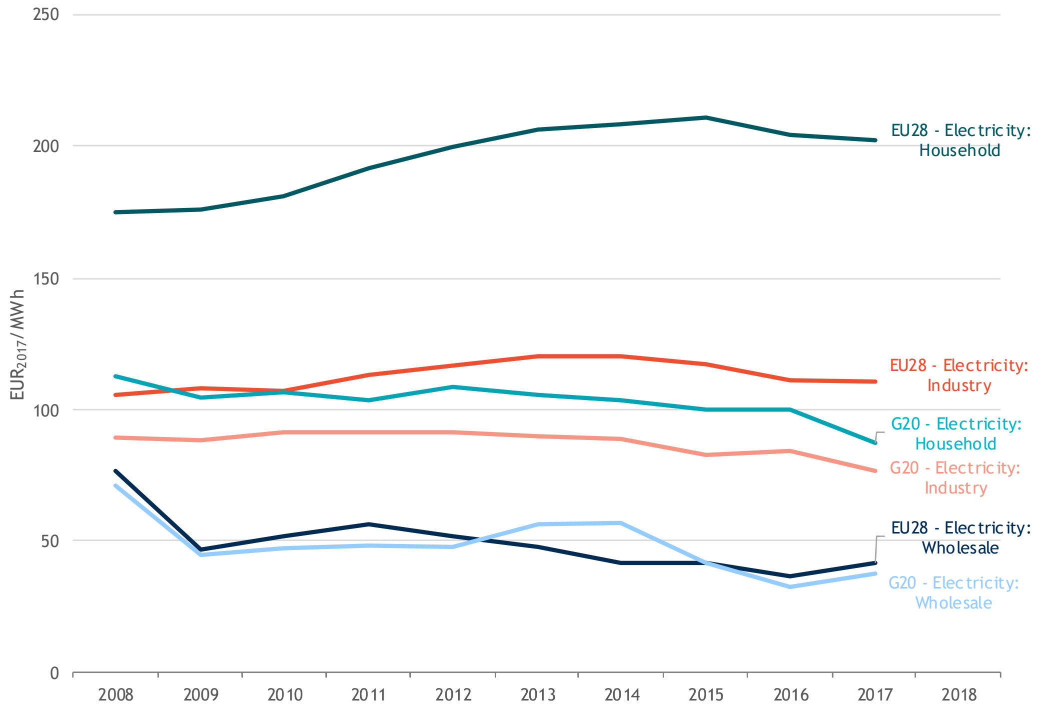
Summary of electricity price analysis

Our analysis of electricity prices in the EU28 and main trading partners in the G20, is summarised in Figure 3-20, and the analysis as a whole found that:

- **Wholesale prices** – EU28 average wholesale prices are comparable to most G20 countries and lower than some (Japan, Australia, Mexico, Turkey), and have seen favourable developments relative to most G20 countries between 2008-2018;

- **Household prices -** EU28 average retail prices are increasing over time while G20 prices are mainly stable or decreasing; EU28 prices are higher than most G20 countries and similar to some. Relatively high consumer taxes in the EU and price regulation/subsidies in the G20 are amongst the main reasons for this. Relatively high network costs may also play a role although data on these in the G20 is very limited;
- **Industrial prices** – EU28 average retail prices are around the same level in 2017 as in 2008. Prices are comparable to China and lower than Japan, but almost double US levels. EU prices remain higher than most other G20 countries. Relatively high non-recoverable taxes in the EU and price regulation/subsidies in the G20 play an important role in this difference;
- As to the role of taxes and levies, network costs and mark-ups – by comparing wholesale and retail prices we find that the difference between the two is by far the highest in the EU (for households) with only a handful of G20 countries (US, CA, JP) having a significant difference. This highlights that most G20 countries still regulate household prices. The same issue also exists for industry but is less acute than for households.

Figure 3-20: Comparison of EU28 weighted average with G20 (trade) weighted average



Sources: Own calculation,

Note: the G20 weighted averages are calculated on the basis of all available price data for a particular year, weighted in the total price by the share a country had in EU imports+exports 2014-2016 (see Table 4-1). Coverage ratios of total trade range from 73-96% (household prices), 58-92% (industrial prices) and 38-58% (wholesale prices).

3.2.2 Natural gas prices

This section presents results for natural gas prices in the EU28 and G20.

Wholesale

Wholesale natural gas prices have relatively complete datasets, the following figures, Figure 3-21, Figure 3-22 and Figure 3-23, present time series of available price data for the EU28 and G20 countries from 2008 to 2018.

Specific assumptions relating to this dataset include:

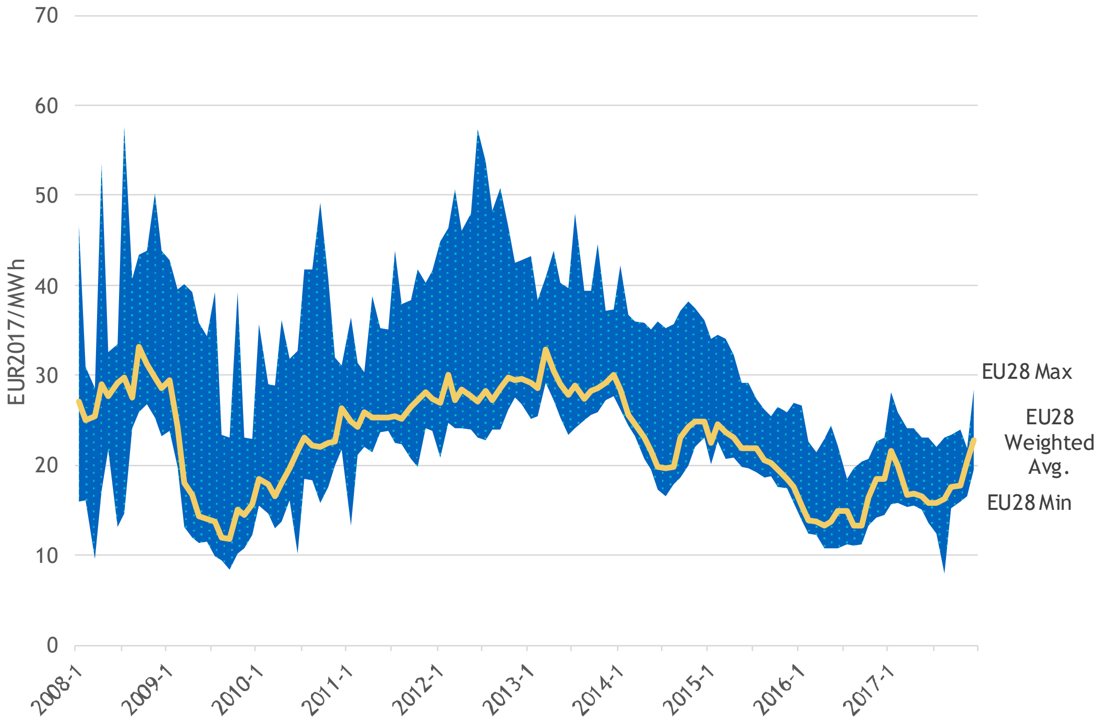
- There is no wholesale market for natural gas in CY and therefore it is excluded from the EU28 dataset;
- For EU28 member states, multiple sets of data were often gathered, particularly in the area of wholesale gas. We selected data in the following order of preference if multiple sources were available:
    - Hub prices – were used as first preference in almost every case for which a hub price was available. In the cases of ES and LT an Estimated Border Price was used as the hub price only had a very limited time series available;
    - Estimated Border Prices – as second preference, were used for BG, EE, EL, HU, IE, LV, PT, RO, SE, SI, SK;
    - LNG prices – were available for a handful of member states, but in the two cases (EL, PT) with no hub prices, estimated border prices were also available and used;
    - Proxy prices – were used for HR and LU: prices were calculated using a proxy average of neighbouring country prices. For HR, a combination of AT, HU, SI prices, and for LU, BE and DE prices were used.

The following conclusions are drawn from the data:

- It is important to note the significant link between gas and crude oil prices, as part of the gas prices are indexed on crude oil prices. Crude oil prices can be found in Figure 3-39, later in this chapter;
- EU28 average wholesale prices have tended after 2009 to move +/- 10 EUR around the 20 EUR/MWh price level. Over the full period, average prices have declined from around 27 EUR/MWh in 2008 to 23 EUR/MWh in 2017, although prices have been edging up since a low of around 13 EUR/MWh in 2016. The EU weighted average price is close to the lower end of the full range, HR, LT and SI are among the outliers at the maximum of the range. Box plots and line charts for each EU country are presented in Annex D2;
- From 2010 onwards, US prices have diverged from around the same level as EU average prices to around half of EU average levels, at less than 10 EUR/MWh, and continue to decline. This is primarily driven by shale gas exploitation and low exports in the US;
- EU average, JP and CN prices have tended to follow similar trends, although there was significant divergence between 2010-15 as JP and CN prices increased much more than EU average prices. This was primarily driven by increasing global LNG prices, tied to the increase in crude oil prices at the same time (see Figure 3-39). Since 2015, prices have converged once more and quite closely track each other, although with greater volatility;
- For other G20 countries, prices in major producers (CA and RU) are significantly lower than the EU average. In AU, also a major producer, prices were consistently lower than the EU average until 2016-2017 where prices rose above the EU average, as domestic supply shortages were experienced due to high exports to Asia. AU prices fell back below EU average levels in late 2017. Other prices (TR, ID, KR) and proxies (localised global LNG prices – AR, BR, IN) all tend to be higher than the EU average and with significantly higher price peaks and volatility than the EU average. KR and ID prices move similarly to JP and CN prices. It is useful to note that global LNG markets have their own price dynamics, different from those to piped gas, and that the comparison with hub prices includes this difference;

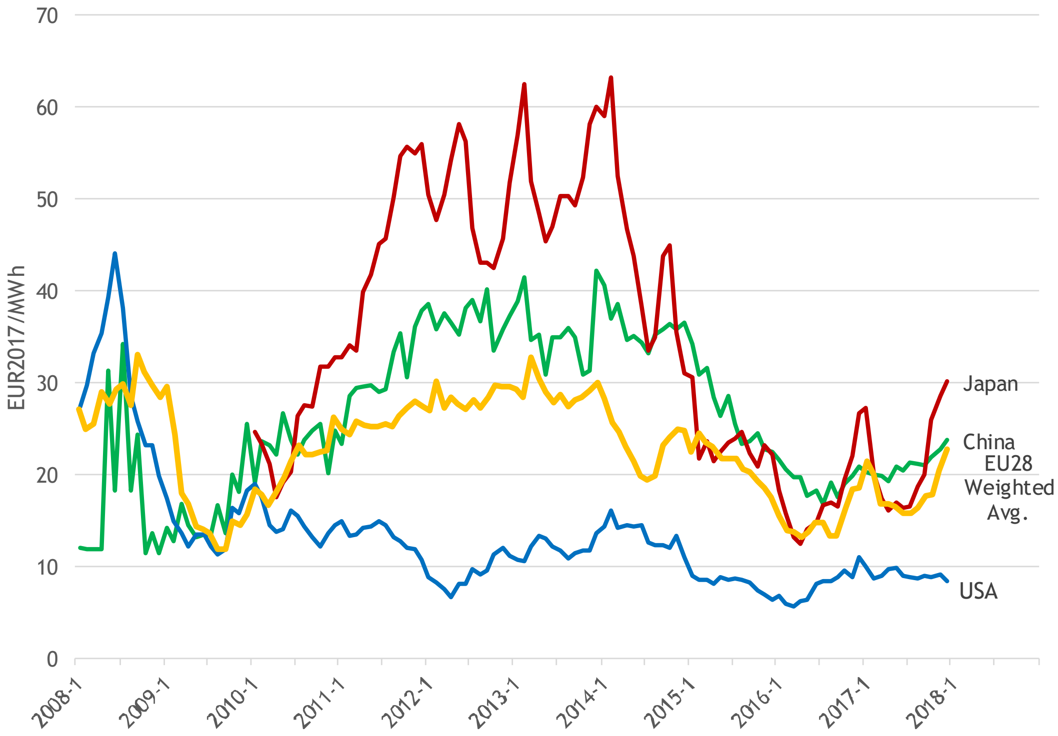
- Analysis of the evolution of price differentials in euros (see Table 3-15) in 2017 constant EUR prices shows that price developments across 7 (AU, BR, CN, JP, MX, RU, KR) of the 13 countries have been positive compared to the EU average. EU prices, previously higher, are now lower in four of these countries (CN, JP, MX and KR). Negative price developments are observed for AR, CA, IN, ID, TR and the US, with higher price declines than the EU. Nevertheless, wholesale prices are only lower in AU, CA, RU and the US;
- In Table 3-15 we present a more detailed presentation of the observed (nominal) price changes with the breakdown of some of the key factors in these changes, namely inflation, national price and exchange effects. Inflation had a significant effect on prices in Argentina, and relatively high impacts in India, Indonesia and Turkey. Looking at the national price effects we see that EU28 weighted average prices decreased by 15% between 2008 and 2017. This change compares favourably with many of the G20 countries, with only Canada, India, Indonesia and the US also experiencing national price declines. Prices increased in all other countries. Exchange rates had a very important influence on prices in Argentina, causing significant price depreciation in euro terms. A similar but smaller effect could be observed for Turkey.

Figure 3-21: Natural gas: Wholesale prices, EU28, 2008-2018, EUR_{2017}/MWh



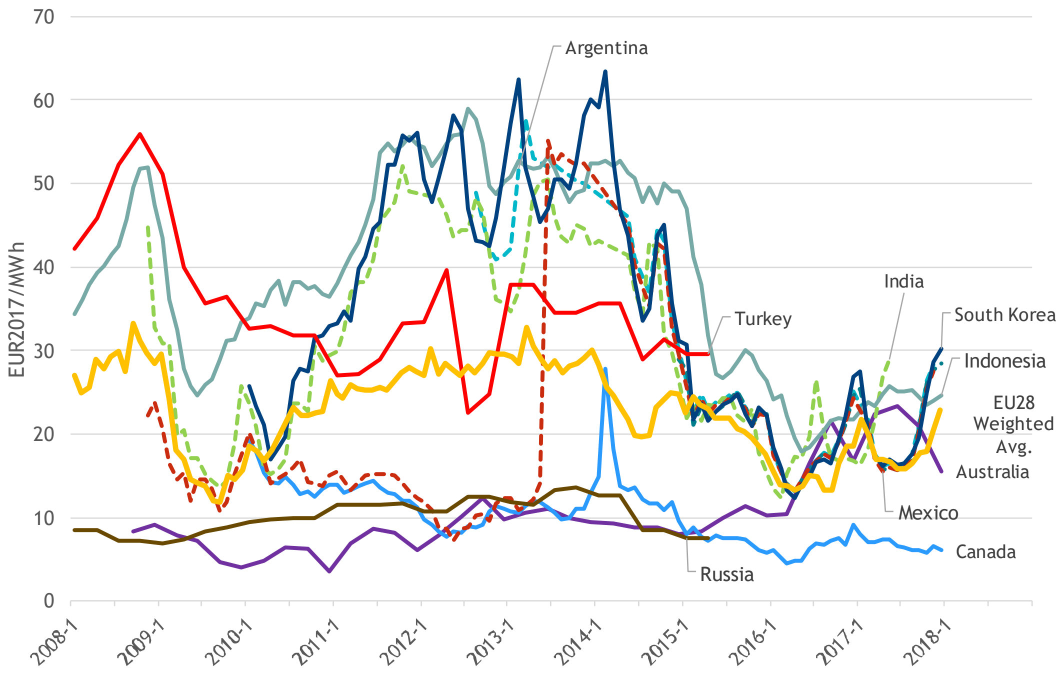
Sources: Own calculations based on data from Platts, Comext, OTE, BAFA, Thomson Reuters, Finnish gas exchange, GET Baltic, POLPX, PXP, GET Baltic

Figure 3-22: Natural gas: Wholesale prices, EU28, CN, JP, US, 2008-2018, EUR_{2017}/MWh



Sources: Own calculation based on data from Platts, Comext, OTE, BAFA, Thomson Reuters, Finnish gas exchange, GET Baltic, POLPX, PXP, GET Baltic, CEIC

Figure 3-23: Natural gas: Wholesale prices, EU28, other G20, 2008-2018, EUR_{2017}/MWh



Sources: Own calculation based on data from Platts, Comext, OTE, BAFA, Thomson Reuters, Finnish gas exchange, GET Baltic, POLPX, PXP, GET Baltic, CEIC, Knoema (World Gas Intelligence; World Bank), ERRA, Bloomberg.

Note: The dotted lines indicate the use of proxy data. In this case, data for IN and AR represents LNG prices.

Table 3-14: Changes in wholesale natural gas prices compared to EU prices, constant 2017 euros per MWh

Country	Start price [EUR2017]	End price [EUR2017]	Change EUR	Change %	Start Gap [EUR]	End Gap [EUR]	Difference [EUR]	Impact for EU
EU28	**27.06**	**22.72**	-4.34	-16.0%				
Argentina	**48.86**	**28.25**	-20.61	-42.2%	21.80	5.53	-16.27	Negative
Australia	**8.43**	**15.54**	7.12	84.5%	-18.63	-7.18	11.46	Positive
Brazil	**28.88**	**28.40**	-0.48	-1.6%	1.82	5.68	3.86	Positive
Canada	**19.10**	**6.04**	-13.06	-68.4%	-7.96	-16.68	-8.73	Negative
China	**11.89**	**23.70**	11.81	99.4%	-15.17	0.98	16.15	Positive
India	**44.75**	**28.86**	-15.89	-35.5%	17.69	6.13	-11.55	Negative
Indonesia	**34.21**	**24.47**	-9.74	-28.5%	7.15	1.75	-5.40	Negative
Japan	**24.64**	**30.11**	5.48	22.2%	-2.42	7.39	9.82	Positive
Mexico	**22.23**	**27.47**	5.23	23.5%	-4.82	4.74	9.57	Positive
Russia	**8.55**	**7.45**	-1.10	-12.9%	-18.51	-15.27	3.24	Positive
Saudi Arabia								
South Africa								
South Korea	**25.73**	**30.11**	4.38	17.0%	-1.33	7.39	8.72	Positive
Turkey	**42.23**	**29.54**	-12.69	-30.1%	15.17	6.82	-8.36	Negative
USA	**27.51**	**8.39**	-19.12	-69.5%	0.45	-14.33	-14.78	Negative

Source: own calculations.

Note: a positive impact for the EU is recorded if the price gap has improved over time, e.g. that if a country had lower prices initially the gap is now smaller or prices are higher than the EU average, or if a country had higher prices that the gap has increased. A negative impact is recorded if a country had lower prices than the EU, and that the gap has now increased, or if the country had higher prices than the EU but this gap has narrowed or the country now has lower prices.

Table 3-15: Factors in observed wholesale natural gas price changes per country, nominal prices per MWh

Country	Start date	End date	Nominal Start price EUR	Change due to inflation [EUR]	Change due to price change in national currency [EUR]	Exchange rate effect [EUR]	Total change [EUR]	Nominal End price EUR	Change due to inflation [%]	Change due to real price change in national currency [%]	Exchange rate effect [%]	Total change [%]
EU28	2008-1	2017-12	**24.34**	2.15	-3.78	0.00	**-1.62**	**22.72**	8.8%	-15.5%	0.0%	**-6.7%**
Argentina	2012-8	2017-11	**41.41**	38.65	15.89	-68.77	**-14.23**	**27.18**	93.3%	38.4%	-166.1%	**-34.4%**
Australia	2008-9	2017-12	**6.18**	0.86	6.01	1.73	**8.60**	**14.78**	13.9%	97.3%	28.0%	**139.2%**
Brazil	2014-12	2017-12	**25.46**	4.24	2.77	-5.37	**1.64**	**27.10**	16.7%	10.9%	-21.1%	**6.4%**
Canada	2010-1	2017-12	**13.53**	1.13	-8.81	-0.09	**-7.77**	**5.76**	8.4%	-65.1%	-0.7%	**-57.4%**
China	2008-1	2017-12	**8.01**	1.84	6.72	6.05	**14.61**	**22.61**	23.0%	83.9%	75.6%	**182.5%**
India	2008-11	2017-5	**34.84**	17.34	-18.38	-4.33	**-5.37**	**29.47**	49.8%	-52.8%	-12.4%	**-15.4%**
Indonesia	2008-1	2017-12	**23.04**	10.85	-6.82	-3.73	**0.30**	**23.35**	47.1%	-29.6%	-16.2%	**1.3%**
Japan	2010-1	2017-12	**17.45**	0.28	11.73	-0.73	**11.28**	**28.73**	1.6%	67.2%	-4.2%	**64.6%**
Mexico	2008-11	2017-11	**17.31**	6.11	11.78	-8.79	**9.10**	**26.42**	35.3%	68.0%	-50.8%	**52.6%**
Russia	2008-1	2015-4	**5.76**	4.03	2.20	-4.38	**1.85**	**7.61**	70.0%	38.2%	-76.0%	**32.1%**
Saudi Arabia	No data											
South Africa	No data											
South Korea	2010-1	2017-12	**18.23**	1.72	2.74	6.04	**10.50**	**28.73**	9.4%	15.0%	33.1%	**57.6%**
Turkey	2008-1	2015-4	**28.45**	14.09	7.53	-19.89	**1.73**	**30.17**	49.5%	26.5%	-69.9%	**6.1%**
USA	2008-1	2017-12	**18.53**	2.43	-14.52	1.57	**-10.52**	**8.00**	13.1%	-78.4%	8.5%	**-56.8%**

Source: own calculations.

Explanation: this table shows the different components of the observed nominal price change, decomposed into inflation, price change and exchange rate effects. By summing the components between the Nominal start price EUR and Total change [EUR] the total change can be calculated, this corresponds to the difference between the Nominal Start price EUR and the Nominal End price EUR. A worked example is provided in the notes to Table 3-7.

This table presents nominal prices, differences can be observed with the previous table which used constant prices, the start prices differ due to application of the currency deflator for the constant price calculation. Whilst the end prices differ as we deflate to a particular year (2017) using an annual average exchange rate, as opposed to the monthly average exchange rate used for the nominal price calculation. An example of this effect is presented in the notes to Table 3-7. As noted there, the observed difference is typically less than +/- 5% of the price.

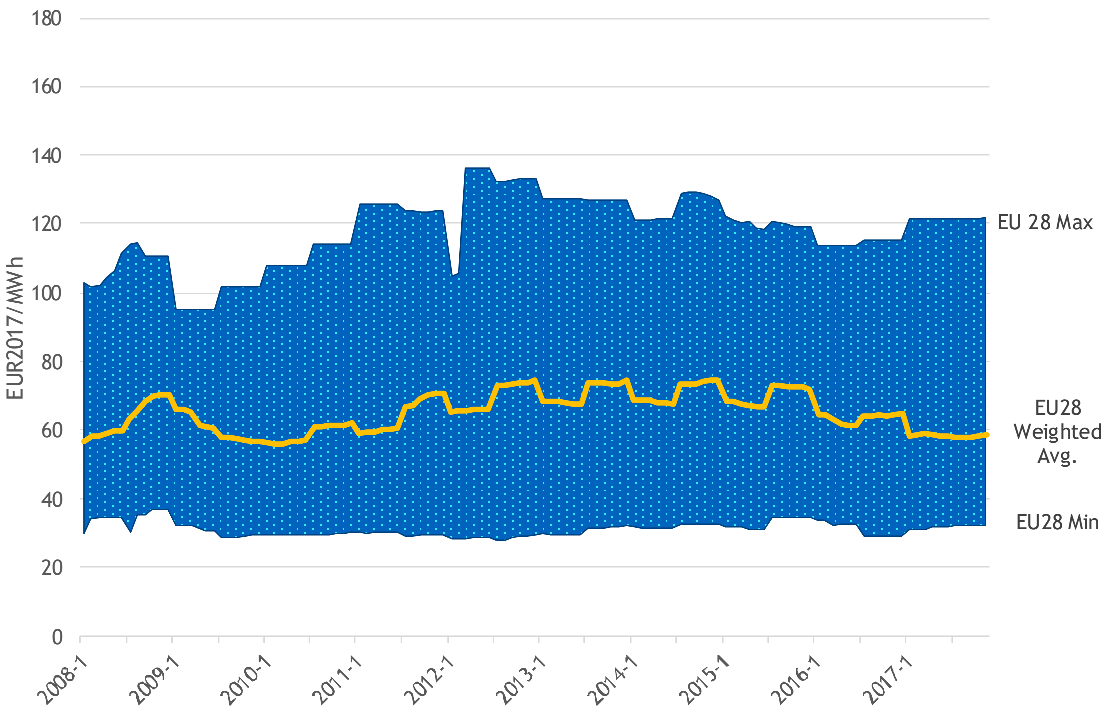
Retail - households

Retail gas prices for households have relatively complete datasets, the following figures, Figure 3-24, Figure 3-25, Figure 3-26 and Figure 3-27 present the time series of available price data for the EU28 and G20 countries from 2008-2018.

Conclusions that can be drawn from this data include:

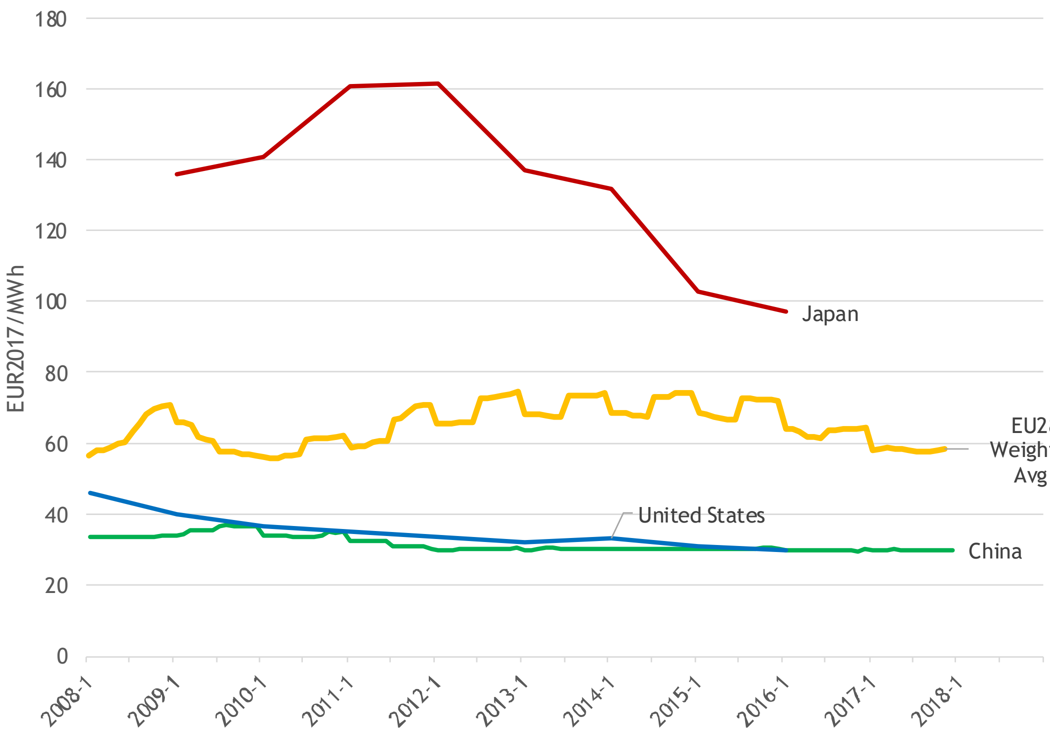
- EU28 average household prices have remained around 60 EUR/MWh between 2008-2018, moving only around 15 EUR/MWh higher or lower. Seasonal variations are noticeable since 2011. Box plots and line charts for each EU country are presented in Annex D2;
- Prices for the USA and CN are almost identical and trends along the 30 EUR/MWh level, about half the EU28 average level. US prices show a decline from around 50 EUR/MWh in 2008 as a result of lower wholesale prices due to shale gas exploitation. Whilst the low Chinese prices relative to wholesale prices reflect price caps for household consumers. Japanese (JP) prices are considerably higher than EU prices but since 2012 have been converging towards the EU28 average prices, this is consistent with the wholesale price movements;
- Prices in other G20 countries all tend to be lower than the EU28 average, although prices in South Korea were broadly comparable. The lowest prices can be found in the major oil and gas producing countries, namely Saudi Arabia (SA), Canada (CA), Russia (RU) and Mexico (MX). Prices are also low in Brazil (BR) and Turkey (TR), this is notable particularly for TR which has higher wholesale prices than the EU, reflecting price subsidies for household gas use. Prices in Argentina (AR) were lowest of all, kept artificially low by subsidies, but since just before and since the new Macri government gained power in 2016, these subsidies have started to be scaled back and prices have begun to rise. These are still very low internationally, but the price rises represent very high increases relative to previous price levels;
- A price index is available for AU and this indicates that prices have increased by around 60% in real terms since 2008. This increase outpaces the change in all the other G20 countries. It is unclear if price levels are similar to EU levels after these changes;
- Analysis of the evolution of prices (see Table 3-16) in 2017 constant EUR prices shows that price developments across all countries except Argentina have been of relative negative impact for the EU. Although this does not affect the competitiveness of the EU, it does signal a worsening of the relative price paid by the average EU household. The starting position was already that only Japan of the 11 countries had higher prices than the EU average in 2008, and whilst this remains the case, Japanese prices have narrowed with the EU and prices in all but Argentina have moved even lower. It is notable that the EU and Argentina were the only countries to record price increases in this period;
- In Table 3-17 we present a more detailed presentation of the observed (nominal) price changes with the breakdown of some of the key factors in these changes, namely inflation, national price and exchange effects. Inflation had a significant effect on prices in Argentina, Brazil, Mexico, Russia and Turkey. Looking at the national price effects we see that the biggest increase by far was experienced in Argentina, although this is largely negated by the exchange rate effect as the currency also devalued significantly against the Euro. Exchange rates also had an important influence on prices in Turkey, with prices depreciating significantly due to this effect. In percentage terms it is notable that prices did increase by more than the EU average in many of the other G20 countries (AR, BR, CN, RU, SA, KR), but from lower starting points in most cases, therefore with lower impacts on totals. Prices declined in Japan and the US over this period.

Figure 3-24: Natural gas: household retail prices - EU28, 2008-2018, EUR2017/MWh



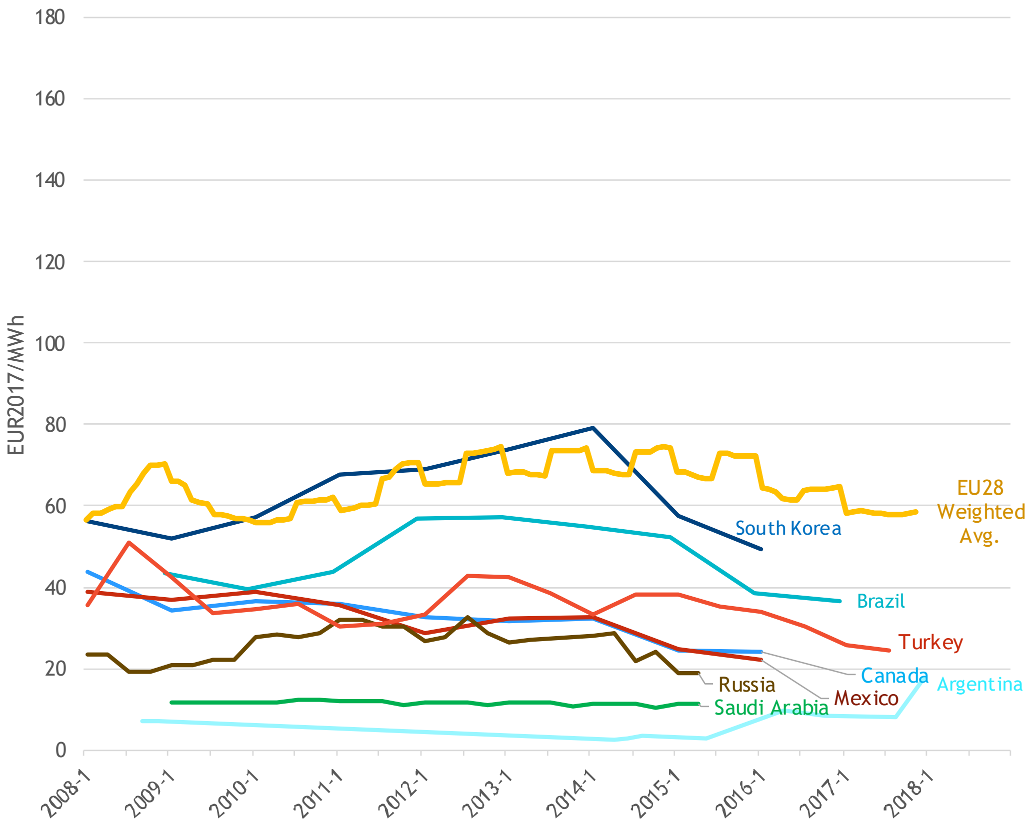
Sources: Own calculations based on data from Eurostat

Figure 3-25: Natural gas: household retail prices, EU, CN, JP, US, 2008-2018, EUR2017/MWh



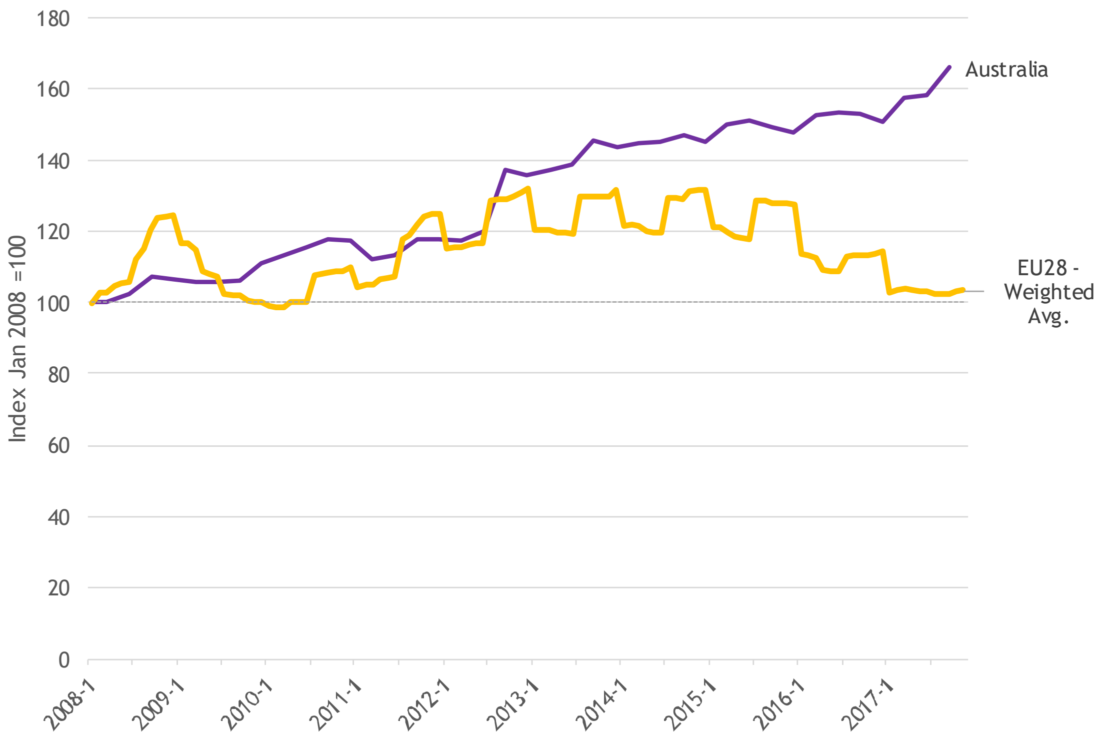
Sources: Own calculations based on data from Eurostat, CEIC, IEA

Figure 3-26: Natural gas: household retail prices for natural gas, EU, other G20, 2008-2018, EUR2017/MWh



Sources: Own calculations based on data from Eurostat, CEIC, IEA, ERRA

Figure 3-27: Natural gas price indices, household retail, EU28, AU, 2008=100, constant prices



Source: Own calculations based on data from Eurostat, CEIC

Table 3-16: Changes in household retail natural gas prices compared to EU prices, constant 2017 euros per MWh

Country	Start price [EUR2017]	End price [EUR2017]	Change EUR	Change %	Start Gap [EUR]	End Gap [EUR]	Difference [EUR]	Impact for EU
EU28	**56.52**	**58.46**	1.94	3.4%				
Argentina	**7.11**	**17.63**	10.52	148.0%	-49.41	-40.83	8.58	Positive
Australia								
Brazil	**43.47**	**36.72**	-6.75	-15.5%	-13.05	-21.74	-8.69	Negative
Canada	**43.81**	**24.10**	-19.71	-45.0%	-12.71	-34.37	-21.65	Negative
China	**33.64**	**30.09**	-3.55	-10.5%	-22.88	-28.37	-5.49	Negative
India								
Indonesia								
Japan	**135.58**	**97.13**	-38.45	-28.4%	79.06	38.67	-40.39	Negative
Mexico	**38.85**	**22.21**	-16.63	-42.8%	-17.68	-36.25	-18.57	Negative
Russia	**23.29**	**18.84**	-4.45	-19.1%	-33.24	-39.62	-6.39	Negative
Saudi Arabia	**11.82**	**11.34**	-0.49	-4.1%	-44.70	-47.13	-2.43	Negative
South Africa								
South Korea	**56.38**	**49.33**	-7.04	-12.5%	-0.14	-9.13	-8.99	Negative
Turkey	**35.49**	**24.30**	-11.19	-31.5%	-21.04	-34.16	-13.13	Negative
USA	**46.27**	**29.78**	-16.49	-35.6%	-10.25	-28.68	-18.43	Negative

Source: own calculations.

Note: a positive impact for the EU is recorded if the price gap has improved over time, e.g. that if a country had lower prices initially the gap is now smaller or prices are higher than the EU average, or if a country had higher prices that the gap has increased. A negative impact is recorded if a country had lower prices than the EU, and that the gap has now increased, or if the country had higher prices than the EU but this gap has narrowed or the country now has lower prices.

Table 3-17: Factors in observed household retail natural gas price changes per country, nominal prices, per MWh

Country	Start date	End date	Nominal Start price EUR	Change due to inflation [EUR]	Change due to price change in national currency [EUR]	Exchange rate effect [EUR]	Total change [EUR]	Nominal End price EUR	Change due to inflation [%]	Change due to real price change in national currency [%]	Exchange rate effect [%]	Total change [%]
EU28	2008-1	2017-11	**29.07**	2.57	-7.67	0.00	**-5.10**	**23.97**	8.8%	-26.4%	0.0%	**-17.5%**
Argentina	2008-9	2017-12	**1.49**	3.76	4.01	-7.41	**0.36**	**1.85**	252.2%	269.0%	-497.0%	**24.1%**
Australia	No data											
Brazil	2008-12	2016-12	**15.75**	10.02	-9.35	-1.46	**-0.79**	**14.97**	63.6%	-59.4%	-9.3%	**-5.0%**
Canada	2008-1	2016-1	**20.58**	1.72	-9.09	-0.50	**-7.87**	**12.71**	8.4%	-44.2%	-2.4%	**-38.2%**
China	2008-1	2017-12	**22.04**	5.06	0.43	10.05	**15.54**	**37.58**	23.0%	2.0%	45.6%	**70.5%**
India	No data											
Indonesia	No data											
Japan	2009-1	2016-1	**36.72**	-0.23	1.01	-2.51	**-1.73**	**35.00**	-0.6%	2.8%	-6.8%	**-4.7%**
Mexico	2008-1	2008-1	**25.30**	0.00	0.00	0.00	**0.00**	**25.30**	0.0%	0.0%	0.0%	**0.0%**
Russia	2008-1	2015-4	**5.78**	4.04	1.63	-4.18	**1.49**	**7.27**	69.9%	28.2%	-72.3%	**25.8%**
Saudi Arabia	No data											
South Africa	No data											
South Korea	2008-1	2016-1	**31.75**	4.76	-0.99	2.18	**5.95**	**37.70**	15.0%	-3.1%	6.9%	**18.7%**
Turkey	2008-1	2017-7	**24.80**	16.30	-1.79	-22.71	**-8.20**	**16.60**	65.7%	-7.2%	-91.6%	**-33.1%**
USA	2008-1	2016-1	**21.69**	2.57	-16.38	2.80	**-11.01**	**10.69**	11.8%	-75.5%	12.9%	**-50.8%**

Source: own calculations.

Explanation: this table shows the different components of the observed nominal price change, decomposed into inflation, price change and exchange rate effects. By summing the components between the Nominal start price EUR and Total change [EUR] the total change can be calculated, this corresponds to the difference between the Nominal Start price EUR and the Nominal End price EUR. A worked example is provided in the notes to Table 3-7.

This table presents nominal prices, differences can be observed with the previous table which used constant prices, the start prices differ due to application of the currency deflator for the constant price calculation. Whilst the end prices differ as we deflate to a particular year (2017) using an annual average exchange rate, as opposed to the monthly average exchange rate used for the nominal price calculation. An example of this effect is presented in the notes to Table 3-7. As noted there, the observed difference is typically less than +/- 5% of the price.

Retail - industry

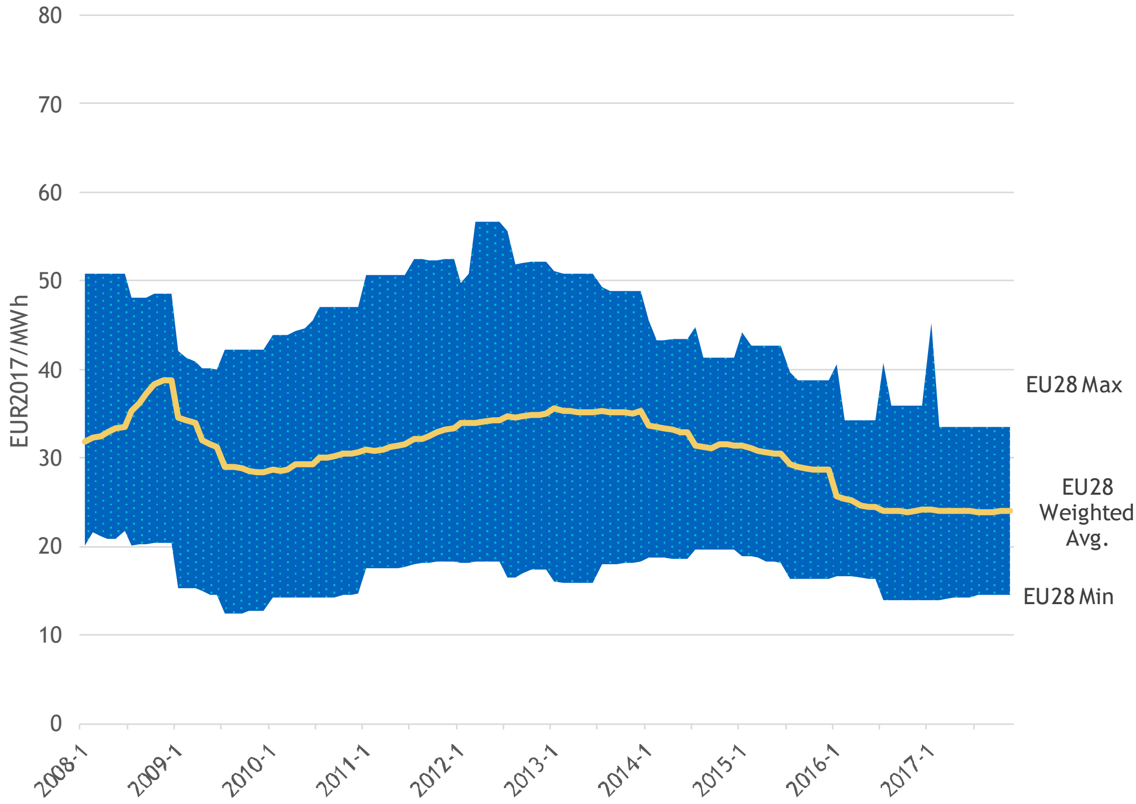
Retail gas prices for industry have relatively complete datasets, the following figures, Figure 3-28, Figure 3-29, Figure 3-30 and Figure 3-31, present the time series of available price data for the EU28 and G20 countries from 2008-2018. Prices are excluding VAT and all recoverable taxes and levies. From 2017 onwards EU prices are for non-household consumers, not just industry.

Conclusions that can be drawn from this data include:

- EU28 average industry prices have tended to move in a range of 25-40 EUR/MWh, but since 2016 have established a level below 25 EUR/MWh, marking a decline of around 20-25% over the 2008-2017 period. Box plots and line charts for each EU country are presented in Annex D2;
- Industry gas prices in the US are considerably lower than the EU28 average, having been around the same in 2008 at around 30 EUR/MWh, they have since diverged considerably lower as prices have declined to around the 10 EUR/MWh level in 2016. Prices in CN have stayed around the 40 EUR/MWh level throughout the period. Prices in JP prices diverged (higher) from the EU average between 2009-2014, but in 2015-16 have converged to close to EU28 average prices, the price movements quite closely tracking the movements in wholesale prices;
- Prices in TR display similar, but slightly lower, levels and trends to the EU28 average. Prices in KR more closely mirror the observed trends for Japan, diverging between 2009-2014, then converging between 2015-16, tracking movements in the wholesale LNG markets on which these countries depend. Prices in BR, CA and RU are around half the EU levels, comparable to prices in the US, with the CA trend, unsurprisingly given the close market links, very closely following the US trend. Prices in Argentina (AR) are the lowest of all, held artificially low by policy, these have started to increase since 2015;
- Information from price indices for countries without absolute price information (AU, MX) is also presented (Figure 3-31). This shows that whilst EU average prices have declined by around 20-25% since 2008, in contrast prices in national currency in Mexico have remained around the same in real terms, whilst prices in Australia, similar to observed changes in household price index have increased by around 50% in real terms (4.6% annual average increases);
- Analysis of the evolution of prices (see Table 3-18) in 2017 constant EUR prices shows that price developments in 6 (BR, CA, JP, KR, TR, US) of the 10 G20 countries were of relative negative impact for the EU, whilst 4 of the 10 were positive (AR, CN, MX, RU). This can have negative trends having potentially important implications for the competitiveness of EU industry, signalling a worsening of the relative price paid for gas, and additional pressure on energy costs for firms. The starting position in 2008, found prices higher than the EU in CN, JP, MX, KR and the US. The US experienced the biggest single change, with the shale gas expansion driving prices significantly lower, Canada also experienced similar benefits. Whilst the price gap with Argentina and Russia decreased, prices in both remained significantly lower than the EU. Prices in Japan and South Korea narrowed closer to EU prices, but also remained higher;
- In Table 3-19 we present a more detailed presentation of the observed (nominal) price changes with the breakdown of some of the key factors in these changes, namely inflation, national price and exchange effects. Inflation had a significant effect on prices in Argentina, Brazil, Russia and Turkey. Looking at the national price effects it is notable that prices increased in AR, CN, JP and RU, whilst declining in the other countries, the biggest changes observed in the US, Canada and Brazil, followed by the EU. Exchange rates had an important influence on prices in Argentina, Russia and Turkey, with prices depreciating significantly due to this effect, whilst in China there was also a significant but appreciating impact on prices from the exchange rate. In percentage terms it is notable that prices decreased by less than the EU

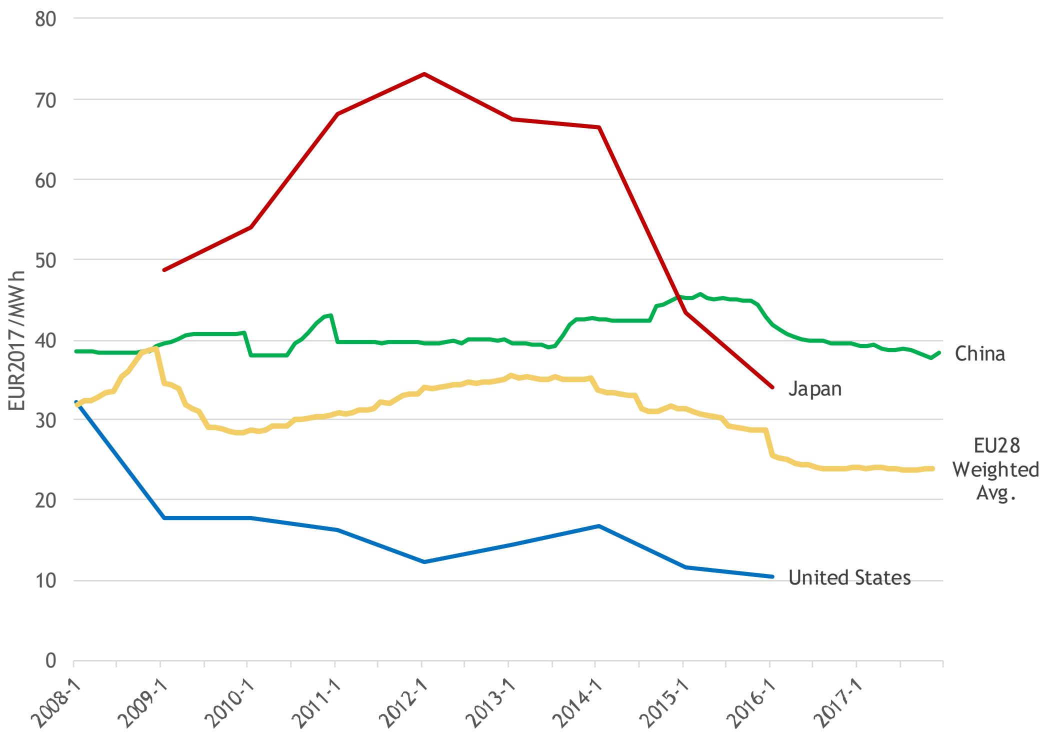
average, or increased, in many of the other G20 countries (AR, BR, CN, JP, KR, RU), but from lower starting points in most cases, therefore with lower impacts on total prices and relative competitiveness.

Figure 3-28: Natural gas: industrial retail prices, EU28, 2008-2018, EUR_{2017}/MWh



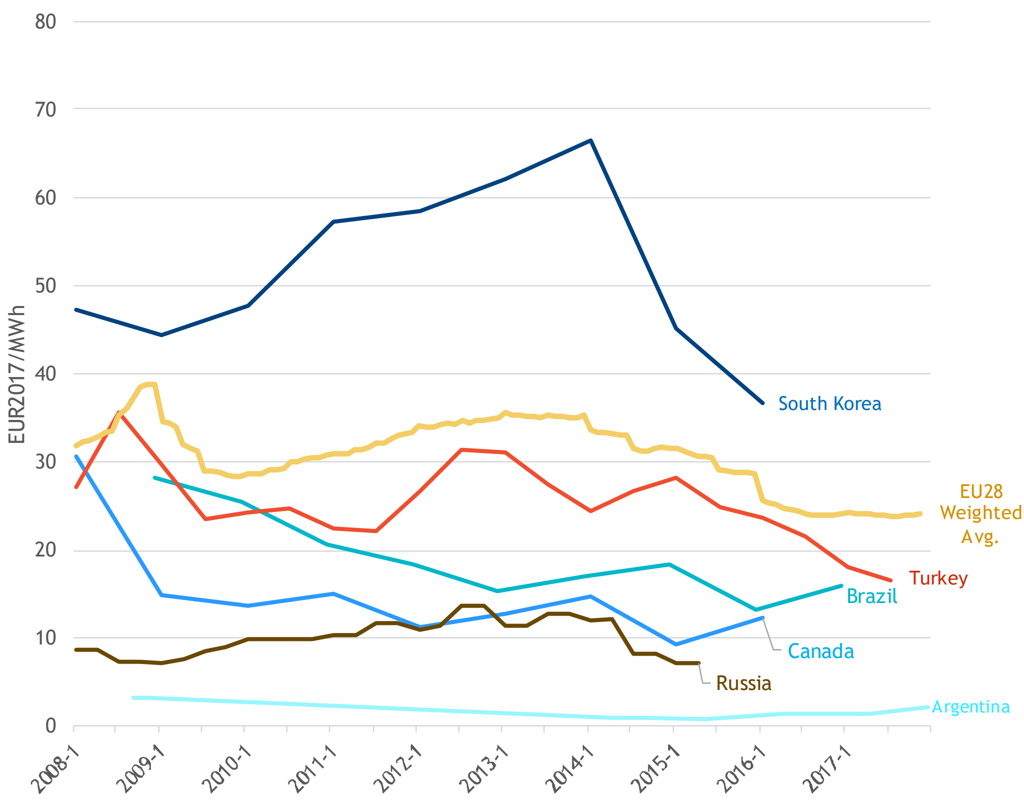
Sources: Own calculations based on data from Eurostat

Figure 3-29: Natural gas: industrial retail prices, EU, CN, JP, US, 2008-2018, EUR$_{2017}$/MWh



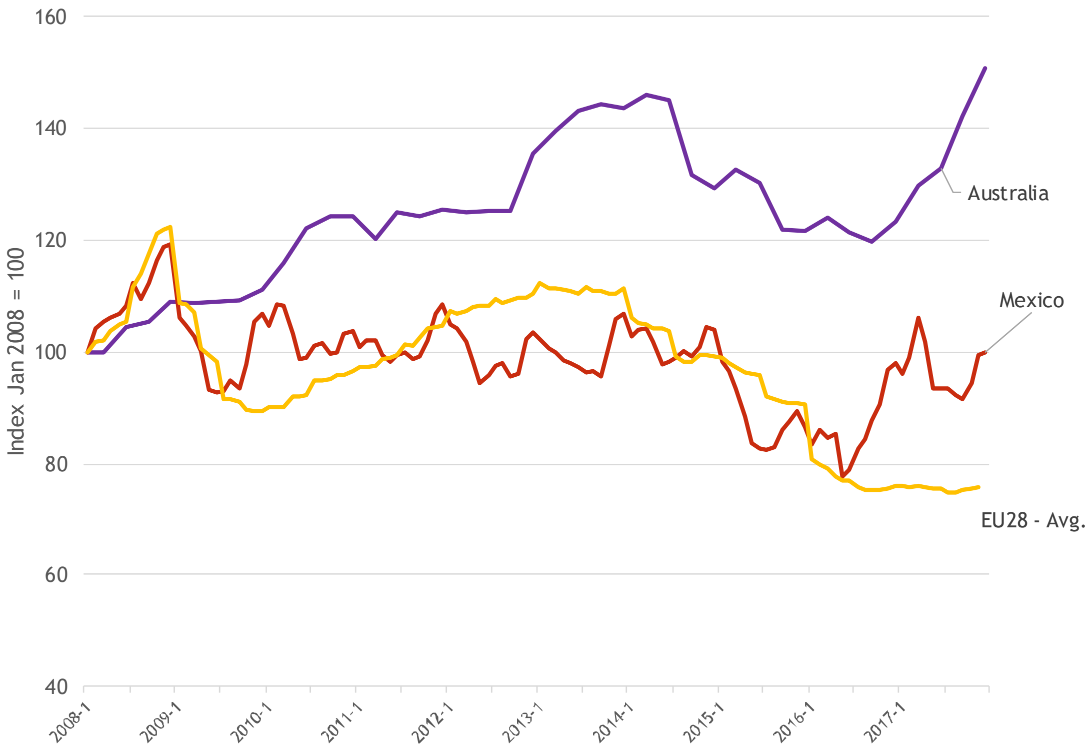
Sources: Own calculations based on data from Eurostat, CEIC

Figure 3-30: Natural gas: industrial retail prices, EU28, other G20, 2008-2018, EUR$_{2017}$/MWh



Sources: Own calculations based on data from Eurostat, CEIC, ERRA, IEA

Figure 3-31: Natural gas price indices, industrial retail, EU28, AR, AU, MX, 2008=100, constant prices



Source: Own calculations based on data from Eurostat, CEIC

Table 3-18: Changes in the industry retail natural gas price differential compared to EU prices, constant 2017 euros per MWh

Country	Start price [EUR2017]	End price [EUR2017]	Change EUR	Change %	Start Gap [EUR]	End Gap [EUR]	Difference [EUR]	Impact for EU
EU28	31.74	23.97	-7.77	-24.5%				
Argentina	3.16	2.17	-0.99	-31.3%	-28.58	-21.80	6.78	Positive
Australia								
Brazil	28.17	15.93	-12.24	-43.5%	-3.57	-8.04	-4.47	Negative
Canada	30.55	12.38	-18.18	-59.5%	-1.19	-11.60	-10.41	Negative
China	38.51	38.47	-0.04	-0.1%	6.77	14.50	7.73	Positive
India								
Indonesia								
Japan	48.67	34.09	-14.59	-30.0%	16.93	10.12	-6.82	Negative
Mexico	37.57	37.57	0.00	0.0%	5.82	13.59	7.77	Positive
Russia	8.58	7.12	-1.46	-17.0%	-23.16	-16.85	6.31	Positive
Saudi Arabia								
South Africa								
South Korea	47.14	36.72	-10.42	-22.1%	15.40	12.74	-2.65	Negative
Turkey	27.08	16.60	-10.48	-38.7%	-4.66	-7.37	-2.71	Negative
USA	32.21	10.41	-21.80	-67.7%	0.47	-13.56	-14.03	Negative

Source: own calculations.

Note: a positive impact for the EU is recorded if the price gap has improved over time, e.g. that if a country had lower prices initially the gap is now smaller or prices are higher than the EU average, or if a country had higher prices that the gap has increased. A negative impact is recorded if a country had lower prices than the EU, and that the gap has now increased, or if the country had higher prices than the EU but this gap has narrowed or the country now has lower prices.

Table 3-19: Factors in observed industrial retail natural gas price changes per country, nominal prices, per MWh

Country	Start date	End date	Nominal Start price EUR	Change due to inflation [EUR]	Change due to price change in national currency [EUR]	Exchange rate effect [EUR]	Total change [EUR]	Nominal End price EUR	Change due to inflation [%]	Change due to real price change in national currency [%]	Exchange rate effect [%]	Total change [%]
EU28	2008-1	2017-11	**29.07**	2.57	-7.67	0.00	**-5.10**	**23.97**	8.8%	-26.4%	0.0%	**-17.5%**
Argentina	2008-9	2017-12	**1.49**	3.76	4.01	-7.41	**0.36**	**1.85**	252.2%	269.0%	-497.0%	**24.1%**
Australia	No data											
Brazil	2008-12	2016-12	**15.75**	10.02	-9.35	-1.46	**-0.79**	**14.97**	63.6%	-59.4%	-9.3%	**-5.0%**
Canada	2008-1	2016-1	**20.58**	1.72	-9.09	-0.50	**-7.87**	**12.71**	8.4%	-44.2%	-2.4%	**-38.2%**
China	2008-1	2017-12	**22.04**	5.06	0.43	10.05	**15.54**	**37.58**	23.0%	2.0%	45.6%	**70.5%**
India	No data											
Indonesia	No data											
Japan	2009-1	2016-1	**36.72**	-0.23	1.01	-2.51	**-1.73**	**35.00**	-0.6%	2.8%	-6.8%	**-4.7%**
Mexico	2008-1	2008-1	**25.30**	0.00	0.00	0.00	**0.00**	**25.30**	0.0%	0.0%	0.0%	**0.0%**
Russia	2008-1	2015-4	**5.78**	4.04	1.63	-4.18	**1.49**	**7.27**	69.9%	28.2%	-72.3%	**25.8%**
Saudi Arabia	No data											
South Africa	No data											
South Korea	2008-1	2016-1	**31.75**	4.76	-0.99	2.18	**5.95**	**37.70**	15.0%	-3.1%	6.9%	**18.7%**
Turkey	2008-1	2017-7	**24.80**	16.30	-1.79	-22.71	**-8.20**	**16.60**	65.7%	-7.2%	-91.6%	**-33.1%**
USA	2008-1	2016-1	**21.69**	2.57	-16.38	2.80	**-11.01**	**10.69**	11.8%	-75.5%	12.9%	**-50.8%**

Source: own calculations.

Explanation: this table shows the different components of the observed nominal price change, decomposed into inflation, price change and exchange rate effects. By summing the components between the Nominal start price EUR and Total change [EUR] the total change can be calculated, this corresponds to the difference between the Nominal Start price EUR and the Nominal End price EUR. A worked example is provided in the notes to Table 3-7.

This table presents nominal prices, differences can be observed with the previous table which used constant prices, the start prices differ due to application of the currency deflator for the constant price calculation. Whilst the end prices differ as we deflate to a particular year (2017) using an annual average exchange rate, as opposed to the monthly average exchange rate used for the nominal price calculation. An example of this effect is presented in the notes to Table 3-7. As noted there, the observed difference is typically less than +/- 5% of the price.

Households – comparing retail prices to wholesale prices

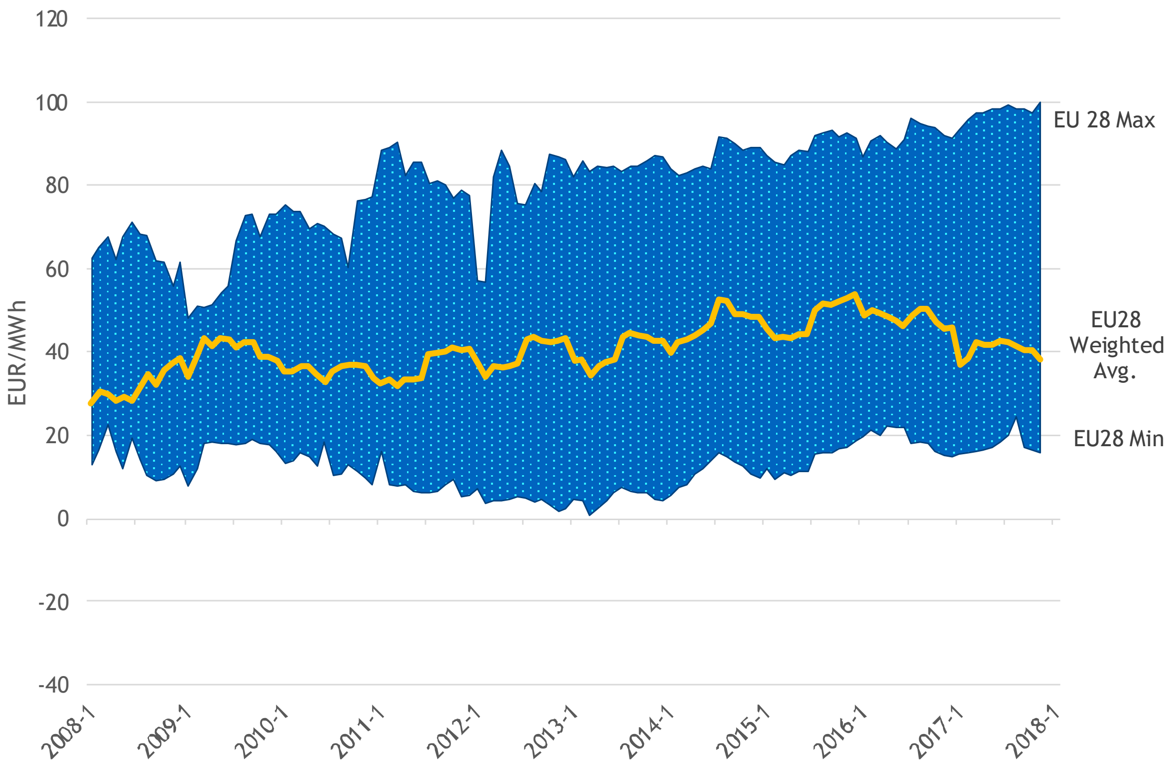
For the international comparison it is interesting to reflect on the role that different price components play in the retail prices paid by consumers and how these differ across countries. Unfortunately, corresponding price data (energy and supply, network charges, taxes and levies) is not available for non-EU countries. As a proxy for a component level analysis we provide in this section a comparison of the difference between the retail prices paid by consumers and the observed wholesale prices. Wholesale prices representing a proxy for the energy and supply component, and the difference between wholesale and retail prices illustrating the other components in the price such as network charges, mark-ups and non-recoverable taxes and levies. This can also illustrate where price regulation and/or tariff deficits exist in other countries.

Analysis of the difference between retail natural gas prices for households and natural gas wholesale prices are presented in the figures below (they show time series of this difference for the EU28 and G20 countries from 2008-2018).

Conclusions that can be drawn from this data include:

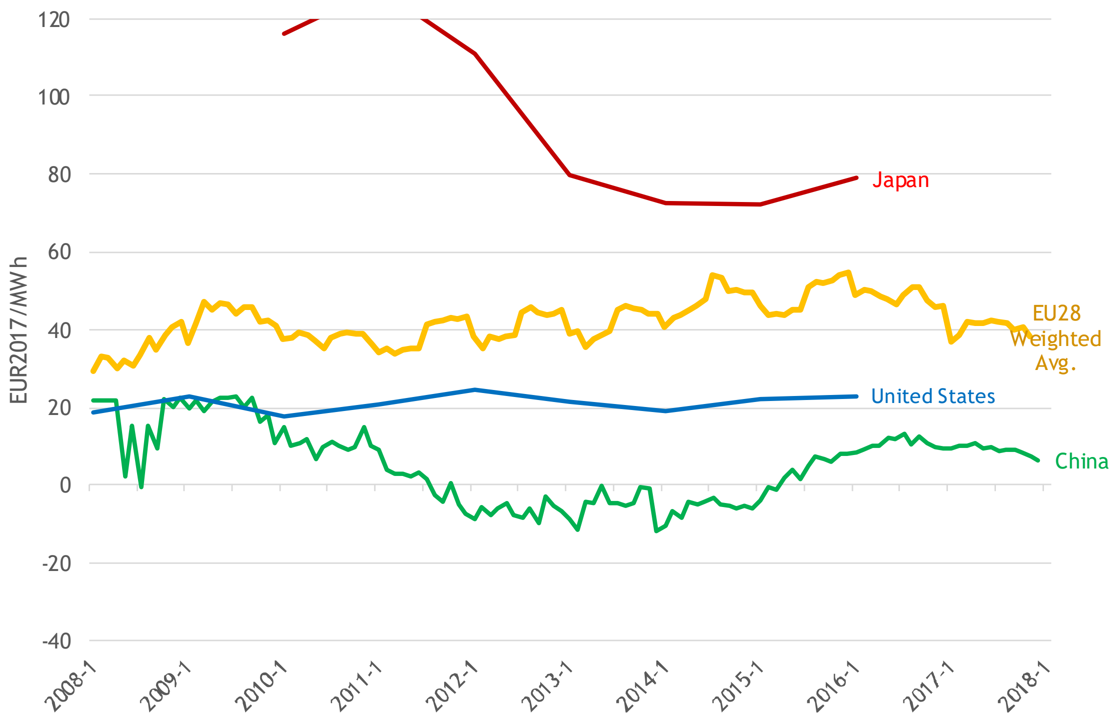
- The EU28 average difference between household retail prices and wholesale prices (see Figure 3-32) has increased from around 30 EUR/MWh in 2008 to around 40 EUR/MWh in 2017. The trend shows some decrease since a peak in the winter of 2015-2016. With wholesale prices averaging around 20-30 EUR/MWh over this period the difference between the two, equating broadly to network charges and taxes and levies, is greater and increasing. As wholesale prices have decreased since 2008, then the trend of the difference demonstrates an increase in other price components in the EU;
- Internationally, we see (Figure 3-33) that the price difference in China is low, starting at around 20 EUR/MWh in 2008, before declining to around -10 EUR/MWh for much of 2012-2015, before increasing to 10 EUR/MWh in 2010. These low and sometimes negative differences highlight that, as with electricity, household consumers in China are not paying the full cost of their natural gas use. The difference in the US is lower than in the EU28 at around 20 EUR/MWh and has only increased a little since 2008, this is notable as US wholesale prices have declined significantly, signalling that the other price components have been increasing. The difference in Japan has declined over the period from more than 120 EUR/MWh to around 80 EUR/MWh but remains around twice as high as EU average levels;
- For the other G20 countries (see Figure 3-34) the difference is lower than the EU28 average. In Mexico (MX) and Turkey (TR) there is only a very small difference between the two prices, highlighting also that retail prices are held low in these countries. The difference in Russia, Canada and Brazil is also lower, around the 20 EUR/MWh level. Only in South Korea is the difference approaching EU levels. In Argentina the prices difference is negative, highlighting that households pay less than wholesale prices, although the gap has narrowed as household retail prices have increased;
- Overall it is possible to see that whilst EU28 average wholesale prices are comparable to a number of other G20 countries that this does not translate into lower household prices. This price difference analysis highlights how this is driven by factors unrelated to the wholesale price and which are increasing within the EU average. It is notable that some countries with higher wholesale prices than the EU, such as Turkey and South Korea, have lower household retail prices.

Figure 3-32: Difference between household retail natural gas prices and wholesale prices, EU28 (weighted) average, min and max, 2008-2018, EUR2017/MWh



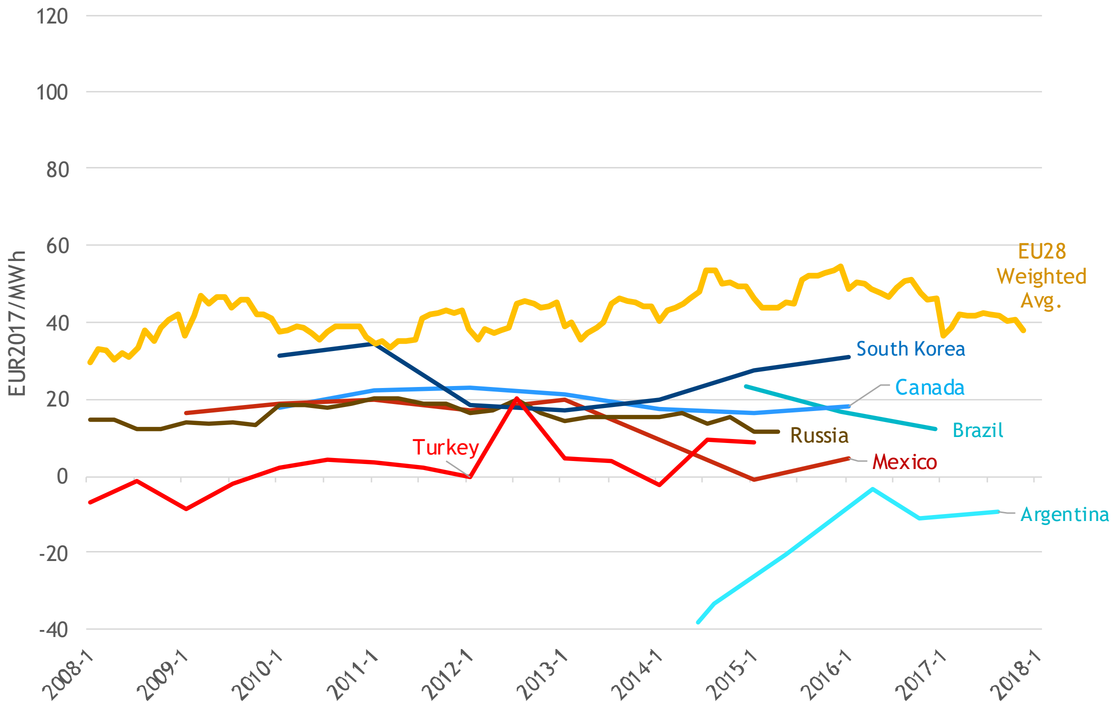
Source: Own calculations

Figure 3-33: Difference between household retail natural gas prices and wholesale prices, EU28, US, CN, JP, 2008-2018, EUR2017/MWh



Source: Own calculations

Figure 3-34: Difference between household retail natural gas prices and wholesale prices, EU28 and other G20 countries, 2008-2018, EUR2017/MWh



Source: Own calculations

Industry - comparing retail prices to wholesale prices

Carrying out a similar international comparison of the difference but now for retail industrial natural gas and wholesale prices brings the results presented in Figure 3-35, Figure 3-36 and Figure 3-37 (which present time series of this difference for the EU28 and G20 countries from 2008-2018).

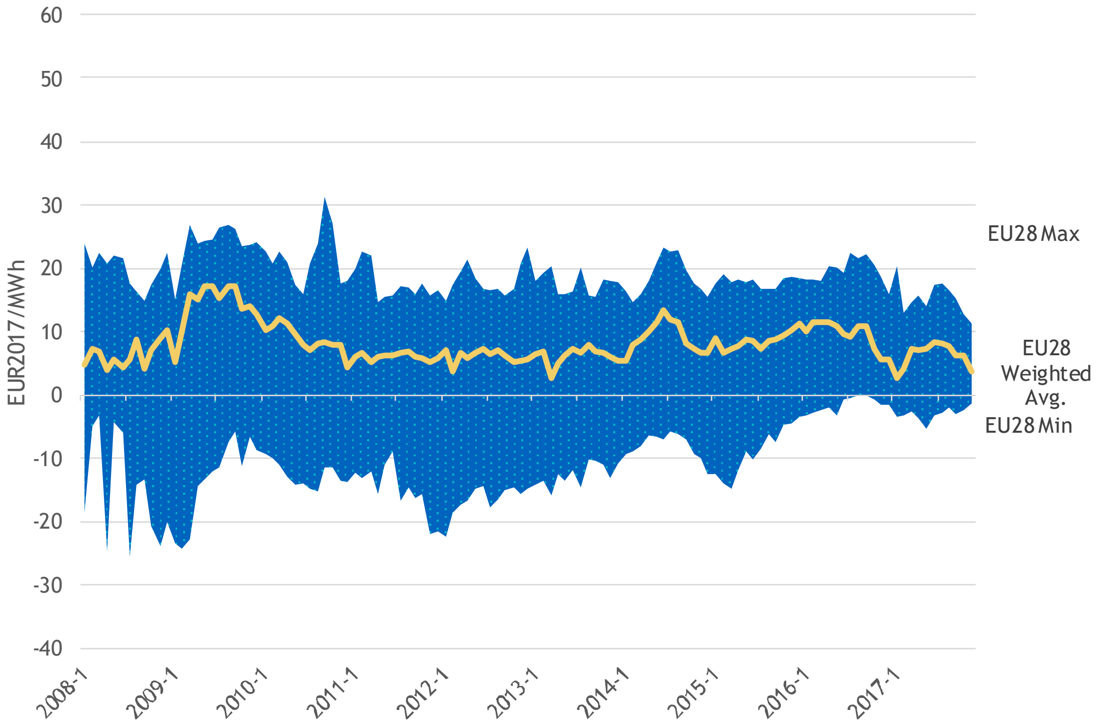
Conclusions that can be drawn from this data include:

- The EU28 average difference between industrial retail prices and wholesale prices (see Figure 3-35) has remained around 5 EUR/MWh between 2008 and 2017. In some Member States (especially Romania, but also Bulgaria) the difference between the two is often negative, highlighting effectively low or negative impacts from other price components. It is notable from the wholesale price analysis (see Figure 3-21 and annexes) that wholesale prices in these member states are relatively high or around the EU average, whilst retail prices are amongst the lowest. It should be noted that the retail price excludes recoverable taxes and levies so the focus is on any mark-up, network charges or non-recoverable taxes;
- Looking at Figure 3-36 the difference in the US has been a little lower than in the EU28 at around 0-5 EUR/MWh over the period. The difference in Japan has been greater than EU, but has substantially converged since 2011. The price difference in China has been greater than in the EU and finished the period at around 15 EUR/MWh. In both Japan and China this reflects both wholesale and retail prices that are similar or higher than in the EU;
- For the other G20 countries (Figure 3-37) the difference with the EU28 average is typically lower, although the difference in South Korea has diverged higher than the EU since 2014. In Turkey, Argentina and Brazil the difference is negative in most years highlighting that industry in these countries typically pays prices lower than the wholesale prices. In Canada and Russia

price differences are close to zero, signalling that firms are paying close to cost prices in these countries;

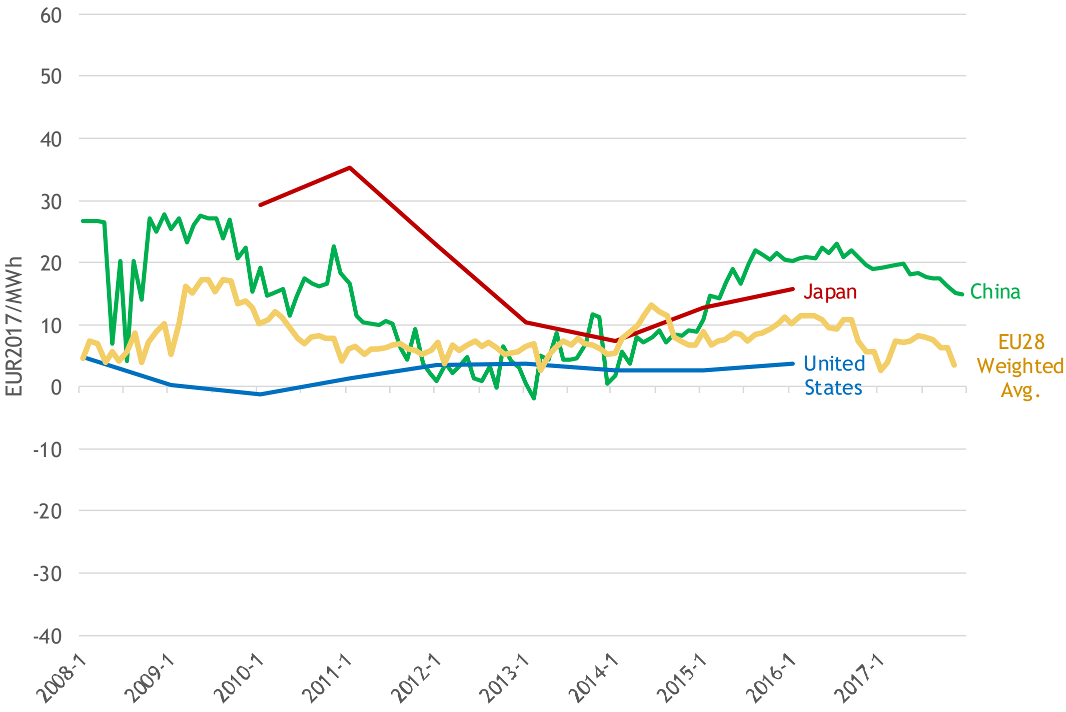
- Overall we find the differences between the EU and the G20 are not great, with the EU showing lower differences than the Asian countries, which have both higher wholesale and retail prices in any case. At the same time the US and Canada have lower differences and a number of countries (Argentina, Turkey, Brazil) have negative prices differences, highlighting the low prices that industry pays in these countries.

Figure 3-35: Difference between industrial retail natural gas prices and wholesale prices, EU28 (weighted) average, min and max, 2008-2018, EUR2017/MWh



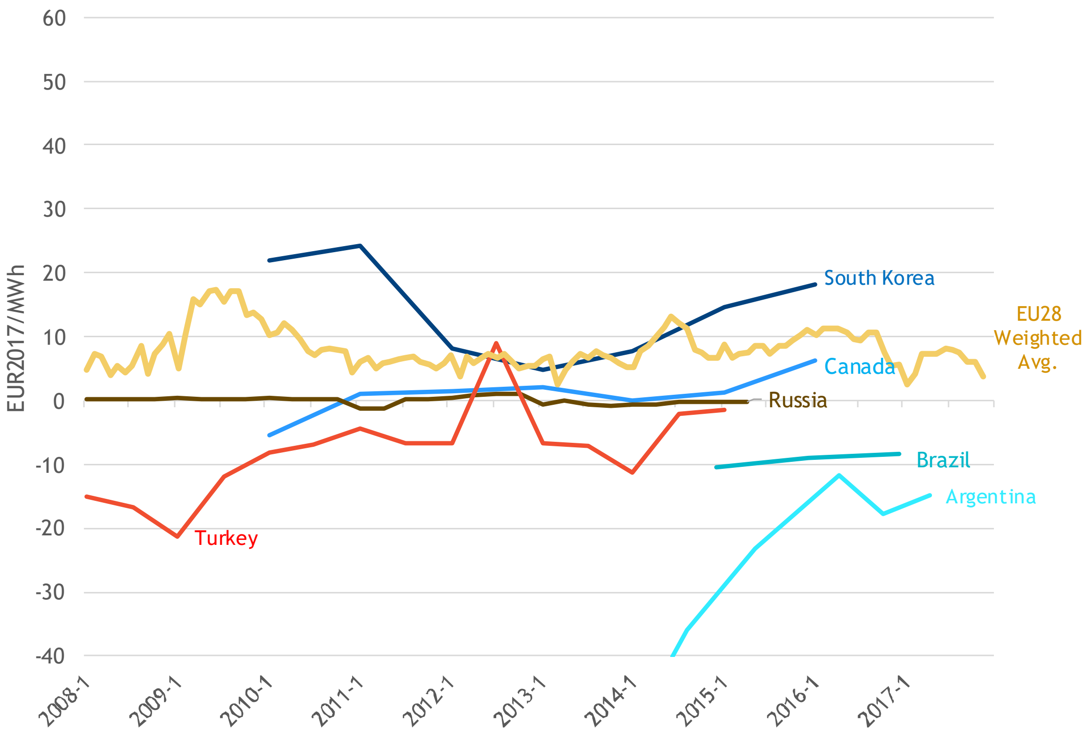
Source: Own calculations

Figure 3-36: Difference between industrial retail natural gas prices and electricity wholesale prices, EU28, US, CN, JP, 2008-2018, EUR2017/MWh



Source: Own calculations

Figure 3-37: Difference between industrial retail natural gas prices and electricity wholesale prices, EU28 and other G20 countries, 2008-2018, EUR2017/MWh



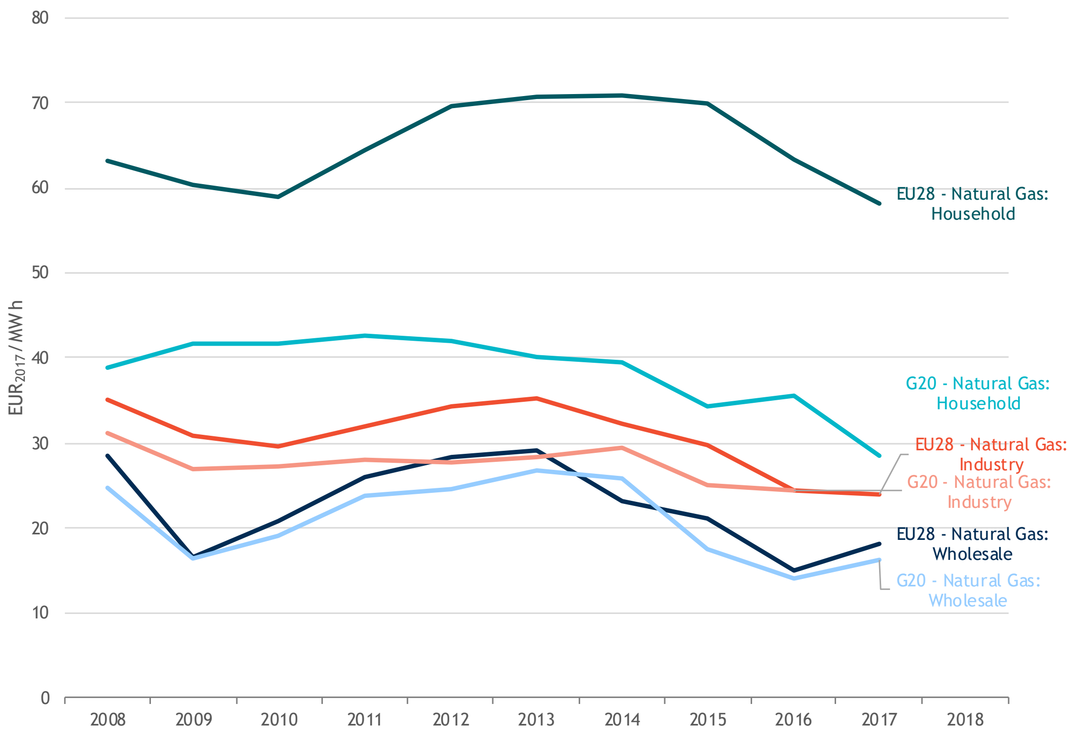
Source: Own calculations

Summary of natural gas price analysis

Our analysis of energy prices in the EU28 and main trading partners in the G20, is summarised in Figure 3-38, and the analysis as a whole found that:

- **Wholesale prices** – in the EU are similar to most other G20 countries, with the exceptions of the US, which benefitted from the onset of shale gas around 2010, and other major producers (Russia, Canada and (until recently) Australia) which have lower prices. Price developments have been relatively positive compared to East Asia (CN, JP, KO) but negative compared to the producers;
- **Household prices -** average EU28 prices are considerably higher than most other G20 countries (except JP and KO), although at the same level in 2018 as 2008. Relatively high consumer taxes in the EU and price regulation/subsidies in the G20 play an important role in the differences;
- **Industrial prices** – average EU28 prices are lower than East Asian countries (Japan, South Korea, China), but higher than most other G20 countries, including the US. Prices have declined since 2008 in the EU, but apart from East Asia and Mexico prices have declined faster elsewhere in the G20. As before non-recoverable taxes in the EU and price regulation/subsidies in the G20 play a role in the difference;
- As to the role of taxes and levies, network costs and mark-ups - by comparing wholesale and retail prices we find that the difference (for households) between the two is the highest in Japan, and second highest in the EU. In most G20 countries the difference is less than half EU average levels and in some (AR, MX, TR) less than, or near, zero. For industry there is a difference of around 5 EUR/MWh between the weighted averages of both, representing around 20% of the total price. The difference compares relatively favourably with JP, CN, US and CA, but other G20 countries (TR, BR, AR, RU) have near zero or negative differences, highlighting likely price regulation/subsidies.

Figure 3-38: Comparison of EU28 weighted average with G20 (trade) weighted average



Source: Own calculations

Note: the G20 weighted averages are calculated on the basis of all available price data for a particular year, weighted in the total price by the share a country had in EU imports+exports 2014-2016 (see Table 4-1). Coverage ratios of total trade range from 31-91% (household prices), 31-86% (industrial prices) and 78-95% (wholesale prices).

3.2.3 Petroleum product prices

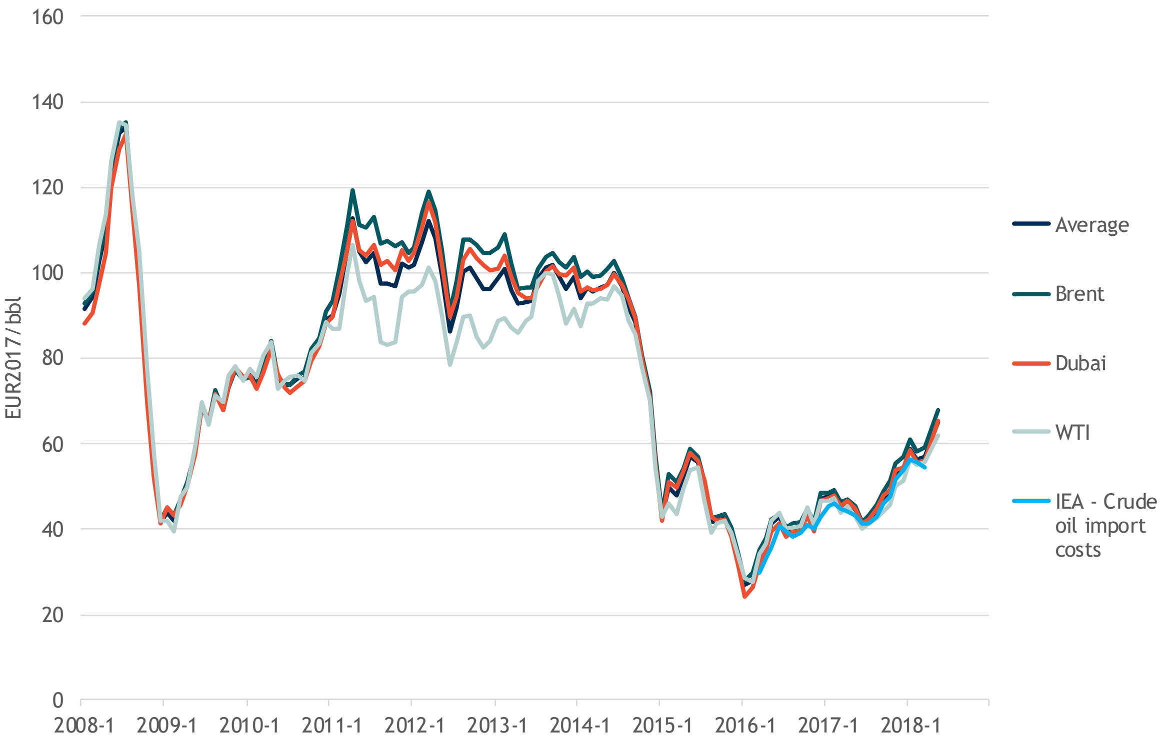
The following section presents results for petroleum products, including crude oil as a proxy for wholesale prices and examining various transport, heating and industrial fuels.

Wholesale - crude oil

Prices from the major crude oil indices (Brent, Dubai, West Texas Intermediate) all track each other very closely over time as shown in Figure 3-39, with prices rarely varying by more than 10 EUR/bbl from each other. Only between 2011-2014 did a divergence start to emerge with rapidly increasing US shale oil production starting to lead to lower prices for West Texas Intermediate oil compared to the other major benchmarks. The response of Saudi Arabia and other OPEC countries to increase production led to a sharp decline in crude prices, this has led to financial difficulties and cutbacks in the US shale oil sector (and a deterioration in public finances in OPEC countries) and to WTI prices converging again with the other benchmark indices. Latest price data from the IEA and World Bank, up to May 2018 indicates an increasing price trend.

Crude oil prices are highly influential in the pricing of petroleum products and natural gas products, as noted previously in the Natural Gas wholesale prices, therefore it will be normal to observe similar price trends for prices in the following sections as shown in Figure 3-39 below.

Figure 3-39: Crude oil prices, main benchmarks, 2008-2018, EUR$_{2017}$/barrel (bbl)



Source: Own calculations based on data from World Bank, IEA

Retail - petrol

Retail petrol prices are available for all countries although for some countries only partial data could be found. The following figures, Figure 3-40, Figure 3-41 and Figure 3-42, present the time series of available price data for the EU28 and G20 countries from 2008-2018. Retail prices for petroleum (gasoline) are strongly driven by taxation, particularly in the EU. We provide a comparison both including and excluding taxes to isolate this component.

Specific assumptions relating to this dataset include:

- The EU28 average is a consumption weighted average calculated by the EC in the Weekly Oil Bulletin;
- **Disclaimer:** for this section, and also diesel, LPG, high sulphur fuel oil, low sulphur fuel oil and heating oil, the EU Oil Bulletin has been used to provide prices. Prices up to and including January 2018 are included from this price data.

Conclusions that can be drawn from this data include:

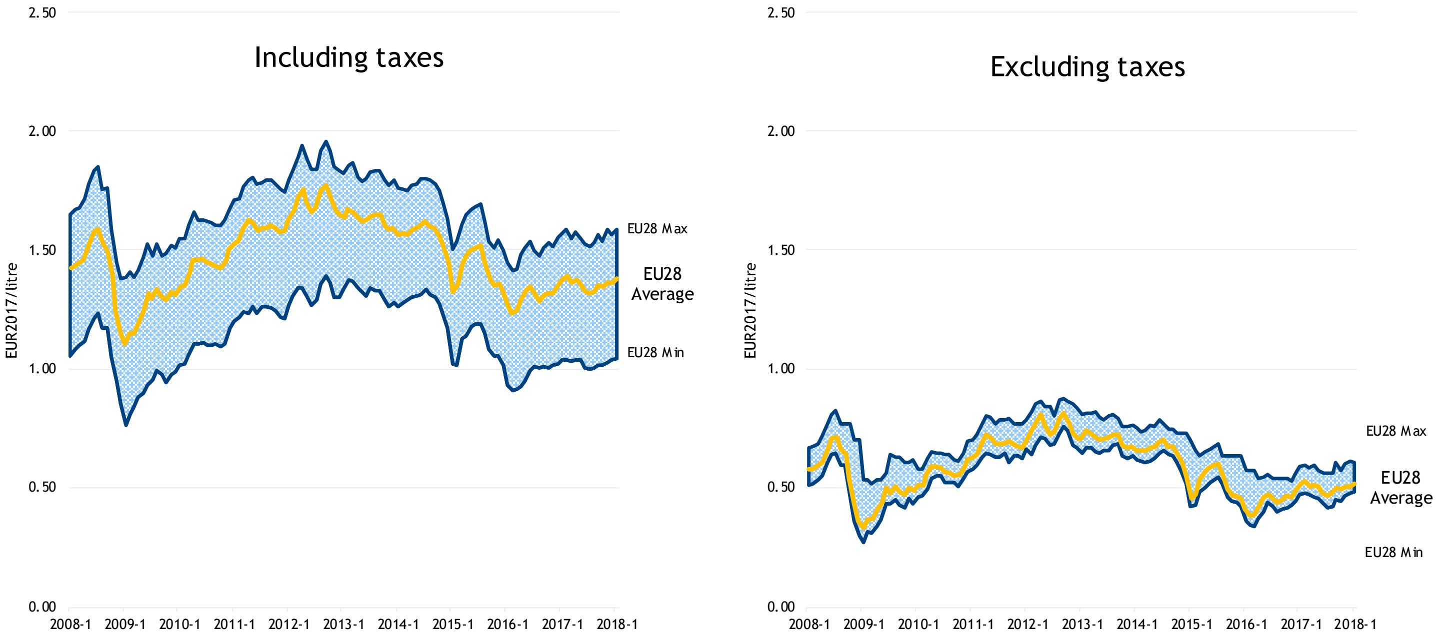
- EU28 average prices including taxes have remained around the 1.40 EUR/litre level since 2008, varying by up to 0.35 EUR/litre higher or lower broadly in line with crude oil price trends. Excluding taxes we find price levels follow a similar volatility trend, but are considerably lower starting at around 0.55 EUR/litre in 2008 and declining to around 0.50 EUR/litre by the beginning of 2018. Taxes constitute on average around 60% of the total retail price in the EU. The range of maximum and minimum prices is much greater for the including taxes price, highlighting the differences in tax regimes between EU member states;
- Japanese and (especially) US prices including taxes follow similar trends to the EU28 average although prices in both countries are lower, significantly so in the US with prices less than half of EU28 average levels. US tax rates are closer to 15-25% of the total price, this being the major explanatory driver of price differences. Prices in CN are also lower than EU levels. Excluding taxes, we find that EU28 average and US prices are very closely comparable. We do not have reliable tax exclusive prices for JP and CN to make a similar comparison;
- Retail prices including taxes in TR and KR were notable for being higher prices than the EU28 average but prices have converged to the EU average level over the period. Prices including taxes are lower than the EU average in all other G20 countries. Prices in Argentina (AR) are unusual as increasing over the period, partly driven by a policy decision by the previous (Kirchner) Government to bolster the oil sector in the country by increasing prices. Prices in CA and MX are a little higher than their US neighbour;
- Prices excluding taxes are more difficult to decipher, with no reliable price data excluding taxes for some of the other G20 (see dotted lines in Figure 3-42), it is impossible to conclude if taxes are present or at which level, although indications are that taxes of around 40% are present in Argentina[20]. Looking at those with more reliable data we see that EU28 price levels correspond closely to other G20 countries and are in fact among the lowest;
- Trends in all countries (except AR) quite closely match movements in crude oil prices, the extent of this effect on prices is greater in countries with lower taxes;
- Using other sources to compare, such as OECD tax data[21], we find that in 2015 taxes in the EU were typically constituted by around 65-75% excise taxes, the remainder as VAT. In other G20

20 https://www.afip.gob.ar/genericos/guiavirtual/consultas_detalle.aspx?id=3000746
21 http://www.oecd.org/ctp/consumption/Table-4.A4.6-Taxation-of-premium-unleaded-(94-96%20RON)-gasoline-(per%20litre)-2015.xls

countries excise taxes typically constitute >75% of all taxes as VAT or sales taxes on fuel are either much lower or entirely absent;

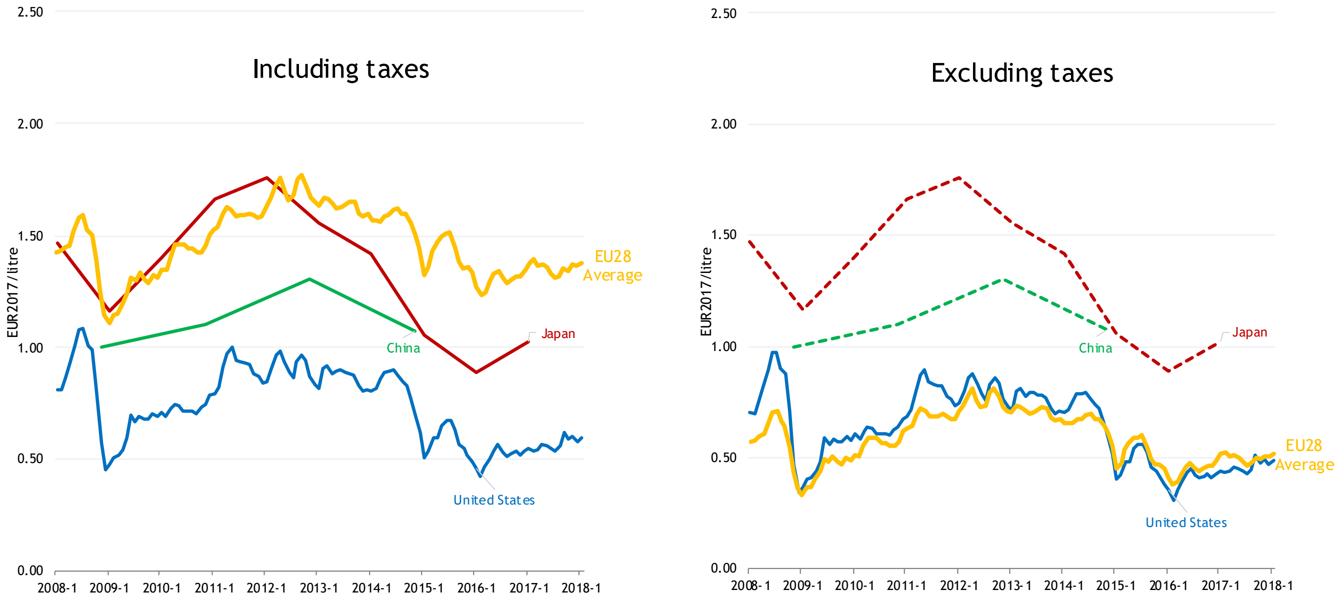
- In summary the main differences in final retail prices can be largely explained by differences in tax treatment, and in this area the EU taxes are among the highest globally.

Figure 3-40: Petrol (unleaded 95): retail prices EU28 2008-2018, EUR$_{2017}$/litre



Source: Own calculations based on data from EU Oil Bulletin

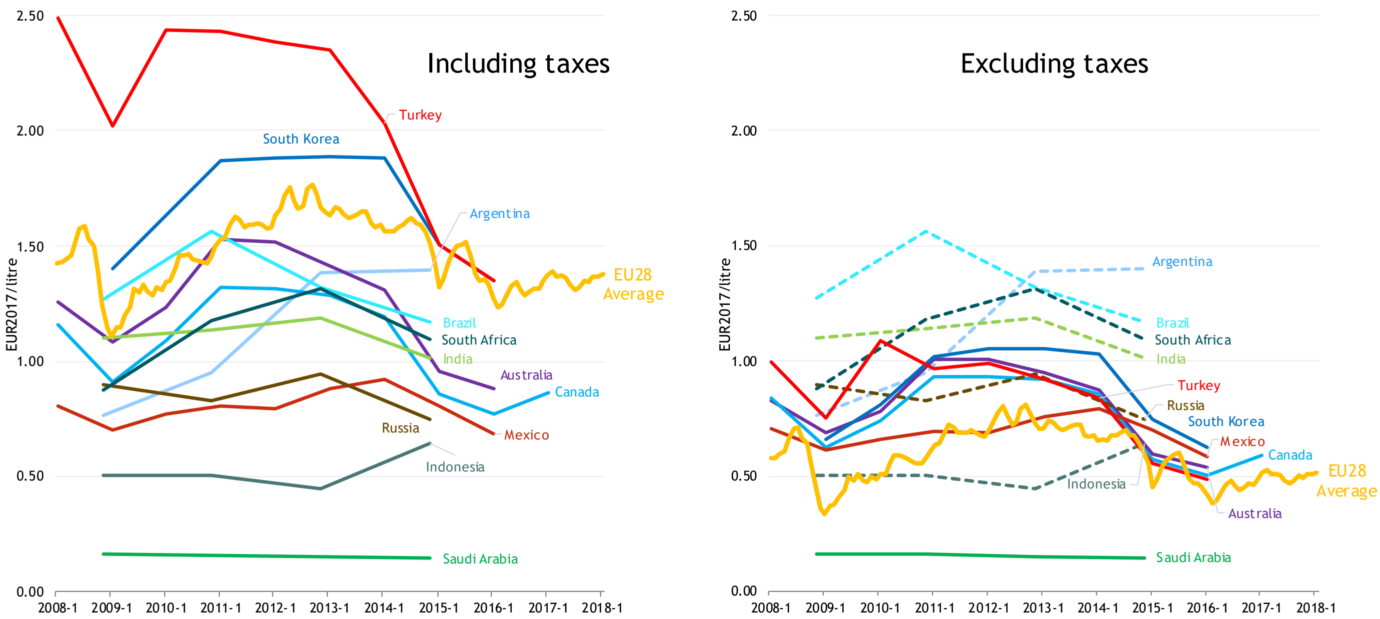
Figure 3-41: Petrol (unleaded 95): retail prices, EU28, US, JP and CN, 2008-2018, EUR$_{2017}$/litre



Sources: Own calculations based on data from EC, IEA, GIZ, EIA.

Note: dotted line highlights that it is unclear if the excluding taxes price actually excludes relevant taxes as no detailed tax information was available. Indications from other sources are that fuel taxes represent around 50% of the fuel price in Japan.

Figure 3-42: Petrol (unleaded 95): retail prices, EU28 and other G20 countries, 2008-2018, EUR2017/litre



Sources: Own calculations based on data from EC, IEA, GIZ.

Note: dotted line highlights that it is unclear if the excluding taxes price actually excludes relevant taxes as no detailed tax information was available. In most cases little or no fuel taxes are levied – see main text for note on AR.

Retail - diesel

The following figures, Figure 3-43, Figure 3-44 and Figure 3-45, present the time series of available price data for the EU28 and G20 countries from 2008-2018.

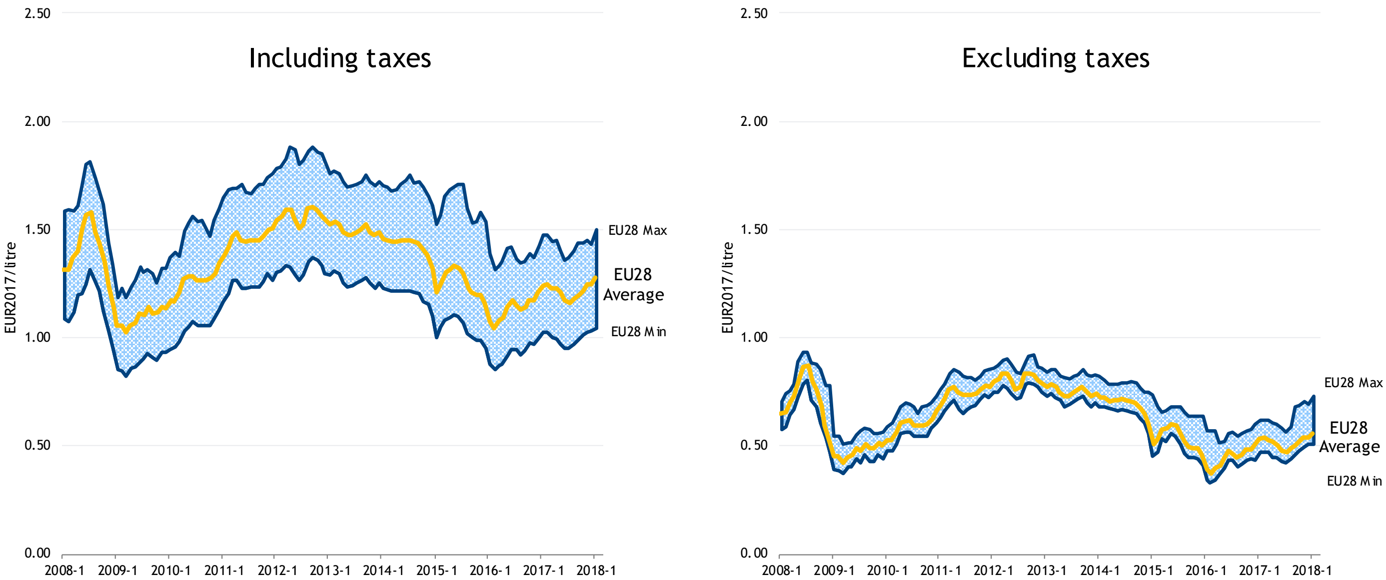
Conclusions that can be drawn from this data are similar to those for petrol and include:

- EU28 average retail prices including taxes have remained around the 1.30 EUR/litre level since 2008, varying by up to 0.30 EUR/litre higher or lower. Excluding taxes, we find price levels follow a similar volatility trend, but are considerably lower starting at around 0.65 EUR/litre in 2008 and declining to around 0.55 EUR/litre by the beginning of 2018, a 0.10 EUR/litre decline. Taxes constitute on average around 55% of the total retail price in the EU. The range of maximum and minimum prices is much greater for the including taxes price, highlighting the differences in tax regimes between EU member states;
- Retail prices including tax in CN, JP and the US follow similar trends to the EU28 average and crude oil prices although prices in all countries are lower than the EU average, significantly so in the US with prices less than half of EU28 average levels. US tax rates are around 15-25% of the total price, compared to the 55% or more in the EU, this being the major explanatory driver of price differences. Prices in CN are also lower than EU levels. Excluding taxes, we find that EU28 average and US and JP prices are very closely comparable. We do not have reliable tax exclusive prices for CN to make a similar comparison;
- For the other G20 and prices including taxes, TR was notable for having higher prices than the EU28 average, but prices have converged to the EU average level over the period. Prices are lower than the EU average in all other G20 countries. A similar trend to petrol can be observed for prices in AR. Prices in CA and MX are also again a little higher than their US neighbours;
- Prices excluding taxes are more difficult to decipher, with no reliable price data excluding taxes for some of the other G20 (see dotted lines in Figure 3-45), it is not possible to conclude

if taxes are present or at which level, although indications are that taxes of around 40% are present in Argentina[22]. Looking at those with more reliable data (AU, CA, KR, MX) we see that EU28 price levels correspond closely to other G20 countries. The lowest prices are found in Saudi Arabia (SA);

- Trends in all countries (except AR) quite closely match movements in crude oil prices, the extent of this effect on prices is greater in countries with lower taxes;
- Using other sources to compare, such as OECD tax data[23], we find that in 2015 taxes in the EU were typically constituted by around 60-75% excise taxes, the remainder as VAT. In other G20 countries excise taxes typically constitute >75% of all taxes as VAT or sales taxes on fuel are either much lower or entirely absent;
- It is also notable that in almost all countries the price of automotive diesel is lower than that of petrol.

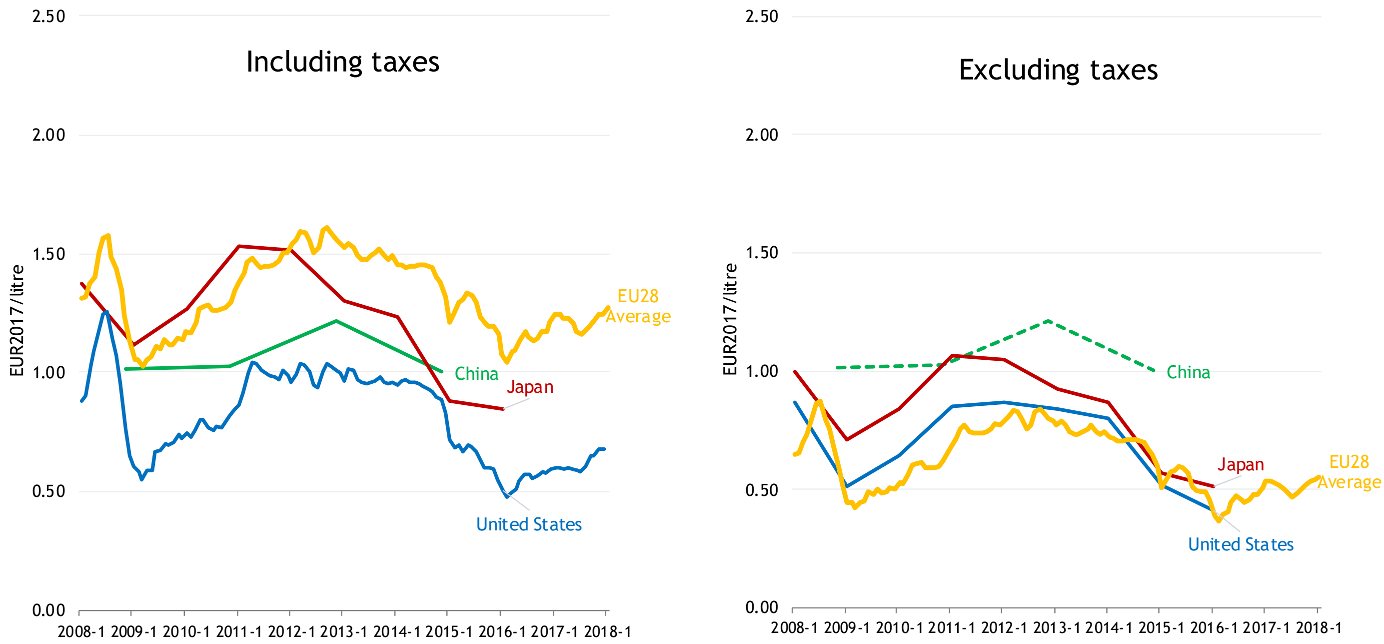
Figure 3-43: Automotive diesel: retail prices, EU28, 2008-2018, EUR_{2017}/litre



Source: Own calculations based on data from EU Oil Bulletin

22 https://www.afip.gob.ar/genericos/guiavirtual/consultas_detalle.aspx?id=3000746
23 http://www.oecd.org/ctp/consumption/Table-4.A4.7-Taxation-of-automotive-diesel-(per%20litre)-2015.xls

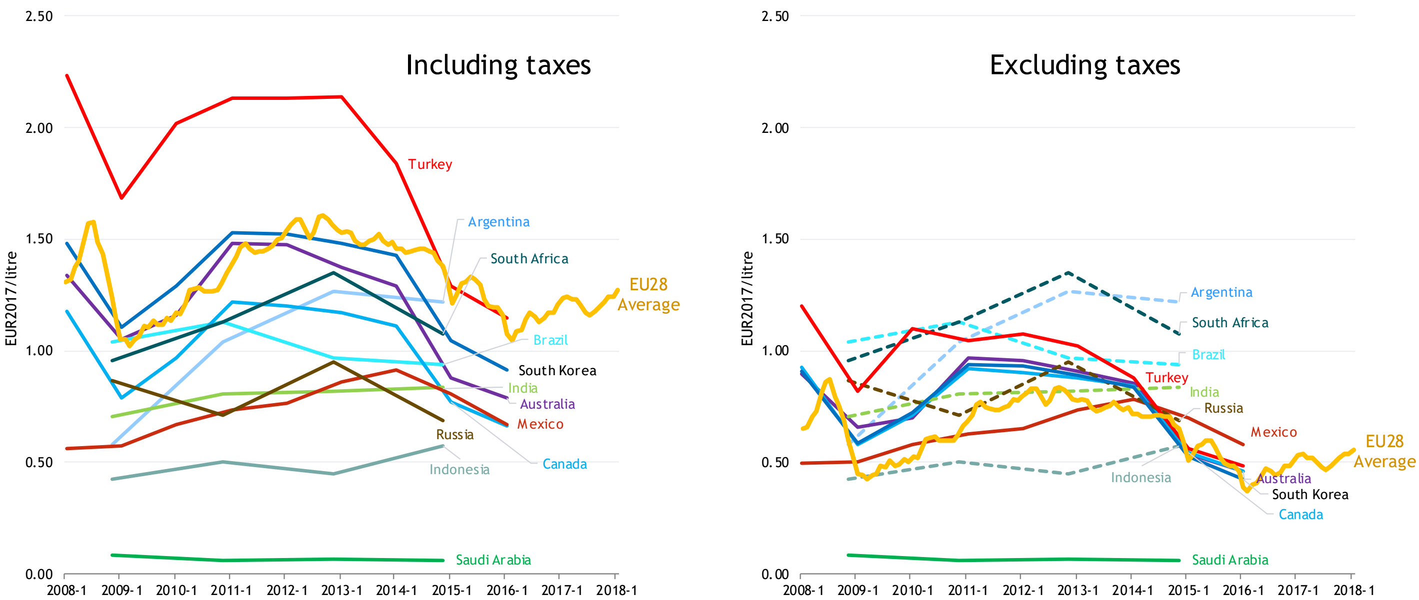
Figure 3-44: Automotive diesel: retail prices EU28, US, JP and CN, 2008-2018, EUR$_{2017}$/litre



Sources: Own calculations based on data from EC, IEA, GIZ, EIA.

Note: dotted line highlights that it is unclear if the excluding taxes price actually excludes relevant taxes as no detailed tax information was available.

Figure 3-45: Automotive diesel: retail prices, EU28 and other G20 countries, 2008-2018, EUR$_{2017}$/litre



Sources: Own calculations based on data from EC, IEA, GIZ.

Note: dotted line highlights that it is unclear if the excluding taxes price actually excludes relevant taxes as no detailed tax information was available. In most cases little or no fuel taxes are levied – see main text for note on AR.

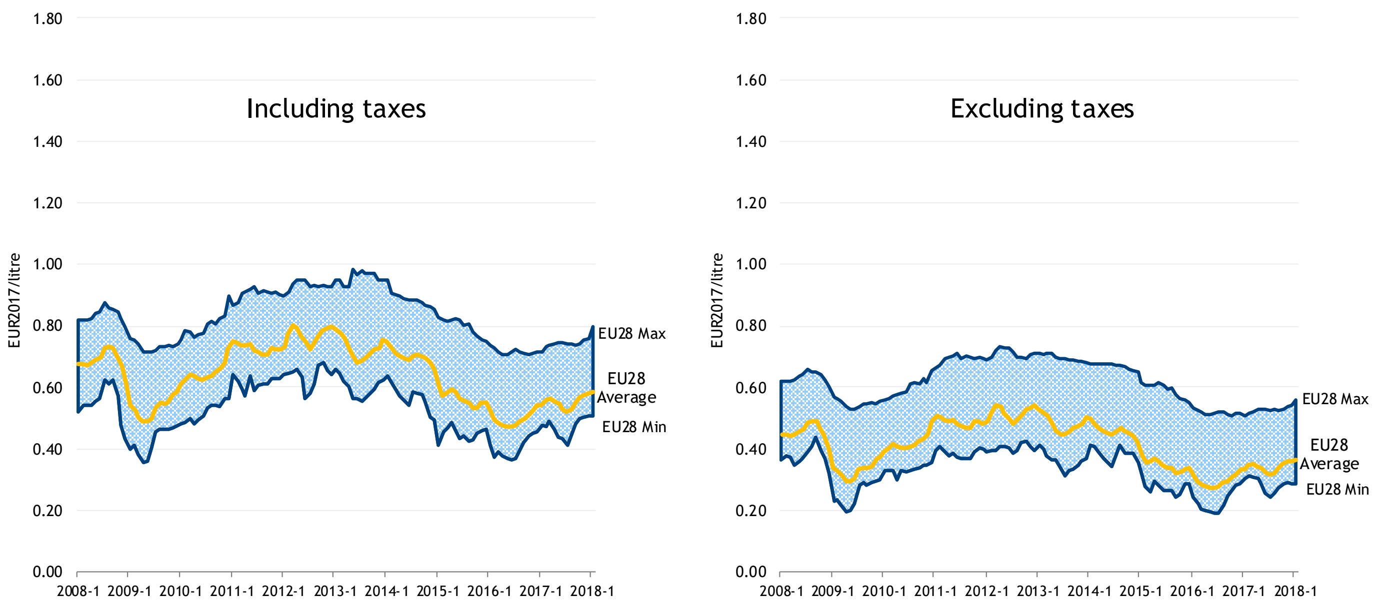
Retail – LPG

The following figures, Figure 3-46 and Figure 3-47, present the time series of available price data for the EU28 and G20 countries from 2008-2018.

Conclusions that can be drawn from this data include:

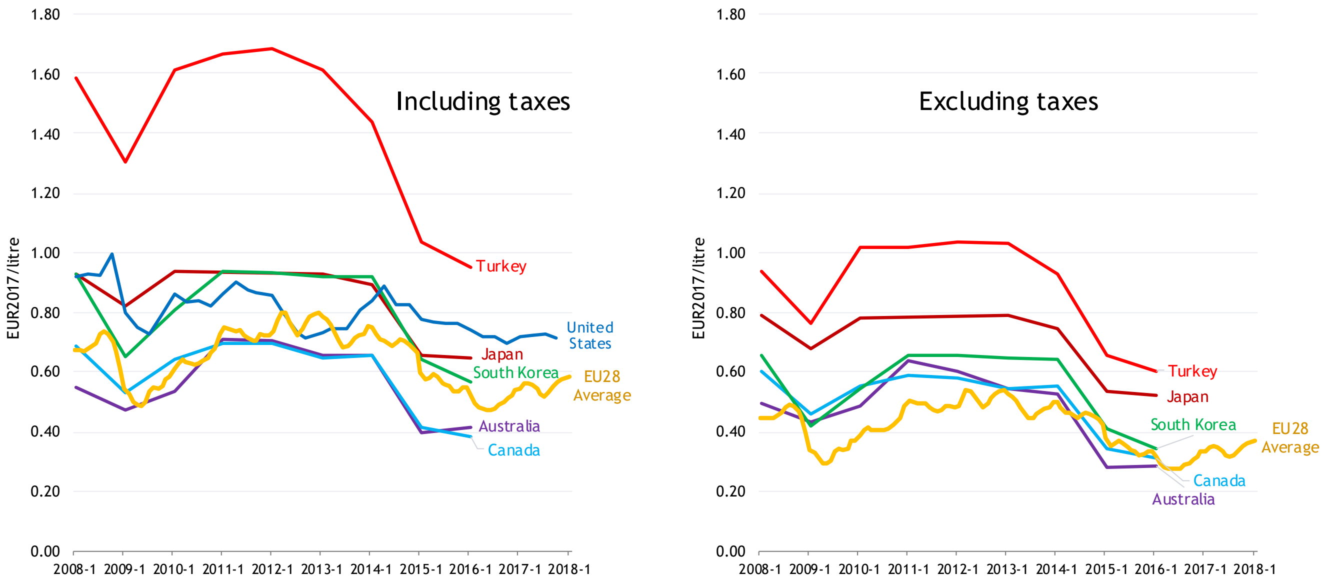
- EU28 average retail prices including taxes have declined from around 0.65 EUR/litre in 2008 to slightly below 0.60 EUR/litre in 2018 (although prices increased between 2009 and 2013 and again since 2016). Excluding taxes, we find price levels excluding taxes, mirror this price decline, moving from 0.45 EUR/litre in 2008 to around 0.35 EUR/litre at the beginning of 2018. Taxes on LPG form around 35% of the total price on average, a lower rate than for petrol or diesel;
- Prices including and excluding taxes the other G20 countries (AU, CA, JP, KR, TR, US) follow similar overall trends to the EU average;
- For prices including taxes it is notable that prices in TR are significantly higher than the EU average, although these have been converging since 2012. Prices in the US are typically higher than the EU average. Whilst prices in JP and KO are very similar to EU28 average levels, prices in AU and CA are generally lower than the EU28 average;
- Excluding taxes we find EU prices very similar to those in South Korea, Canada and Australia. Prices in Turkey and Japan are higher than the EU. It was not possible to find US LPG tax data, but based on other fuels it is feasible that tax rates are around 25% and therefore also comparable to EU levels, when taxes are excluded.

Figure 3-46: LPG: retail prices EU28, 2008-2018, EUR_{2017}/litre



Source: Own calculations based on data from EU Oil Bulletin

Figure 3-47: LPG: retail prices EU28 and other G20 countries, 2005-2018, EUR$_{2017}$/litre



Source: Own calculations based on data from EU Oil Bulletin, IEA, US AFDA

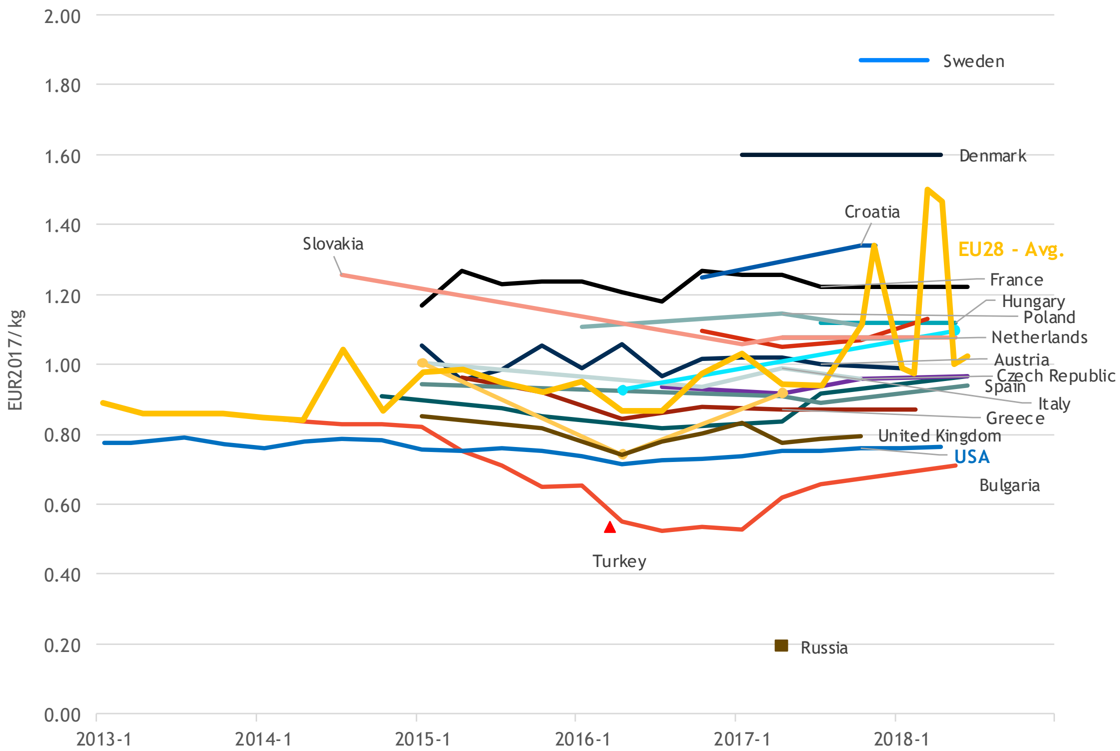
Retail - CNG

Retail CNG prices are available to some extent within the EU28 although only unofficial sources are available and therefore the quality of the price data cannot be guaranteed. Amongst G20 countries only data for the US was found as time series, with single data points for Russia and Turkey. The price data that is available is presented in Figure 3-48.

Conclusions that can be drawn from this data include:

- EU28 (simple) average prices have trended slowly upwards over time, but the volatility that is visible is related to the availability of prices from a particular country in a period rather than real volatility in price movements, as CNG prices tend to be quite stable;
- CNG prices in the US tend to be lower than EU prices but relatively stable over time. Lower prices are likely to be driven by lower US wholesale natural gas prices resulting from higher domestic natural gas production (shale gas);
- The price point data from Turkey and Russia suggests very low CNG prices, in Russia this is consistent with low prices for energy and fuels in general.

Figure 3-48: CNG: retail prices EU28 Member States, USA, Turkey, Russia, 2013-2018, EUR2017/kg



Source: Own calculations based on data from CNG Europe, US AFDA

Retail - LNG

No data on LNG prices in the EU28 or G20 was found, markets for this emerging fuel are not yet mature enough to publish sufficient price data.

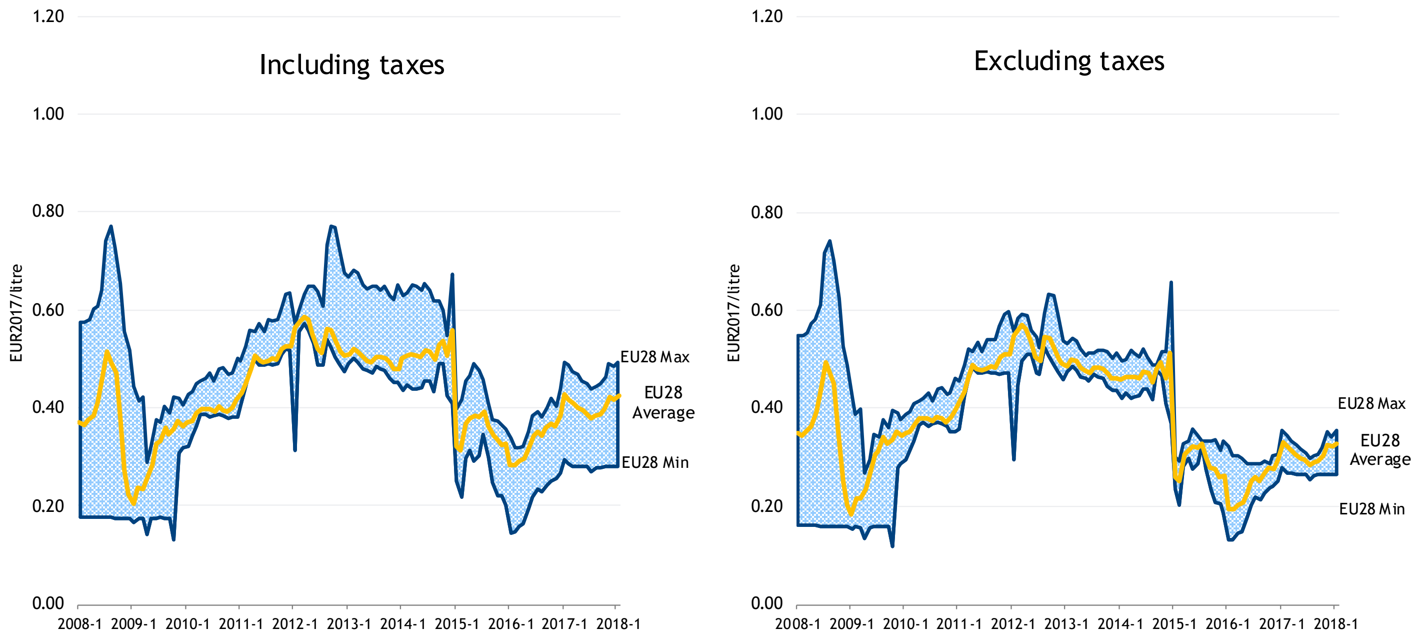
Retail - Fuel oil (high sulphur)

There is relatively comprehensive information in the EU oil bulletin for the EU28 countries, however prices are scarce outside the EU28, with the exception of countries covered by the IEA (CA, JP, KO, MX, TR, USA). The following figures, Figure 3-49 and Figure 3-50, present the time series of available price data for the EU28 average and G20 countries from 2008-2018.

Conclusions that can be drawn from this data include:

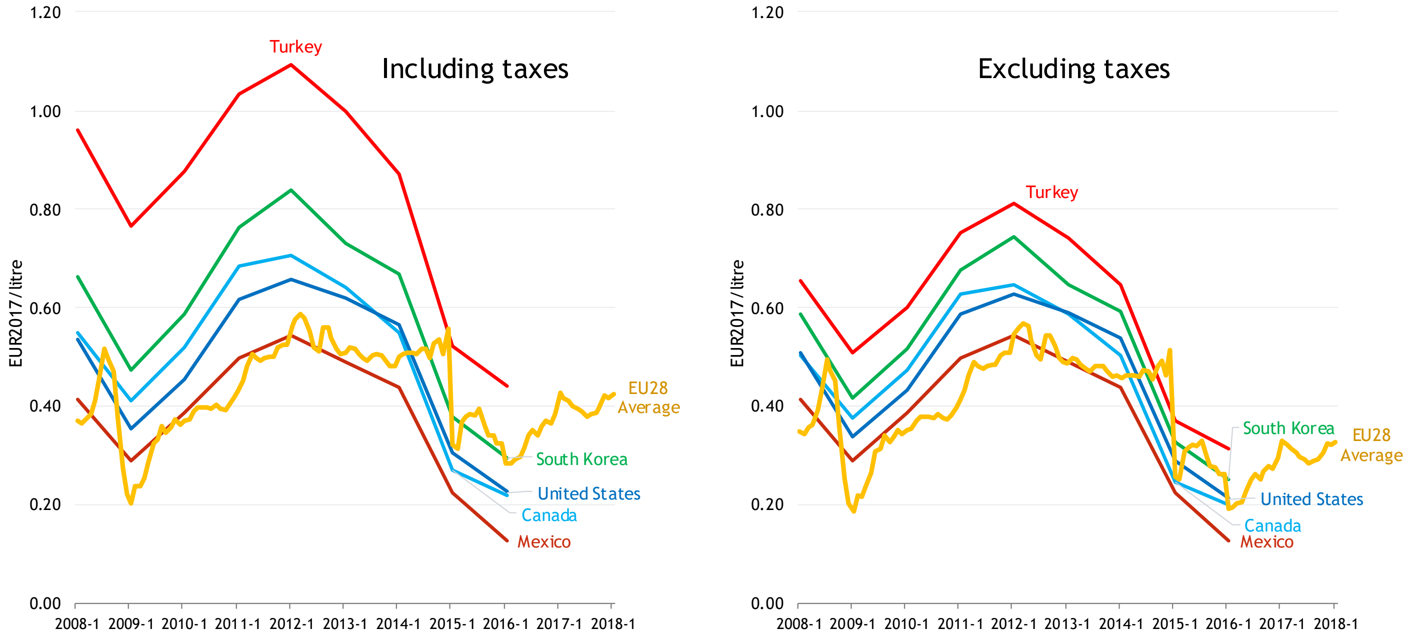
- EU28 average prices including taxes in 2018 have increased by around 10% compared to those in 2008, with prices ending at around 0.40 EUR/litre. Observed short term volatility corresponds quite closely to movements in global crude oil prices. Prices excluding taxes are only a little lower than tax inclusive prices, signalling that the tax rates on this fuel are relatively low, with tax forming 10% or less of the price;
- Prices in other G20 countries (CA, MX, TR, KR, US) show similar trends, and prices both including and excluding taxes are close to EU28 average levels, although in 2014-2015 many of these prices switched from being higher than the EU average to lower than the EU average. Prices in TR are somewhat higher than the EU28 average levels (although they have converged since 2012), with higher taxes being one of the major factors in this.

Figure 3-49: Fuel oil (>1% [high] sulphur content): retail prices EU28 2008-2018, EUR2017/t



Source: Own calculations based on data from EU Oil Bulletin

Figure 3-50: Fuel oil (>1% [high] sulphur content): retail prices EU28 and G20 countries 2008-2018, EUR2017/t



Source: Own calculations based on data from EU Oil Bulletin, IEA

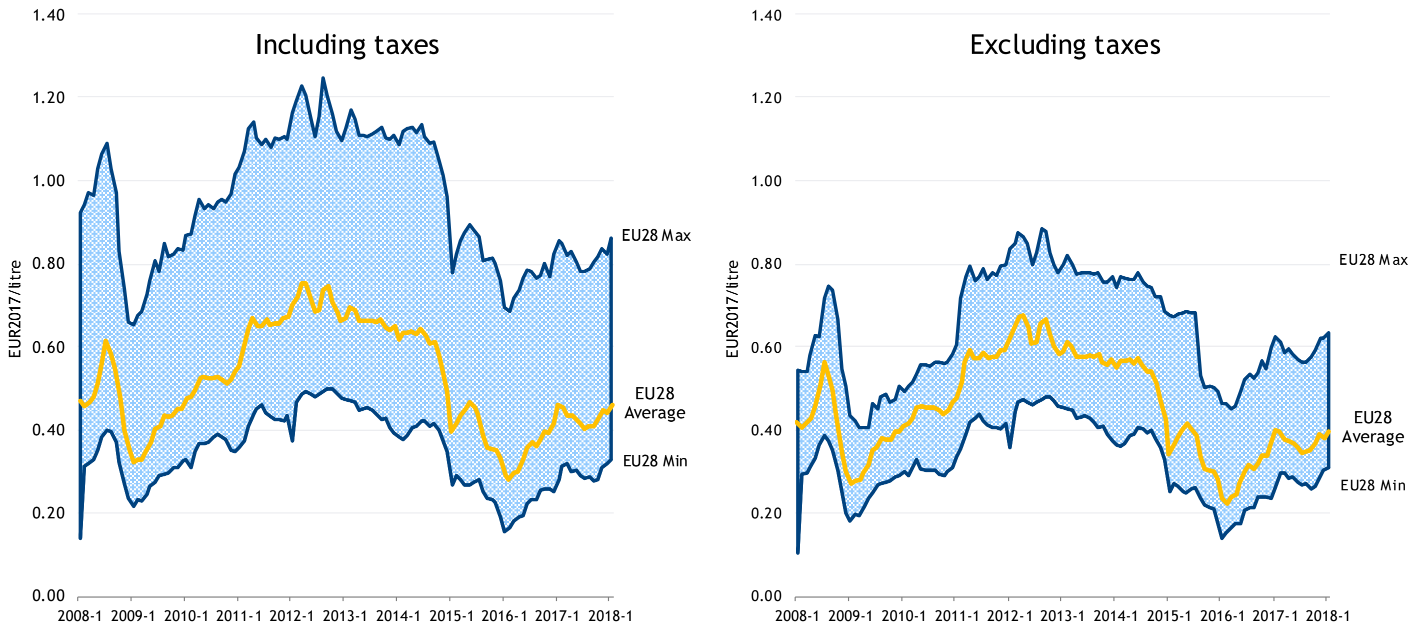
Retail - Fuel oil (low sulphur)

There is relatively comprehensive information in the EU oil bulletin for the EU28 countries, however prices are scarce outside the EU28, with the exception of countries covered by the IEA (JP and KO). The following figures, Figure 3-51 and Figure 3-52, present the time series of available price data for the EU28 average and G20 countries from 2008-2018.

Conclusions that can be drawn from this data include:

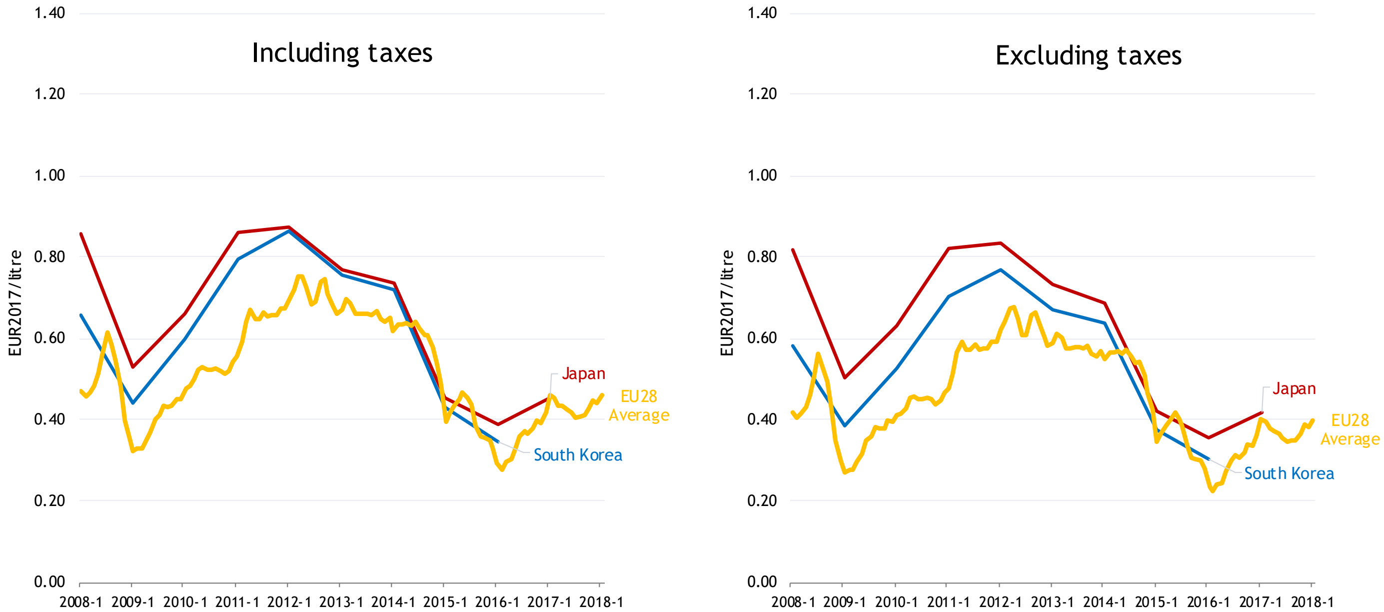
- Similar to high sulphur content fuel oil, EU28 average prices including taxes for low sulphur fuel oil are at a similar level in 2018 as in 2008 at around 0.45 EUR/litre. The observed trend corresponds quite closely to movements in global crude oil prices. Prices excluding taxes are a little lower, again signalling the relatively low tax levels compared to fuels such as petrol and diesel;
- Prices in other G20 countries (JP, KR) are very close to EU28 average levels and mirror the price trends.

Figure 3-51: Fuel oil (<1% [low] sulphur): retail prices 2008-2018, EUR2017/t



Source: Own calculations based on data from EU Oil Bulletin

Figure 3-52: Fuel oil (<1% [low] sulphur): retail prices EU28 and G20 countries 2008-2018, EUR2017/t



Source: Own calculations based on data from EU Oil Bulletin, IEA

Retail - Heating oil

Retail heating oil prices are relatively comprehensive for the EU28, from the information in the EU Oil Bulletin. Price data for heating oil was found for G20 countries covered by the IEA (CA, JP, KR, TR, USA). The following figures,
Figure 3-53, and Figure 3-54, present the time series of available price data for the EU28 average, minimum and maximum from 2008-2018 as well as for the G20 countries.

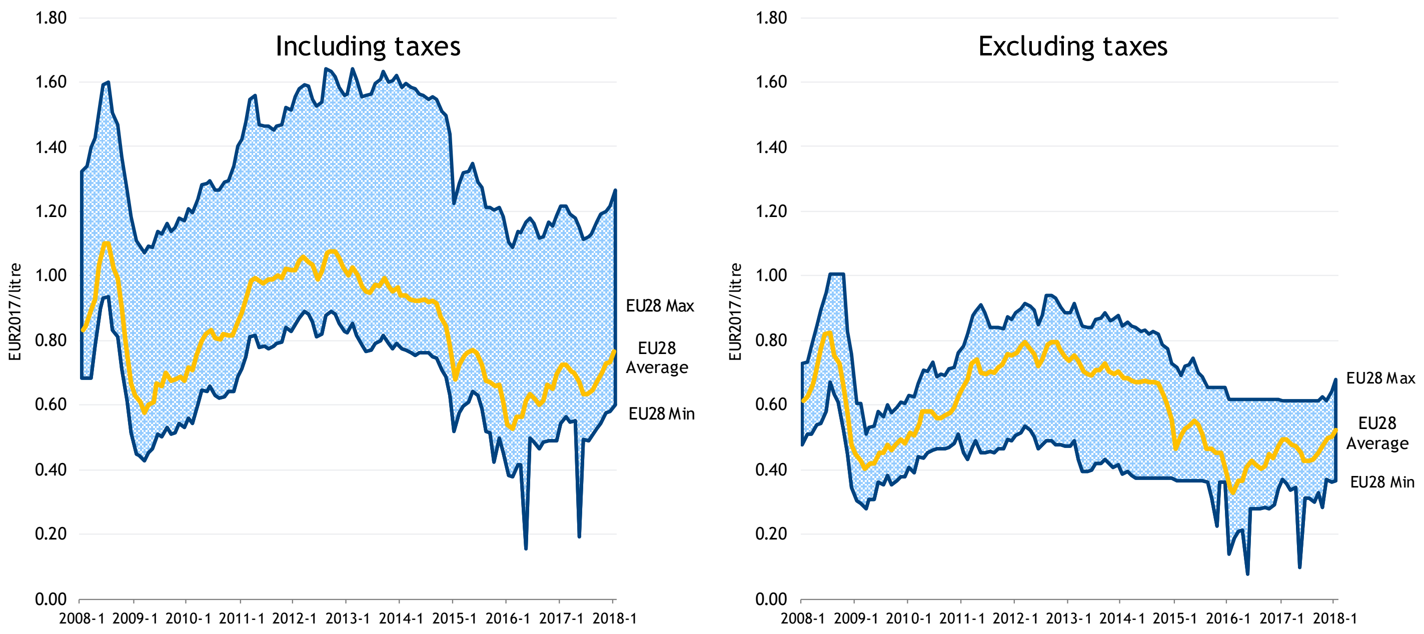
Specific assumptions relating to this dataset include:

- In the IEA dataset light fuel oil for residential use is equivalent to heating oil in the EU Oil Bulletin.

Conclusions that can be drawn from this data include:

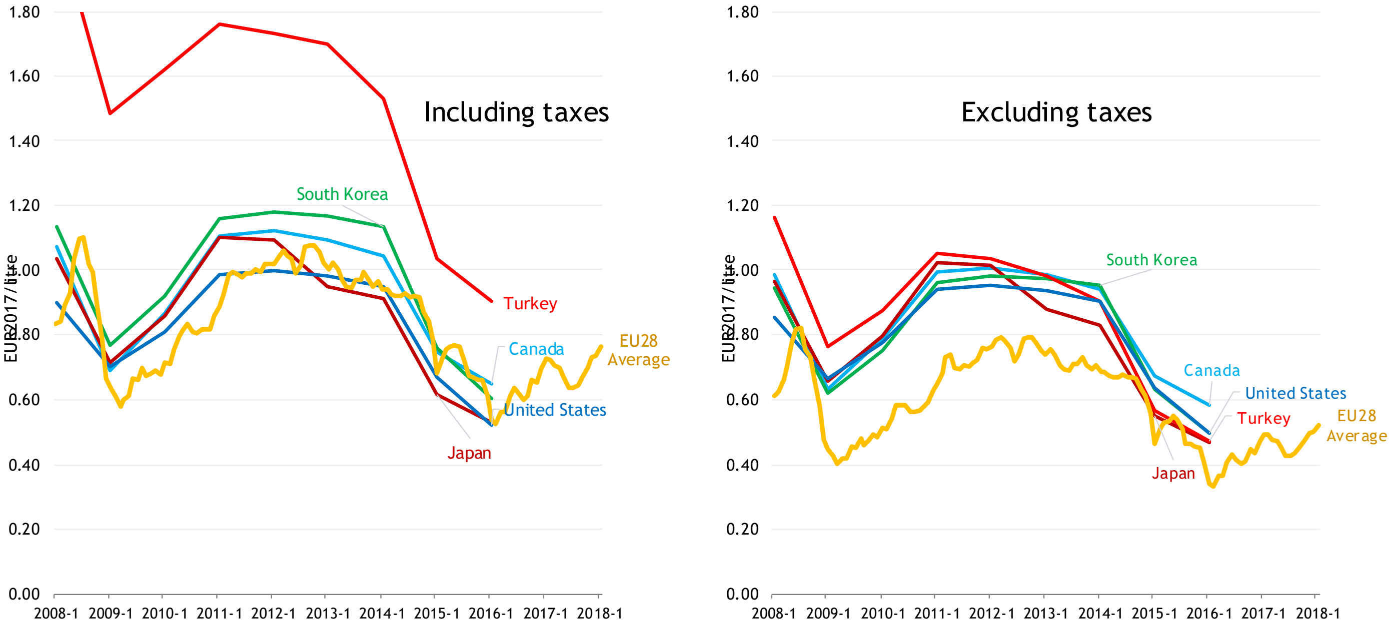
- EU28 average prices for heating oil including taxes have decreased a little over the period 2008-2018 from around 0.85 EUR/litre to almost 0.75 EUR/litre. The observed short term volatility corresponds quite closely to movements in global crude oil prices. Prices excluding taxes are around 0.20 EUR/litre lower than prices including taxes, highlighting tax rates of 20-30% in most EU countries. The graphs highlight relatively high levels of tax prices in some EU countries (namely DK, IT, SE, PT);
- Prices levels and movements in CA, JP, KR and the US very closely match those of the EU28 average both including and excluding taxes. Prices in TR including taxes are by far the highest of all countries, although these have been decreasing since 2011 and particularly from 2014, the prices are converging with those of the EU28 average prices and other G20 countries. Excluding taxes the EU28 average price is the lowest of all countries for which there is data.

Figure 3-53: : Heating oil: retail prices EU28, 2008-2018, EUR$_{2017}$/litre



Source: Own calculations based on data from EU Oil Bulletin

Figure 3-54: Heating oil: retail prices, EU28 and G20 countries 2008-2018, EUR_{2017}/litre



Source: Own calculations based on data from EU Oil Bulletin, IEA

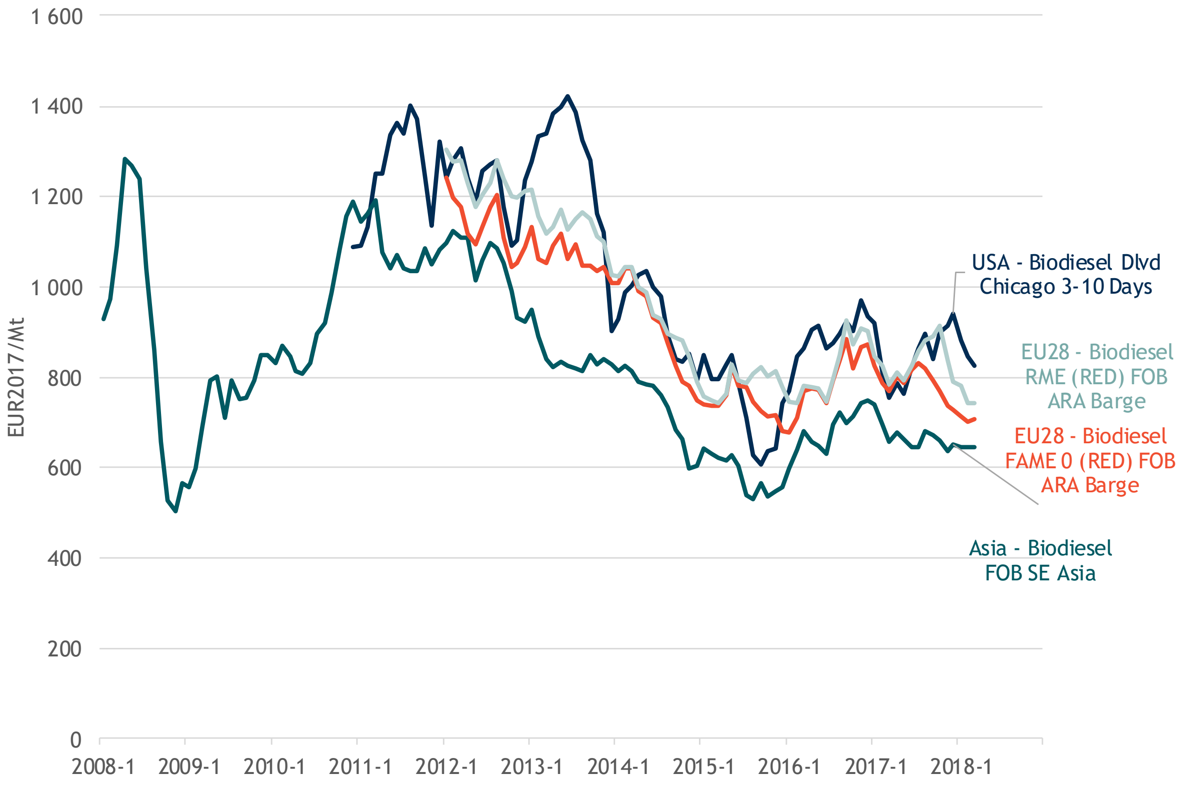
Wholesale - Biofuel

Wholesale biofuels data has proved limited, with access to international and EU price indicators available only through the Platts Biofuelscan dataset. The price data provided through this source is presented within which we provide a split between biodiesel and ethanol and series for the EU, Asian and US markets.

Conclusions that can be drawn from this data include:

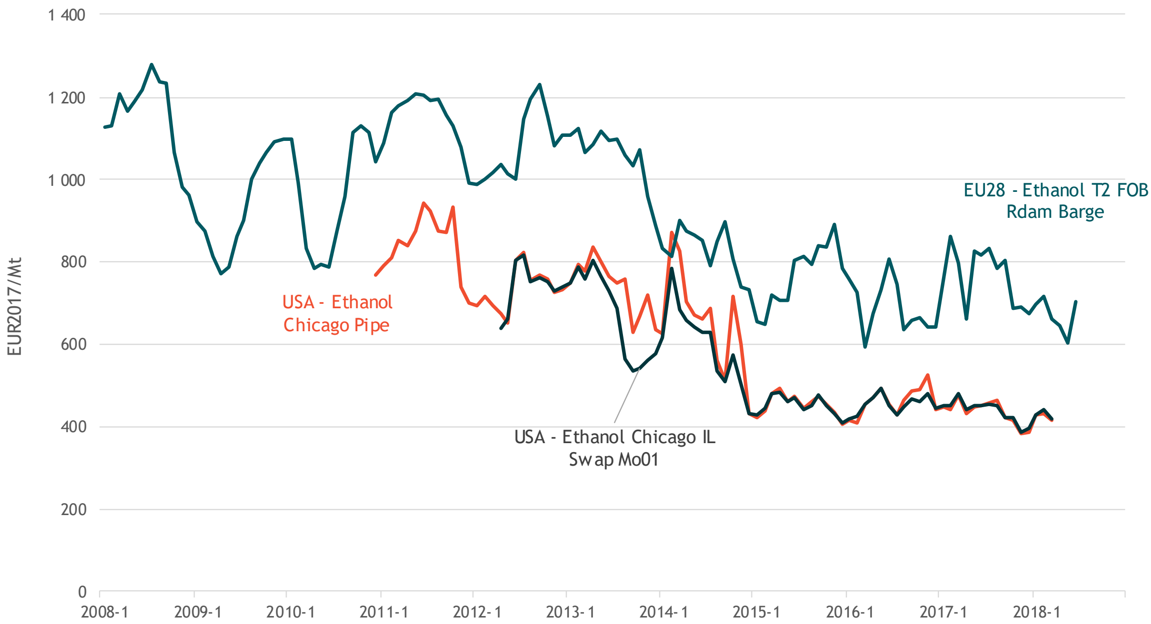
- Prices for biodiesel (see Figure 3-55) are lowest in the Asian market, whilst EU28 and US price levels are similar. The price trends are similar across all markets, signalling the links between the three. US prices show greater volatility than the other series. It is notable that since 2011 prices have significantly declined from around 1 200 EUR/Mt to around 800 EUR/Mt in 2018 as supply has increased;
- Prices for ethanol (see Figure 3-56) were available for two price series in the US market and one EU price series, the Rotterdam benchmark. The US series show almost identical trends and notably, a halving of prices between 2011 and 2018. The EU price series also displays a similar significant price decline over the period, but EU prices remain higher than US prices, the difference most likely explained by higher transport costs to bring ethanol to EU markets from major global producers (US and Brazil).

Figure 3-55: Biodiesel: wholesale prices, 2008-2018, EUR2017/Mt



Source: Own calculations based on data from Platts

Figure 3-56: Ethanol, wholesale prices, 2008-2018, EUR2017/Mt



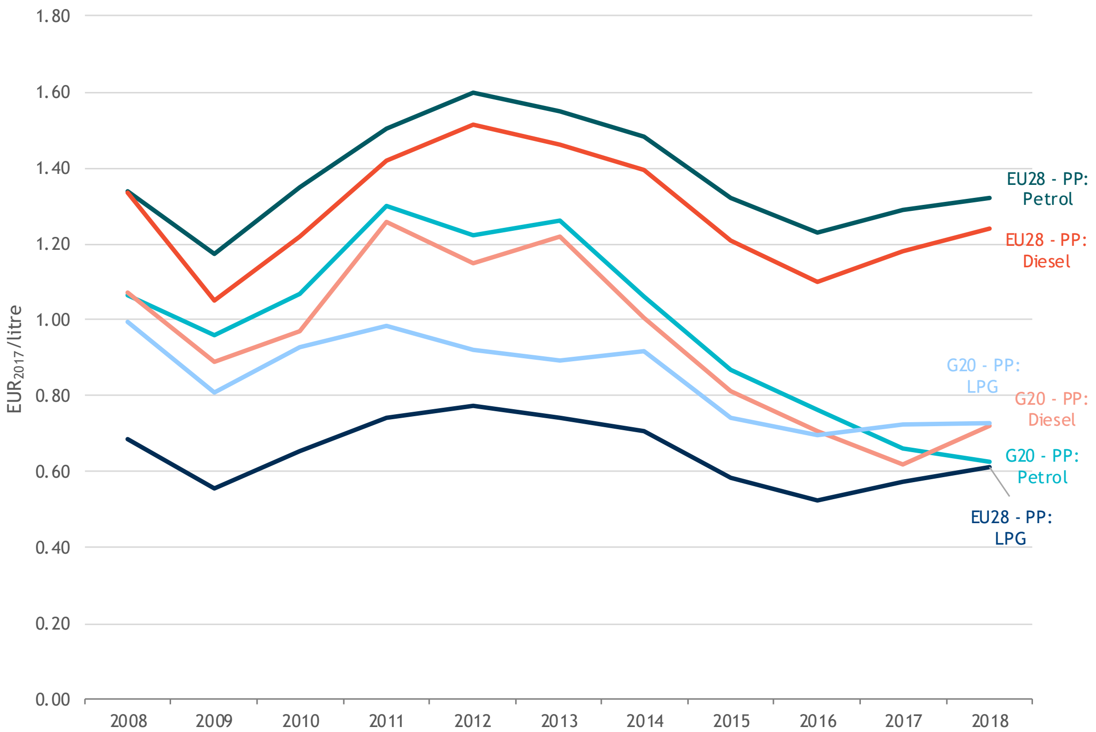
Source: Own calculations based on data from Platts

Summary of petroleum product price analysis

Our analysis of petroleum (and natural gas) products prices in the EU28 and main trading partners in the G20, is summarised in Figure 3-57, and the analysis as a whole found that has found that:

- EU28 prices, particularly for conventional automotive fuels (**petrol, diesel**), tend to be higher than in other G20 countries, highly driven by differences in taxes. Excluding taxes, EU28 average prices are comparable or lower than most G20 countries for petrol and diesel;
- EU28 **LPG** prices are amongst the lowest internationally both including and excluding taxes, part of the reason is a relatively low level of tax levied on this fuel in the EU, particularly in comparison to levels on petrol and diesel;
- For **CNG** price data is limited for the G20, but comparison to the United States suggests EU prices are on average higher than US levels. EU prices have tended not to change significantly between 2013 and 2018;
- For **high and low sulphur fuel oils** (primarily for marine transport) EU prices are also comparable or amongst the lowest of all prices internationally. Relatively low taxes in the EU are also evident. This is logical considering the greater ease, compared to road transport, with which shipping can refuel in lower cost jurisdictions;
- For **heating oil** EU28 average prices are amongst the lowest in the G20 both including and excluding taxes, although in a handful of EU countries (DK, SE, IT, PT) high taxes lead to relatively high prices;
- EU **ethanol** prices are higher than their US equivalents, but EU **biodiesel** prices are similar to comparable US and Asian benchmarks;
- Prices in all countries for oil-derived fuels tend to follow the crude oil price trend.

Figure 3-57: Comparison of EU28 weighted average prices with G20 (trade) weighted average prices



Source: Own calculations

Note: the G20 weighted averages are calculated on the basis of all available price data for a particular year, weighted in the total price by the share a country had in EU imports+exports 2014-2016 (see Table 4-1). Coverage ratios of total trade range from 36-100% (petrol prices), 28-100% (diesel prices) and 16-21% (LPG prices).

4 Task 2 - Analysis of energy costs for industry in the EU and major trading partners

4.1 Our approach and methodology

The aim of this task was to assess the energy costs and prices for industry in the EU and major trading partners. The task was based on the approach adopted in the previous study "Prices and costs of EU Energy - Ecofys BV (2014)"[24], updating the information with latest data and enlarging the analysis with additional sectors for the NACE C section (e.g. manufacturing sector) and some other NACE sections following the latest EUROSTAT classification[25] (NACE A: Agriculture, forestry and fishing; B: Mining and quarrying; D: Electricity, gas, steam and air-conditioning supply; E: Water supply, sewerage, water management and remediation activities; F: construction; G: Wholesale and retail trade; H: Transportation and retail trade).

4.1.1 Scoping of countries

Data was collected for all EU28 countries, Norway, Switzerland and major EU trading partners, for the period between 2008 and the most recent available year.

Among the G20 trading partners selected, a greater emphasis was placed on the following key EU trading partners (see Table 4-1):

- USA and China, that each contribute to more than 20% of the EU trade with G20 countries (identified in orange in the table below);
- Russia, Turkey, Japan, South Korea and India, that each contribute to more than 3% of EU trade with G20 countries (identified in bold in the table below);
- Switzerland and Norway as these two countries are the countries with the third and sixth largest trading volume with the EU[26]

Table 4-1: Trade volume of G20 countries with the EU (average 2014-2016)

Partner	Import + Export value (Average 2014-2016, € million)	Share (%)
United States	585,128	28%
China	500,980	24%
Russia	**228,976**	**11%**
Turkey	**138,147**	**7%**
Japan	**116,971**	**6%**
South Korea	**85,955**	**4%**
India	**75,815**	**4%**
Brazil	64,771	3%
Canada	62,289	3%
Saudi Arabia	59,389	3%
Mexico	51,101	2%
South Africa	44,188	2%
Australia	41,777	2%
Indonesia	24,785	1%
Argentina	16,638	1%
Total G20	2,096,911	100%

[24] https://ec.europa.eu/energy/en/studies/prices-and-costs-eu-energy-%E2%80%93-ecofys-bv-study
[25] Eurostat classification NACE Rev 2
http://ec.europa.eu/eurostat/ramon/nomenclatures/index.cfm?TargetUrl=LST_NOM_DTL&StrNom=NACE_REV2&StrLanguageCode=FR
[26] The 2014-2016 average trade volumes of the EU with Switzerland and Norway are respectively €251,233 million and €123,304 million.

Source: Own calculation based on data from Comext

4.1.2 Scoping of sectors

For the analysis, we have selected 30 sectors at NACE 2 and NACE 3-digit level for section C (Manufacturing) and 15 sectors at NACE 1 or 2-digit level for the other sections.

Table 4-2 below shows the selected sectors, while the criteria for their selection and the assessment can be found in section 4.2.

Table 4-2: The 45 sectors selected for the analysis

Section	Code	Description
A - Agriculture, forestry and fishing	A	Agriculture, forestry and fishing
B - Mining and quarrying	B	Mining and quarrying
	B06	Extraction of crude petroleum and natural gas
	B07	Mining of metal ores
	B08	Other mining and quarrying
C - Manufacturing	C103	Processing and preserving of fruit and vegetables
	C106	*Manufacture of grain mill products, starches and starch products*
	C11	Manufacture of beverages
	C132	*Weaving of textiles*
	C161	*Sawmilling and planning of wood*
	C171	*Manufacture of pulp, paper and paperboard*
	C172	Manufacture of articles 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*
	C206	*Manufacture of man-made fibres*
	C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
	C222	Manufacture of plastics products
	C231	*Manufacture of glass and glass products*
	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*
	C239	Manufacture of abrasive products and non-metallic mineral products n.e.c.
	C241	*Manufacture of basic iron and steel and of ferro-alloys*
	C244	*Manufacture of basic precious and other non-ferrous metals*
	C245	Casting of metals
	C25	Manufacture of fabricated metal products, except machinery and equipment
	C26	Manufacture of computer, electronic and optical products
	C27	Manufacture of electrical equipment
	C28	Manufacture of machinery and equipment n.e.c.
	C29	Manufacture of motor vehicles, trailers and semi-trailers
	C30	Manufacture of other transport equipment
	C32	Other manufacturing
	C33	Repair and installation of machinery and equipment
D – Electricity, gas, steam and air-conditioning supply	D35	Electricity, gas, steam and air conditioning supply

Section	Code	Description
E - Water supply, sewerage, water management and remediation activities	E38	Waste collection, treatment and disposal activities; materials recovery
F - Construction	F	Construction
G - Wholesale and retail trade	G	Wholesale and retail trade
H - Transportation and storage	H49	Land transport and transport via pipelines
	H51	Air transport
I - Accommodation and food service activities	I	Accommodation and food service activities
J - Information and communication	J	Information and communication
M - Professional, scientific and technical activities	M	Professional, scientific and technical activities
N - Administrative and support service activities	N	Administrative and support service activities

Italic blue: Sectors analysed in the previous study

4.1.3 Scoping of data

10 data series on energy costs and their drivers have been collected for each country to be able to analyse the energy costs for industry. They correspond to the following data:

- Purchases of energy products in million EUR (€ m);
- Personnel costs in million EUR (€ m);
- Total purchases of goods and services in in million EUR (€ m);
- Gross operating surplus in in million EUR (€ m);
- Value added (at factor cost) in in million EUR (€ m),Production value in million EUR (€ m);
- Energy consumption split by fuel: total, coal, oil, gas, electricity, other in million tons of oil equivalent[27] (Mtoe);
- Energy prices (excluding VAT and recoverable taxes for electricity and gas; excluding taxes for oil and coal[28]);
- Inflation rates;
- Exchange rates.

4.2 Data collection

The data collection was made in four steps as described below:

1. A data availability review;
2. The scoping of sectors;
3. The integration of the data in the Excel tool;
4. Data gaps management.

4.2.1 Data availability review

A comprehensive data availability review was made for EU, Norway, Switzerland and G20 countries. It consisted mainly of a screening of international and national sources and leveraging our expert network for insights.

[27] By using the International Energy Agency conversion coefficients
[28] Since recoverable taxes are not a cost for the industry, prices used should exclude them. For oil and coal, prices excluding VAT are not available.

The screening was made via the websites of international sources (OECD-Structural Business Statistics (SBS)[29], Eurostat SBS[30], IHS[31]), National Statistical Offices (NSO), National Banks, Energy Ministries and Economy/Industry Ministries, EU project such ODYSSEE-MURE[32].

4.2.2 Scoping of sectors

The selection of sectors was based on the criteria of most relevance at the total EU level (size of sector, importance of energy costs, trade exposure) and the availability of data in the EU and internationally.

Relevance of a sector

Three indicators have been used to represent the relevance of a sector:

1) The energy cost per production value, calculated by dividing expenses for energy by the total production value of each sector[33];
2) Economic relevance calculated as the share of sectoral value added in GDP of the country;
3) The trade intensity, calculated by dividing the total sum of imports and exports of a product to and from the EU, by the size of the EU market, as represented by the sum of EU production value and imports.

Scoping of section C

The scoping for section C involved a mix of 30 groups at NACE 3-digit and NACE 2-digit level, selected in 3 steps:

1. 15 sectors already covered in the previous study;
2. Addition of 5 sectors with the highest energy intensity, trade intensity >10% and with a share of value added in GDP >0.02%[34];
3. Addition of 10 sectors at NACE 2-digit level with sufficient data coverage to allow a detailed analysis of the energy costs.

Scoping of sections A, B, D-H

Six of the selected NACE 2-digit sectors, within sections A,B, D-H, correspond to the criteria used during the previous study and are based on energy intensity above 3% or 0.05 ktoe/€, trade intensity of more than 3% and a share of GDP greater than 0.02%.

8 sectors of the sections A, B, D to H, at NACE 2-digit level were added to the selection due to their strategic economic importance, the available data and to improve the coverage of an economy (for sectors which do not belong to industry).

Table 4-3 and Table 4-4 present the selected sectors and the criteria assessment previously described.

29 https://stats.oecd.org/Index.aspx?DataSetCode=SSIS_BSC
30 http://ec.europa.eu/eurostat/web/structural-business-statistics
31 https://ihsmarkit.com/research-analysis/energy.html
32 http://www.odyssee-mure.eu/
33 Due to a lack of energy cost data at EU level for level A and G to S, indicator 1) could not be calculated. For these sectors the importance of energy costs was estimated by assessing the energy intensity level (energy consumption/value added) instead.
34 Referring to in Article 11 of the energy taxation Directive, where either the purchases of energy products and electricity amount to at least 3,0 % of the production value or the national energy tax payable amounts to at least 0,5 % of the added value.

Table 4-3: Sector scope of the analysis for sector C (manufacturing)

Selected sectors	Code	NACE 1	Name 1	NACE 2	Name 2	NACE 3	Name 3	NACE 4	Name 4	Energy Intensity based on cost data (%)	VAD/GDP (%)	Trade intensity (%)	Countries for which		Countries for which Energy	
													EU28	Other	EU28	Other
Y2	C103	C	Manufacturing	C10	Manufacture of food products	C103	Processing and preserving of fruit and vegetables			2,9%	0,10%	13%	AT, BE, BG,	NO, JP, KR,	DE, NL	CA, US
Y1	C106	C	Manufacturing	C10	Manufacture of food products	C106	Manufacture of grain mill products, starches and s			3,6%	0,06%	13%	AT, BE, BG,	NO, JP, KR,	DE, NL	US
Y3	C11	C	Manufacturing	C11	Manufacture of beverages					1,7%	0,28%	12%	AT, BE, BG, C	NO, JP, KR, T	AT, DE, FI, NI	CA, CN, MX, US
Y1	C132	C	Manufacturing	C13	Manufacture of textiles	C132	Weaving of textiles			3,1%	0,03%	27%	AT, BE, BG,	NO, JP, KR,	DE	US
Y1	C161	C	Manufacturing	C16	Manufacture of wood and of products of wood and cork, ex	C161	Sawmilling and planing of wood			3,4%	0,05%	8%	AT, BE, BG,	NO, JP, KR,	DE	CA, US
Y1	C171	C	Manufacturing	C17	Manufacture of paper and paper products	C171	Manufacture of pulp, paper and paperboard			10,3%	0,12%	15%	AT, BE, BG,	NO, JP, KR,	DE	CA, US
Y2	C172	C	Manufacturing	C17	Manufacture of paper and paper products	C172	Manufacture of articles of paper and paperboard			2,9%	0,19%	10%	AT, BE, BG,	NO, JP, KR,	DE	CA
Y1	C192	C	Manufacturing	C19	Manufacture of coke and refined petroleum products	C192	Manufacture of refined petroleum products			1,7%	0,10%	25%	AT, BE, BG,	JP, KR	DE, NL	CA, US
Y1	C201	C	Manufacturing	C20	Manufacture of chemicals and chemical products	C201	Manufacture of basic chemicals, fertilisers and nit			6,4%	0,47%	26%	AT, BE, BG,	NO, JP, KR,	DE, NL	US
Y1	C206	C	Manufacturing	C20	Manufacture of chemicals and chemical products	C206	Manufacture of man-made fibres			7,1%	0,02%	36%	AT, BE, CY,	JP, KR	DE	CA, CN, US
Y3	C21	C	Manufacturing	C21	Manufacture of basic pharmaceutical products and pharma					1,1%	0,62%	48%	AT, BE, BG, C	NO, JP, KR, T	AT, DE, FI, LV	CA, CN, US
Y2	C222	C	Manufacturing	C22	Manufacture of rubber and plastic products	C222	Manufacture of plastics products			2,8%	0,46%	14%	AT, BE, BG,	NO, JP, KR,	DE	CA, CN
Y1	C231	C	Manufacturing	C23	Manufacture of other non-metallic mineral products	C231	Manufacture of glass and glass products			8,7%	0,11%	14%	AT, BE, BG,	NO, JP, KR,	DE, FR, HR,	CA, MX, US
Y1	C232	C	Manufacturing	C23	Manufacture of other non-metallic mineral products	C232	Manufacture of refractory products			5,9%	0,01%	22%	AT, BE, BG,	NO, JP, KR,	DE	
Y1	C233	C	Manufacturing	C23	Manufacture of other non-metallic mineral products	C233	Manufacture of clay building materials			12,1%	0,04%	14%	AT, BE, BG,	JP, KR, TR	DE, NL	
Y1	C234	C	Manufacturing	C23	Manufacture of other non-metallic mineral products	C234	Manufacture of other porcelain and ceramic produ			5,4%	0,03%	31%	AT, BE, BG,	NO, JP, KR,	DE	
Y1	C235	C	Manufacturing	C23	Manufacture of other non-metallic mineral products	C235	Manufacture of cement, lime and plaster			15,5%	0,05%	5%	AT, BE, BG,	JP, KR, TR	AT, BE, CY,	CA, MX, US
Y1	C237	C	Manufacturing	C23	Manufacture of other non-metallic mineral products	C237	Cutting, shaping and finishing of stone			3,5%	0,04%	12%	AT, BE, BG,	NO, JP, KR,	DE	
Y2	C239	C	Manufacturing	C23	Manufacture of other non-metallic mineral products	C239	Manufacture of abrasive products and non-metall			4,9%	0,05%	18%	AT, BE, BG,	NO, JP, KR,	DE	
Y1	C241	C	Manufacturing	C24	Manufacture of basic metals	C241	Manufacture of basic iron and steel and of ferro-a			7,8%	0,16%	23%	AT, BE, BG,	NO, TR	AT, BE, BG,	CA, MX, US
Y1	C244	C	Manufacturing	C24	Manufacture of basic metals	C244	Manufacture of basic precious and other non-ferrc			4,3%	0,12%	32%	AT, BE, BG,	NO, JP, KR,	AT, BE, BG,	CA, US
Y2	C245	C	Manufacturing	C24	Manufacture of basic metals	C245	Casting of metals			5,5%	0,09%	10%	AT, BE, BG,	NO, JP, KR,	DE	CA, US
Y3	C25	C	Manufacturing	C25	Manufacture of fabricated metal products, except machiner					1,9%	1,20%	11%	AT, BE, BG, C	NO, JP, KR, T	AT, DE, EE, FI	NO, CA, CN, US
Y3	C26	C	Manufacturing	C26	Manufacture of computer, electronic and optical products					0,8%	0,56%	40%	AT, BE, BG, C	NO, JP, KR, T	AT, DE, EE, FI	CA, CN, US
Y3	C27	C	Manufacturing	C27	Manufacture of electrical equipment					1,1%	0,64%	27%	AT, BE, BG, C	NO, JP, KR, T	AT, DE, FI, LV	CA, CN, US
Y3	C28	C	Manufacturing	C28	Manufacture of machinery and equipment n.e.c.					1,0%	1,44%	35%	AT, BE, BG, C	NO, JP, KR, T	AT, DE, FI, LV	NO, CA, US
Y3	C29	C	Manufacturing	C29	Manufacture of motor vehicles, trailers and semi-trailers					0,9%	1,20%	33%	AT, BE, BG, C	NO, JP, KR, T	AT, DE, FI, LV	CA, CN, MX
Y3	C30	C	Manufacturing	C30	Manufacture of other transport equipment					0,7%	0,38%	52%	AT, BE, BG, C	NO, JP, KR, T	AT, DE, FI, LV	CA
Y3	C32	C	Manufacturing	C32	Other manufacturing					1,1%	0,32%	37%	AT, BE, BG, C	NO, JP, KR, T	AT, DE, FI, NI	CA
Y3	C33	C	Manufacturing	C33	Repair and installation of machinery and equipment					0,9%	0,45%	18%	AT, BE, BG, C	NO, JP, TR	AT, DE, FI, LV	NO

Source: Own calculations based on data from Eurostat

Note: in blue aggregated sectors (NACE 2)

Table 4-4: Sector scope of the analysis for sector A, B and D to S

Selected sector	Code	NACE 1	Name 1	NACE 2	Name 2	Energy Intensity		VAD/GDP (%)	Trade intensity (%)	Countries for which Energy Costs data is available		Countries for which Energy Consumption data is available	
						Based on cost data (%)	Based on consumption data (ktoe/M€)			EU28	Other	EU28	Other
Y2	A	A	Agriculture, forestry and fishing				0,117			CZ, DK, EE, HR, HU, IE, LU	US, TR, KR, JP, AU	EU28	All countries
Y2	B	B	Mining and quarrying			2,7%	0,156	0,64%	6%	27 countries	US, JP, KR, TR, AU	EU28	All countries
Y2	B06	B	Mining and quarrying	B06	Extraction of crude petroleum and natural gas	0,6%	0,168	0,35%	2%	20 countries	US, JP, KR, TR, AU	EU28	All countries
Y1	B07	B	Mining and quarrying	B07	Mining of metal ores	7,8%		0,05%	23%	23 countries	JP, KR, TR, AU	UK, AT	CN
Y1	B08	B	Mining and quarrying	B08	Other mining and quarrying	7,7%		0,09%	6%	EU28	JP, KR, TR, AU	UK, AT	CN
Y1	D35	D	Electricity, gas, steam and AC suppl	D35	Electricity, gas, steam and air conditioning supp	15,7%	1,632	1,68%	5%	13 countries	US, JP, AU	EU28	All countries
Y1	E38	E	Water supply; sewerage, WM, etc	E38	Waste collection, treatment,etc	3,1%		0,35%	7%	13 countries	US, JP, AU	AT, EE	
Y2	F	F	Construction			1,2%	0,014	3,71%	1%	EU28 except LV & ML	US, TR, AU	EU28	All countries
Y2	G	G	Wholesale and retail trade; etc				0,023	8,84%	29%	EE	US, AU	10 countries	CN
Y1	H49	H	Transportation and storage	H49	Land transport and transport via pipelines		0,736	1,56%	3%	EE	US, AU	EU28	All countries
Y2	I	I	Accommodation and food				0,073	1,61%	0%	EE	US, AU	10 countries	
Y2	J	J	Information and communication				0,015	3,91%	3%		US, AU	AT, CY, EE	
Y2	M	M	Professional, scientific, etc				0,044	4,61%	5%		US, AU	10 countries	
Y2	N	N	Administrative and support service				0,015	3,28%	6%		US, AU	8 countries	

Source: Own calculations based on data from Eurostat

Note : in blue aggregates for non-manufacturing sectors

4.2.3 Data gap management

Data gaps have been managed during the study to improve the data coverage of countries and sectors.

i. Energy costs

For EU countries, energy cost shares (calculated by dividing *purchases for energy* by the *total production value* of each sector) are available from EUROSTAT SBS (code sbs_na_ind_r2) for sections B to F but not for the other sections. For the other sections, the energy costs were estimated as energy consumption multiplied by prices when consumption data and prices data were available. For non-EU countries, energy costs data were collected from national sources by using the same methodology as for EU countries. Where energy costs (purchases of energy) data were not available and consumption and price data were available, energy costs (purchases of energy) were also calculated as energy consumption multiplied by prices.

Energy costs provided by Eurostat only cover the cost of purchased fuels (i.e. mainly natural gas and electricity) and not the self-generated and self-consumed oil and gas (i.e. liquid fuels and fuel gas self-generated in the refining process and used as fuel in the refineries) and feedstocks (e.g. crude oil).

For refineries, feedstock cost is the decisive factor for the total energy costs as suggested in the box text below. In the chemical and petrochemical sectors around 60% of the energy that is used is consumed as feedstock. For specific chemical products such ammonia, methanol, ethylene or propylene industries, the costs of production are very dependent upon the feedstock cost, with this in turn dependent on the fuels used, their prices (i.e. natural gas versus heavy fuel oil for instance), where feedstock are locally produced, and the technologies used. Due to a lack of data on energy consumption and production costs per product in the basic chemicals (which is one target sector of our study), it has not been possible to analyse this sector in more detail. Costs related to basic chemicals in this report only refer to purchased fuel costs and do not include self-produced fuels (Eurostat SBS only takes into account purchases of fuels).

Estimating the full cost ratio in the refineries (C192) sector.

The refining sector was selected as a specific and interesting sector where there are difficulties to estimate comprehensively the impact of the consumption of energy prices on their energy costs.

Eurostat SBS only provides information of the purchase of energy products covering oil products, coal, gas, renewables, electricity and heat[35]. Crude oil is however not part of this category. As crude oil is the most important feedstock for refineries, we have tried to estimate this cost. Costs of feedstocks are estimated by multiplying crude oil and (liquefied) natural gas inputs by the import price of crude oil.

The total energy cost of refineries is the sum of purchase of energy products and feedstock stocks. Energy cost share is then calculated as the ratio "total energy costs / personal costs and total purchase of goods and services". The estimated ratio varied from 50% to 80% on average depending on countries. The result already show the critical relevance of crude oil for refinery costs, but the specific numbers should be taken with care as the data seems to be underestimating the importance of crude oil for refineries in some country (or overestimating it in the case of Japan where feedstocks costs are higher than total purchase of goods and services).

Refineries also consume petroleum products, refinery gas and petroleum coke for its own use. Such products are self-consumed and so far cannot be considered as a cost but almost as 'savings'.
The amount of 'saved' costs from self-consumed fuels have been estimated by multiplying the quantity of self-produced energy (e.g. refinery gas, petroleum coke and fuel oil, diesel and LPG) used by refineries (collected from Eurostat[36]) by the market prices of each product. It should be noted that for refinery gas, we have used natural gas prices for non-households corresponding to the Eurostat upper gas consumption band (I5, >1 000 000 GJ, and <4 000 000 GJ), without recoverable taxes and levies. The estimated monetary amounts from self-generated products only represent a small share in total energy costs which tends to be smaller where products of the prices are lower (particularly as regards gas).

ii. Energy prices

Energy prices are rarely available at the requested level of disaggregation (e.g. at NACE 2 or 3-digit level). When not available, energy prices for each sector were estimated based on:

- The prices per type of consumer;
- An estimation of the average electricity and gas consumption for a typical consumer.

Data sources for energy prices per type of consumer

The data was collected from DG-ENER, Eurostat, the International Energy Agency, CEIC and national sources (see chapter 3 – Task 1 of this report for more details on the price sources).

[35] https://ec.europa.eu/eurostat/cache/metadata/en/sbs_pu_esms.htm
[36] Eurostat public database http://ec.europa.eu/eurostat/data/database , table [nrg102a] on supply, transformation and consumption of oil

Estimation of the average electricity and gas consumption for a typical consumer

The estimation of the average electricity and gas consumption for a typical consumer was calculated as the ratio of the average energy consumption of a sector in the country and the average number of companies with more than 20 employees in a sector in that country.

The allocation of the consumption bands for each sector, the assumed average consumption for a typical consumer and the intermediary data are provided in Table 4-5 and Table 4-6 below for electricity and gas, respectively. The corresponding consumption bands are given in BOX 2.

Table 4-5: Average annual electricity consumption and allocation of Eurostat electricity consumption band by sector

Sector	Country covered	Average electricity consumption Mtoe (2013-2015)	Average number of companies (2013-2015)	Assumed average company electricity consumption [GWh]/year	Eurostat electricity consumption band
C103 - Processing and preserving of fruit and vegetables	DE, NL	0.14	841	1.88	IC
C106 - Manufacture of grain mill products, starches and starch products	DE, NL	0.20	675	3.50	ID
C11 - Manufacture of beverages	AT,DE,FI,NL,SI, UK	0.44	4 546	1.12	IC
C132 - Weaving of textiles	DE	0.03	218	1.83	IC
C161 - Sawmilling and planing of wood	DE	0.10	2119	0.55	IC
C171 - Manufacture of pulp, paper and paperboard	DE	1.32	321	47.95	IE
C172 - Manufacture of articles of paper and paperboard	DE	0.35	1 404	2.87	ID
C192 - Manufacture of refined petroleum products	NL	0.23	42	62.61	IE
C201 - Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms	DE,NL	4.88	1 321	42.94	IE
C206 - Manufacture of man-made fibres	DE	0.09	52	20.33	IE
C21 - Manufacture of basic pharmaceutical products and pharmaceutical preparations	AT,DE,FI,LV,NL, SI,UK	0.43	1 549	3.21	ID
C222 - Manufacture of plastics products	DE	1.01	6 342	1.85	IC
C231 - Manufacture of glass and glass products	DE,FR,HR,NL,PL , PT,SE	5.93	5 533	12.45	ID
C232 - Manufacture of refractory products	DE	0.02	107	1.95	IC
C233 - Manufacture of clay building materials	DE,NL	0.09	281	3.67	ID
C234 - Manufacture of other porcelain and ceramic products	DE	0.03	867	0.39	IB
C235 - Manufacture of cement, lime and plaster	AT,BE,DE,ES,FR, HR,IT,PL,PT,SE	11.62	585	230.9	IG
C237 - Cutting, shaping and finishing of stone	DE	0.01	5 016	0.02	IA

Sector	Country covered	Average electricity consumption Mtoe (2013-2015)	Average number of companies (2013-2015)	Assumed average company electricity consumption [GWh]/year	Eurostat electricity consumption band
C239 - Manufacture of abrasive products and non-metallic mineral products n.e.c.	DE	0.10	456	2.65	ID
C241 - Manufacture of basic iron and steel and of ferro-alloys	AT,BE,BG,CZ,DE, DK,EL,ES,FI,FR, HR,HU,IE,IT,LU, LV,NL,PL,PT,RO ,SE,SI,SK	84.62	2 257	436.0	IG
C244 - Manufacture of basic precious and other non-ferrous metals	AT,BE,BG,CZ,DE ,EE,EL,ES,FI,FR, HR,HU,IT,LV,NL, PL,PT,SE,SI,SK	42.50	2 986	165.5	IG
C245 - Casting of metals	DE	0.49	785	7.26	ID
C25 - Manufacture of fabricated metal products, except machinery and equipment	AT,DE,EE,FI,LV, NL,SI,UK	1.97	94 416	0.24	IB
C26 - Manufacture of computer, electronic and optical products	AT,DE,EE,FI,LV, NL,SI,UK	0.82	17 161	0.56	IC
C27 - Manufacture of electrical equipment	AT,DE,FI,LV,NL, SI,UK	0.87	11 851	0.85	IC
C28 - Manufacture of machinery and equipment n.e.c.	AT,DE,FI,LV,NL, SI,UK	1.42	30 886	0.53	IC
C29 - Manufacture of motor vehicles, trailers and semi-trailers	AT,DE,FI,LV,NL, SI,UK	1.85	6 953	3.09	ID
C30 - Manufacture of other transport equipment	AT,DE,FI,LV,NL, SI,UK	0.31	5 213	0.70	IC
C32 - Other manufacturing	AT,DE,FI,NL,SI, UK	0.26	38 313	0.08	IB
C33 - Repair and installation of machinery and equipment	AT,DE,FI,LV,NL, SI	0.10	27 698	0.04	IB
A - Agriculture, forestry and fishing	DK,NL	0.71	31 486	0.26	IB
B - Mining and quarrying	CY,DE	0.73	1 875	4.55	ID
B06 - Extraction of crude petroleum and natural gas	AT,BG,CZ,DE,EE ,ES,FR,HR,HU, IT,LT,NL,PL,RO, UK	0.58	405	16.56	ID
B07 - Mining of metal ores	AT	0.00	2	4.31	ID
B08 - Other mining and quarrying	AT,DE,UK	0.37	2 735	1.56	IC
D35 - Electricity, gas, steam and air conditioning supply	AT,BE,BG,CY,CZ, DE,DK,EE,EL,ES, FI,FR,HR,HU,IE,I T,LT,LU,LV,MT, NL,PL, PT,RO,SE,SI,SK	16.35	86 168	2.21	ID
E38 - Waste collection, treatment and disposal activities; materials recovery	AT,EE,UK	0.05	6 237	0.10	IB
F - Construction	AT,CY,EE	0.06	50 636	0.01	IA
G - Wholesale and retail trade; repair of motor vehicles and motorcycles	AT,CY,DE,DK,EE ,	14.69	4 509 736	0.04	IB

Sector	Country covered	Average electricity consumption Mtoe (2013-2015)	Average number of companies (2013-2015)	Assumed average company electricity consumption [GWh]/year	Eurostat electricity consumption band
	ES,FR,HR,IT, MT,NL,PT,RO,SE , UK				
H49 - Land transport and transport via pipelines	AT,BE,BG,CY,CZ ,DE,DK,EE,EL,ES ,FI, FR,HR,HU,IE,IT, LT,LU,LV,NL,PL, PT, RO,SE,SI,SK,UK	4.64	931 909	0.06	IB
I - Accommodation and food service activities	AT,CY,DE,DK,EE , ES,FR,HR,IT,MT, NL,PT,RO,SE,UK	6.02	1 491 549	0.05	IB
J - Information and communication	AT,CY,EE	0.06	23 545	0.03	IB
M - Professional, scientific and technical activities	AT,CY,DE,DK,EE , HR,IT,MT,NL, PT,SE,UK	6.13	2 260 636	0.03	IB
N - Administrative and support service activities	AT,CY,DE,DK,EE , HR,IT,MT,NL, PT,RO,SE,UK	2.68	779 338	0.04	IB

Source: Own calculations based on Eurostat, DG-ENER, IEA, CEIC and national sources

Note: Air transport excluded as non-relevant for electricity consumption

Table 4-6: Average annual gas consumption and allocation of Eurostat gas consumption band by sector

Sector	Country covered	Average gas consumption Mtoe (2013-2015)	Average number of companies (2013-2015)	Assumed average firm gas consumption [GWh]/year	Eurostat gas consumption band
C103 - Processing and preserving of fruit and vegetables	DE,NL	0.35	841	4.89	I3
C106 - Manufacture of grain mill products, starches and starch products	DE,NL	0.30	675	5.20	I3
C11 - Manufacture of beverages	AT,DE,NL,SI,UK	0.73	4 452	1.92	I2
C132 - Weaving of textiles	DE	0.03	218	1.38	I2
C161 - Sawmilling and planing of wood	DE	0.00	2 119	0.01	I1
C171 - Manufacture of pulp, paper and paperboard	DE	1.99	321	72.20	I4
C172 - Manufacture of articles of paper and paperboard	DE	0.51	1 404	4.21	I3
C192 - Manufacture of refined petroleum products	NL	0.43	42	119.1	I4
C201 - Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms	DE,NL	10.38	1 321	91.33	I4
C21 - Manufacture of basic pharmaceutical products and pharmaceutical preparations	AT,DE,LV,NL,SI, UK	0.48	1 517	3.65	I3

Sector	Country covered	Average gas consumption Mtoe (2013-2015)	Average number of companies (2013-2015)	Assumed average firm gas consumption [GWh]/year	Eurostat gas consumption band
C222 - Manufacture of plastics products	DE	0.39	6 342	0.71	I2
C231 - Manufacture of glass and glass products	DE,FR,HR,NL,PL,PT,SE	20.27	5 533	42.61	I4
C232 - Manufacture of refractory products	DE	0.09	107	9.34	I3
C233 - Manufacture of clay building materials	DE,NL	0.72	281	29.65	I4
C234 - Manufacture of other porcelain and ceramic products	DE	0.11	867	1.47	I2
C235 - Manufacture of cement, lime and plaster	AT,BE,DE,ES,FR, HR,IT,PL,PT	1.89	569	38.61	I4
C237 - Cutting, shaping and finishing of stone	DE	0.00	5 016	0.00	I1
C239 - Manufacture of abrasive products and non-metallic mineral products n.e.c.	DE	0.16	456	4.14	I3
C241 - Manufacture of basic iron and steel and of ferro-alloys	AT,BE,BG,CZ,DE, DK,EL,ES,FI,FR, HR, HU,IE,IT,LU,LV, NL,PL,PT,RO,SE, SI,SK	108.62	2 257	559.63	I5
C244 - Manufacture of basic precious and other non-ferrous metals	AT,BE,BG,CZ,DE ,EE,EL,ES,FI,FR, HR, HU,IT,LV,NL,PL, PT,SE,SI,SK	20.64	2 986	80.39	I4
C245 - Casting of metals	DE	0.30	785	4.47	I3
C25 - Manufacture of fabricated metal products, except machinery and equipment	AT,DE,EE,LV,NL, SI,UK	1.39	89 814	0.18	I1
C26 - Manufacture of computer, electronic and optical products	AT,DE,EE,LV,NL, SI,UK	0.28	16 594	0.20	I1
C27 - Manufacture of electrical equipment	AT,DE,LV,NL,SI, UK	0.47	11 435	0.48	I2
C28 - Manufacture of machinery and equipment n.e.c.	AT,DE,LV,NL,SI, UK	0.90	29 465	0.36	I2
C29 - Manufacture of motor vehicles, trailers and semi-trailers	AT,DE,LV,NL,SI, UK	1.54	6 707	2.68	I2
C30 - Manufacture of other transport equipment	AT,DE,LV,NL,SI, UK	0.37	4 854	0.89	I2
C32 - Other manufacturing	AT,DE,NL,SI,UK	0.19	37 024	0.06	I1
C33 - Repair and installation of machinery and equipment	AT,DE,LV,NL,SI	0.07	25 039	0.03	I1
A - Agriculture, forestry and fishing					
B - Mining and quarrying	DE	0.44	1 812	2.79	I3
B06 - Extraction of crude petroleum and natural gas	AT,BG,CZ,DE,DK, ES,FR,HR,HU,IT, LT,NL,PL,RO,SI, UK	6.96	415	195.29	I4
B07 - Mining of metal ores					I2

Sector	Country covered	Average gas consumption Mtoe (2013-2015)	Average number of companies (2013-2015)	Assumed average firm gas consumption [GWh]/year	Eurostat gas consumption band
B08 - Other mining and quarrying	AT,DE,UK	0.25	2 735	1.04	I2
D35 - Electricity, gas, steam and air conditioning supply	AT,BE,BG,CZ,DE,DK,EE,EL,ES,FI,FR,HR,HU,IE,IT,LT,LU,LV,NL,PL,PT,RO,SE,SI,SK	73.64	86 111	9.94	I3
E38 - Waste collection, treatment and disposal activities; materials recovery	AT,EE,UK	0.02	6 237	0.03	I1
F - Construction	AT,EE	0.05	43 236	0.01	I1
G - Wholesale and retail trade; repair of motor vehicles and motorcycles	AT,EE	0.07	92 635	0.01	I1
H49 - Land transport and transport via pipelines	AT,EE	0.25	15 416	0.19	I1
I - Accommodation and food service activities	AT,EE	0.06	49 482	0.01	I1
J - Information and communication	AT,EE	0.01	22 492	0.01	I1
M - Professional, scientific and technical activities	AT,EE	0.02	75 447	0.00	I1
N - Administrative and support service activities	AT,EE	0.01	18 765	0.01	I1

Source: Own calculations based on Eurostat, DG-ENER, IEA, CEIC and national sources

Note: Air transport excluded as non-relevant for gas consumption

Box 2 presents the annual consumption bands for electricity and gas as displayed by Eurostat.

For electricity prices:

Electricity households:

Band-DA (Very small): annual consumption below 1 000 kWh

Band-DB (Small): annual consumption between 1 000 and 2 500 kWh

Band-DC (Medium): annual consumption between 2 500 and 5 000 kWh

Band-DD (Large): annual consumption between 5 000 and 15 000 kWh

Band-DE (Very large): annual consumption above 15000 kWh

Electricity industry:

Band-IA: annual consumption below 20 MWh

Band-IB: annual consumption between 20 and 500 MWh

Band-IC: annual consumption between 500 and 2 000 MWh

Band-ID: annual consumption between 2 000 and 20 000 MWh

Band-IE: annual consumption between 20 000 and 70 000 MWh

Band-IF: annual consumption between 70 000 and 150 000 MWh

Band-IG: annual consumption above 150 000 MWh (reported on a voluntary basis)

For gas prices:

Natural gas households:

Band-D1 (Small): annual consumption below 20 GJ

Band-D2 (Medium): annual consumption between 20 and 200 GJ

Band-D3 (Large): annual consumption above 200 GJ

Natural gas industry:

Band-I1: annual consumption below 1 000 GJ

Band-I2: annual consumption between 1 000 and 10 000 GJ

Band-I3: annual consumption between 10 000 and 100 000 GJ

Band-I4: annual consumption between 100 000 and 1 000 000 GJ

Band-I5: annual consumption between 1 000 000 and 4 000 000 GJ

Band-I6: annual consumption above 4 000 000 GJ (voluntary)

iii. Energy consumption

Energy consumption data availability for all NACE sectors was limited. For some sectors at NACE 2 level, as well as energy-intensive sectors (steel, paper, cement, glass, aluminium), energy consumption was extracted from the ODYSSEE[37] and the IEA "World energy statistics" databases. Some statistical offices in the EU provide detailed energy consumption statistics at more detailed levels for section C (France with INSEE-survey EACEI, Germany with DESTATIS, Netherlands with CBS, UK with BEIS, etc.). However, such data for other sections is rarely available in other countries, with the exceptions of Austria and Estonia.

Outside Europe, some statistical offices provide consumption data at NACE 3-digit level for section C (USA, China, Japan) and NACE 2-digit level for the other sections (USA), but data is limited for the other countries.

[37] http://www.odyssee-mure.eu/

Where unavailable, energy consumption was estimated as energy costs divided by prices where energy costs and price data were available.

As a conclusion, Table 4-7 provides for each sector the countries for which it was possible to make the decomposition analysis (cf. section 4.6) based on the available data and the work done to manage the data gaps. Estimations allowed for around 330 additional series to be covered in section C (either series over the full 2008-2015 period, or 1-2 data points only) and around 90 additional series for the other sections. Despite the important data collection and estimation work, the data coverage for the decomposition analysis remained limited.

Table 4-7: Data coverage for each sector and each country

Section	Code	Description	Countries for which the decomposition analysis can be done based on the available data	
			EU MS	G20 countries
A - Agriculture, forestry and fishing	A	Agriculture, forestry and fishing	17 countries	TR, US
B - Mining and quarrying	B	Mining and quarrying	27 countries	NO, JP, KR, TR, US, RU
	B06	Extraction of crude petroleum and natural gas	11 countries	TR
	B07	Mining of metal ores	9 countries	TR
	B08	Other mining and quarrying	11 countries	TR
C - Manufacturing	C103	Processing and preserving of fruit and vegetables	12 countries	TR, US
	C106	*Manufacture of grain mill products, starches and starch products*	*12 countries*	TR, US
	C11	Manufacture of beverages	*13 countries*	TR, US
	C132	*Weaving of textiles*	*10 countries*	TR, US
	C161	*Sawmilling and planing of wood*	*11 countries*	TR, US
	C171	*Manufacture of pulp, paper and paperboard*	*12 countries*	TR, US
	C172	Manufacture of articles of paper and paperboard	12 countries	TR
	C192	*Manufacture of refined petroleum products*	*25 countries*	NO, JP, KR, TR
	C201	*Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms*	*12 countries*	TR, US
	C206	*Manufacture of man-made fibres*	11 countries	TR, US
	C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	13 countries	TR, US
	C222	Manufacture of plastics products	11 countries	TR
	C231	*Manufacture of glass and glass products*	13 countries	NO, TR, US
	C232	*Manufacture of refractory products*	12 countries	TR
	C233	*Manufacture of clay building materials*	12 countries	TR
	C234	*Manufacture of other porcelain and ceramic products*	11 countries	TR, US
	C235	*Manufacture of cement, lime and plaster*	14 countries	TR, US
	C237	*Cutting, shaping and finishing of stone*	11 countries	TR, US

Section	Code	Description	Countries for which the decomposition analysis can be done based on the available data	
			EU MS	G20 countries
	C239	Manufacture of abrasive products and non-metallic mineral products n.e.c.	12 countries	TR
	C241	*Manufacture of basic iron and steel and of ferro-alloys*	24 countries	NO, TR, US
	C244	*Manufacture of basic precious and other non-ferrous metals*	26 countries	NO, TR, US
	C245	Casting of metals	12 countries	TR, US
	C25	Manufacture of fabricated metal products, except machinery and equipment	15 countries	NO, TR, US
	C26	Manufacture of computer, electronic and optical products	15 countries	TR, US
	C27	Manufacture of electrical equipment	28 countries	TR, US
	C28	Manufacture of machinery and equipment n.e.c.	14 countries	NO, TR, US
	C29	Manufacture of motor vehicles, trailers and semi-trailers	14 countries	TR, US
	C30	Manufacture of other transport equipment	14 countries	TR
	C32	Other manufacturing	13 countries	TR
	C33	Repair and installation of machinery and equipment	14 countries	NO, TR
D - Electricity, gas, steam and air-conditioning supply	D35	Electricity, gas, steam and air conditioning supply	15 countries	NO, JP
E - Water supply, sewerage, water management and remediation activities	E38	Waste collection, treatment and disposal activities; materials recovery	DK, EE, NL, UK	
F - Construction	F	Construction	26 countries	
G - Wholesale and retail trade	G	Wholesale and retail trade	AT, EE	
H - Transportation and storage	H49	Land transport and transport via pipelines	AT, EE, FR, PL	
	H51	Air transport	DE, EE, IT, SE	US
I - Accommodation and food service activities	I	Accommodation and food service activities	DK, EE	
J - Information and communication	J	Information and communication		
M - Professional, scientific and technical activities	M	Professional, scientific and technical activities	DE	
N - Administrative and support service activities	N	Administrative and support service activities		

Source: Own calculation based on ODYSSEE, IEA World energy statistics and national sources

4.3 Analysis of energy costs

4.3.1 *Energy costs as a share of total (operational) production costs*

To understand the competitiveness impact of energy costs for EU industry it is important first to understand the importance of these as a share of a sector's total (operational) production costs.

Energy costs are divided by total (operational) production costs, where total (operational) production costs are equal to personnel costs and total purchase of goods and services (including energy).

$$energy\ costs = \frac{purchase\ of\ energy\ products}{personnel\ costs + purchase\ of\ good\ and\ services}$$

According to Eurostat, **total purchases of goods and services** include 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).

Personnel costs are defined as the total remuneration, in cash or in kind, payable by an employer to an employee (regular and temporary employees as well as home workers) in return for work done by the latter during the reference period. . Personnel costs are made up of wages and salaries and employers' social security costs, which include taxes and employees' social security contributions retained by the unit as well as the employer's compulsory and voluntary social contributions.

It is important to note that we identified a possible underestimation of the impact of energy costs in the competitiveness of some energy intensive sectors (chemicals, cement, non-ferrous metals, steel and paper industries) due to the heterogeneity of these sectors in terms of energy intensity. In addition costs of self-produced fuels are not taken into account by sector. Indeed, these five industries include companies producing high energy intensive primary products (basic chemicals & fertilizers, clinker, primary metals, crude steel and pulp, respectively), and therefore are strongly impacted by the evolution of energy costs, alongside companies producing low energy intensive secondary products but which are still classified in the same sector, and which are much more weakly impacted by energy costs (this is the case for instance in the chemicals sector). This issue was not addressed in this study but is being addressed in a separate bottom-up study coordinated by DG-GROW[38] which will look at more disaggregated industrial segments and take into account other features that influence the full energy costs in some of these sectors (consumption of self-generated energy, interruptibility schemes, exemptions to regulatory costs, etc.) .

Table 4-8 summarises energy cost shares over time for all the sectors of the study. This tables presents the changes over the period 2008-2015, 2008-2011, 2011-2015, as well as the average rate, and the maximum and minimum levels reached, to show the variability of cost shares over years.

[38] Study on Composition and Drivers of Energy Prices and Costs: Case Studies in Selected Energy Intensive Industries, CEPS and Ecofys, 2018

Table 4-8: Evolution of the energy cost shares over time of all sectors analysed

	2008	2009	2010	2011	2012	2013	2014	2015	Changes 2008-2015	Changes 2008-2011	Changes 2011-2015	Level 2015	Average	Max. level	Low. level	Diff max-low level
Section C																
C103 - Fruit and vegetables	3.6%	3.5%	2.8%	2.8%	3.0%	2.8%	2.9%	2.5%	-1.1%	-0.8%	-0.3%	2.5%	3.0%	3.6%	2.5%	1.1%
C106 - Grain products	3.8%	3.8%	3.3%	3.1%	3.3%	3.1%	3.3%	3.0%	-0.8%	-0.6%	-0.1%	3.0%	3.3%	3.8%	3.0%	0.8%
C132 - Textiles	4.3%	6.4%	3.6%	2.5%	2.7%	2.4%	2.3%	2.1%	-2.2%	-1.8%	-0.4%	2.1%	3.3%	6.4%	2.1%	4.3%
C161 - Sawmills	3.7%	4.1%	3.6%	4.1%	3.7%	3.6%	3.4%	3.1%	-0.6%	0.4%	-1.0%	3.1%	3.7%	4.1%	3.1%	1.0%
C171 - Pulp and paper	12.2%	13.0%	11.1%	11.2%	10.7%	9.9%	9.1%	8.4%	-3.9%	-1.1%	-2.8%	8.4%	10.7%	13.0%	8.4%	4.6%
C172 - Articles of paper	3.6%	3.7%	3.1%	2.8%	3.0%	3.0%	2.7%	2.5%	-1.0%	-0.8%	-0.3%	2.5%	3.0%	3.7%	2.5%	1.2%
C192 - Refineries	3.2%	2.4%	2.5%	2.0%	2.8%	3.1%	3.1%	3.7%	0.6%	-1.2%	1.7%	3.7%	2.8%	3.7%	2.0%	1.7%
C201 - Basic chemicals	7.1%	7.7%	6.8%	7.0%	6.7%	6.7%	6.1%	5.7%	-1.4%	-0.1%	-1.3%	5.7%	6.7%	7.7%	5.7%	2.0%
C206 - Man-made fibres	8.6%	12.4%	7.8%	7.1%	6.7%	8.5%	6.5%	6.2%	-2.4%	-1.6%	-0.9%	6.2%	8.0%	12.4%	6.2%	6.2%
C222 - Plastics products	3.5%	3.5%	2.9%	2.9%	2.8%	2.9%	2.7%	2.6%	-0.9%	-0.6%	-0.3%	2.6%	3.0%	3.5%	2.6%	0.9%
C231 - Glass	9.8%	10.1%	8.9%	9.1%	10.3%	10.1%	9.3%	8.2%	-1.7%	-0.7%	-0.9%	8.2%	9.5%	10.3%	8.2%	2.1%
C232 - Refractory products	6.9%	6.5%	6.2%	5.9%	6.5%	6.6%	5.8%	6.1%	-0.8%	-1.0%	0.1%	6.1%	6.3%	6.9%	5.8%	1.1%
C233 - Clay building materials	15.4%	14.1%	11.8%	11.0%	12.4%	12.4%	11.3%	11.1%	-4.3%	-4.4%	0.1%	11.1%	12.4%	15.4%	11.0%	4.4%
C234 - Porcelain and ceramics	6.0%	5.7%	4.8%	5.0%	5.3%	5.4%	5.0%	4.3%	-1.7%	-1.0%	-0.8%	4.3%	5.2%	6.0%	4.3%	1.7%
C235 - Cement, lime and plaster	22.1%	22.9%	22.1%	23.5%	21.4%	21.8%	20.9%	16.3%	-5.8%	1.5%	-7.3%	16.3%	21.4%	23.5%	16.3%	7.3%
C237 - Stone	4.8%	4.4%	3.3%	3.4%	2.6%	4.3%	3.1%	3.2%	-1.5%	-1.4%	-0.1%	3.2%	3.6%	4.8%	2.6%	2.1%
C239 - Abrasive products	5.8%	5.3%	4.9%	4.9%	5.0%	5.2%	4.8%	5.1%	-0.7%	-0.9%	0.1%	5.1%	5.1%	5.8%	4.8%	1.0%
C241 - Iron and steel	9.2%	11.9%	9.5%	7.7%	8.5%	8.5%	7.3%	7.5%	-1.7%	-1.4%	-0.3%	7.5%	8.8%	11.9%	7.3%	4.6%
C244 - Non-ferrous metals	4.6%	6.0%	4.2%	4.0%	3.9%	4.0%	3.6%	3.5%	-1.1%	-0.5%	-0.6%	3.5%	4.2%	6.0%	3.5%	2.5%
C245 - Casting of metal	6.4%	7.1%	6.0%	5.2%	5.4%	5.5%	5.3%	4.9%	-1.4%	-1.1%	-0.3%	4.9%	5.7%	7.1%	4.9%	2.2%

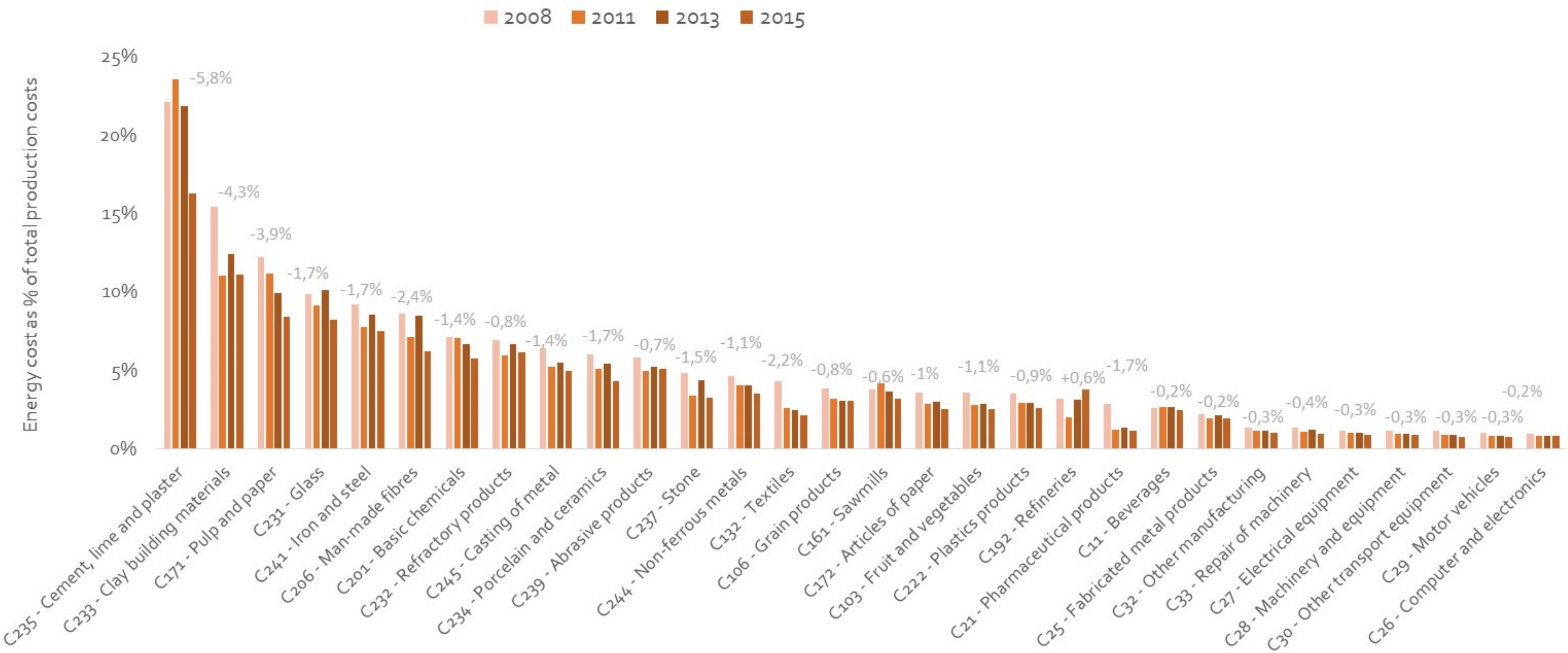
	2008	2009	2010	2011	2012	2013	2014	2015	Changes 2008-2015	Changes 2008-2011	Changes 2011-2015	Level 2015	Average	Max. level	Low. level	Diff max-low level
C11 - Beverages	2.6%	2.6%	2.6%	2.7%	2.6%	2.6%	2.5%	2.4%	-0.2%	0.1%	-0.2%	2.4%	2.6%	2.7%	2.4%	0.2%
C21 - Pharmaceutical products	2.8%	1.7%	1.2%	1.2%	1.3%	1.3%	1.2%	1.1%	-1.7%	-1.6%	-0.1%	1.1%	1.5%	2.8%	1.1%	1.7%
C25 - Fabricated metal products	2.2%	2.4%	2.3%	1.9%	2.0%	2.1%	2.1%	1.9%	-0.2%	-0.3%	0.0%	1.9%	2.1%	2.4%	1.9%	0.5%
C26 - Computer and electronics	0.9%	0.9%	0.7%	0.8%	0.8%	0.8%	0.8%	0.8%	-0.2%	-0.2%	0.0%	0.8%	0.8%	0.9%	0.7%	0.2%
C27 - Electrical equipment	1.1%	1.3%	1.0%	1.0%	1.0%	1.0%	1.1%	0.9%	-0.3%	-0.2%	-0.1%	0.9%	1.0%	1.3%	0.9%	0.5%
C28 - Machinery and equipment	1.1%	1.2%	1.0%	0.9%	0.9%	1.0%	0.9%	0.8%	-0.3%	-0.2%	-0.1%	0.8%	1.0%	1.2%	0.8%	0.4%
C29 - Motor vehicles	1.0%	1.0%	0.8%	0.8%	0.8%	0.8%	0.7%	0.7%	-0.3%	-0.2%	-0.1%	0.7%	0.8%	1.0%	0.7%	0.3%
C30 - Other transport equipment	1.1%	1.0%	0.9%	0.8%	0.8%	0.9%	0.7%	0.8%	-0.3%	-0.3%	-0.1%	0.8%	0.9%	1.1%	0.7%	0.4%
C32 - Other manufacturing	1.3%	1.4%	1.3%	1.1%	1.1%	1.1%	1.1%	1.0%	-0.3%	-0.2%	-0.1%	1.0%	1.2%	1.4%	1.0%	0.4%
C33 - Repair of machinery	1.3%	1.2%	1.1%	1.1%	1.1%	1.2%	1.1%	0.9%	-0.4%	-0.2%	-0.2%	0.9%	1.1%	1.3%	0.9%	0.4%
Other sections																
B - Mining and quarrying	3.4%	2.9%	2.9%	2.7%	2.8%	2.8%	2.7%	3.1%	-0.3%	-0.8%	0.5%	3.1%	2.9%	3.4%	2.7%	0.8%
B06 - Oil and gas	1.6%	0.6%	0.6%	0.5%	0.6%	0.7%	0.7%	0.7%	-0.9%	-1.1%	0.2%	0.7%	0.7%	1.6%	0.5%	1.1%
B07 - Mining of metal ores	15.8%	16.6%	19.7%	20.8%	19.6%	19.4%	17.7%	18.4%	2.6%	5.0%	-2.4%	18.4%	18.5%	20.8%	15.8%	5.0%
B08 - Other mining	10.3%	9.8%	10.4%	10.4%	10.9%	10.2%	9.6%	9.4%	-0.9%	0.1%	-1.0%	9.4%	10.1%	10.9%	9.4%	1.5%
D35 - Electricity, gas and steam	17.0%	16.8%	16.9%	16.4%	14.3%	12.3%	11.4%	11.5%	-5.5%	-0.6%	-4.9%	11.5%	14.6%	17.0%	11.4%	5.6%
E38 - Waste management	4.0%	3.0%	3.1%	3.5%	4.2%	4.3%	4.8%	4.3%	0.3%	-0.5%	0.8%	4.3%	3.9%	4.8%	3.0%	1.8%
F - Construction	1.5%	1.5%	1.5%	1.7%	1.7%	1.7%	1.6%	1.4%	0.0%	0.2%	-0.3%	1.4%	1.6%	1.7%	1.4%	0.3%
G - Wholesale and retail trade	0.7%	0.8%	0.7%	0.6%	0.7%	0.6%	0.6%	0.6%	-0.1%	0.0%	0.0%	0.6%	0.7%	0.8%	0.6%	0.2%
H49 - Land transport	36.3%	31.0%	33.2%	40.6%	37.0%	34.4%	32.1%	27.0%	-9.3%	4.3%	-13.6%	27.0%	33.9%	40.6%	27.0%	13.6%
H51 - Air transport	19.5%	16.7%	21.6%	20.1%	23.3%	20.0%	24.4%	20.2%	0.7%	0.6%	0.1%	20.2%	20.7%	24.4%	16.7%	7.8%
I - Accommodation and restaurants	3.9%	4.2%	4.7%	4.2%	4.5%	4.3%	3.7%	3.9%	0.0%	0.3%	-0.3%	3.9%	4.2%	4.7%	3.7%	1.1%

Source: Own calculations

Figure 4-1 shows that:

- In the period 2008-2015, energy costs for the selected manufacturing sectors typically constituted between approximately 1-10% of total (operational) production costs, although for a handful of sectors the costs significantly exceed 10% (e.g. Cement, lime and plaster C235; Clay building materials C233), reaching up to 40% in one year in the Land transport sector (H49);
- Amongst the 15 most energy intensive manufacturing sectors, energy costs constitute more than 10% of production costs in at least one year in the manufacture of pulp and paper (C171), clay building materials (C233), iron and steel (C241) and in particular, the cement, lime and plaster (C235) sectors, highlighting these as the most energy intensive sectors, which are most sensitive to energy prices, and cost changes and differentials. For the other sectors energy costs range from 2-10% of total (operational) production costs;
- Amongst the 15 less energy intensive manufacturing sectors, energy costs are typically only 1-3% of operational (production) costs and therefore a relatively minor cost component for most businesses in these sectors. For computers and electronics (C26), motor vehicles (C29) and other transport equipment (C30), costs do not reach 1% of total production costs;
- Over the period 2008-2015, energy cost shares have fallen in every sector except for the refineries (C192) sector, which has a unique situation as reflected in Box 1). The largest percentage point decline in cost share can be observed in the cement, lime and plaster (C235) sector with a decline in cost share from around 22% to 16% observed (-6%). It is also the case that the largest percentage point declines in this ratio are also experienced by the other most energy intensive sectors, such as clay building materials (-4%), pulp and paper (-4%), glass (-1.7%) and iron and steel (-1.7%). Please refer to the decomposition analysis in section 4.6 for deeper insights into these effects;
- Some of the other sectors with smaller percentage point declines nevertheless see proportionally high decreases in their energy cost share ratios, such as non-ferrous metals (C244), textiles (C232) and pharmaceutical products (C21);
- Whilst the overall trend in the ratio is for decline in energy cost shares across all sectors over the full period, there are a few exceptions to this trend in more recent years, for example in the period 2011-2015. These include the refractory products (C232), clay building materials (C233), abrasive products (C239), fabricated metal products (C25) and computer and electronics (C26) sectors for which the cost shares increased by approximately 1-3%.

Figure 4-1: Change in average energy cost as % of total operational (production) cost for manufacturing sectors 2008-2015



Source: Own calculations based on Eurostat SBS

Note: Costs for basic chemicals only include purchase energy, not the cost of own produced fuels. For refineries, the figure includes the full costs (purchase including crude oil feedstock and self-produced fuels).

Amongst the non-manufacturing sectors for which data was available energy cost shares are particularly high in 5 sectors, being comparable to or higher than cost shares in the most energy intensive manufacturing sectors. These 5 sectors are Land transport (H49), Air transport (H51), Mining of metal ores (B07), Electricity, gas and steam (D36) and other mining (B08). Clearly fuel costs are important drivers of costs in the transport and electricity and gas sectors, whilst mining is also an energy intensive activity. It is notable that energy cost shares in Waste management (E38) and Accommodation and restaurants (I) also have cost shares of 3-5%, which is comparable to many of the energy intensive manufacturing sectors. Energy cost shares are negligible in the construction (F) and Wholesale and retail (G) sectors (Figure 4-2).

Figure 4-2: EU aggregated average energy cost as % of total operational (production) cost for selected non-manufacturing sectors

Source: Own calculations based on Eurostat SBS

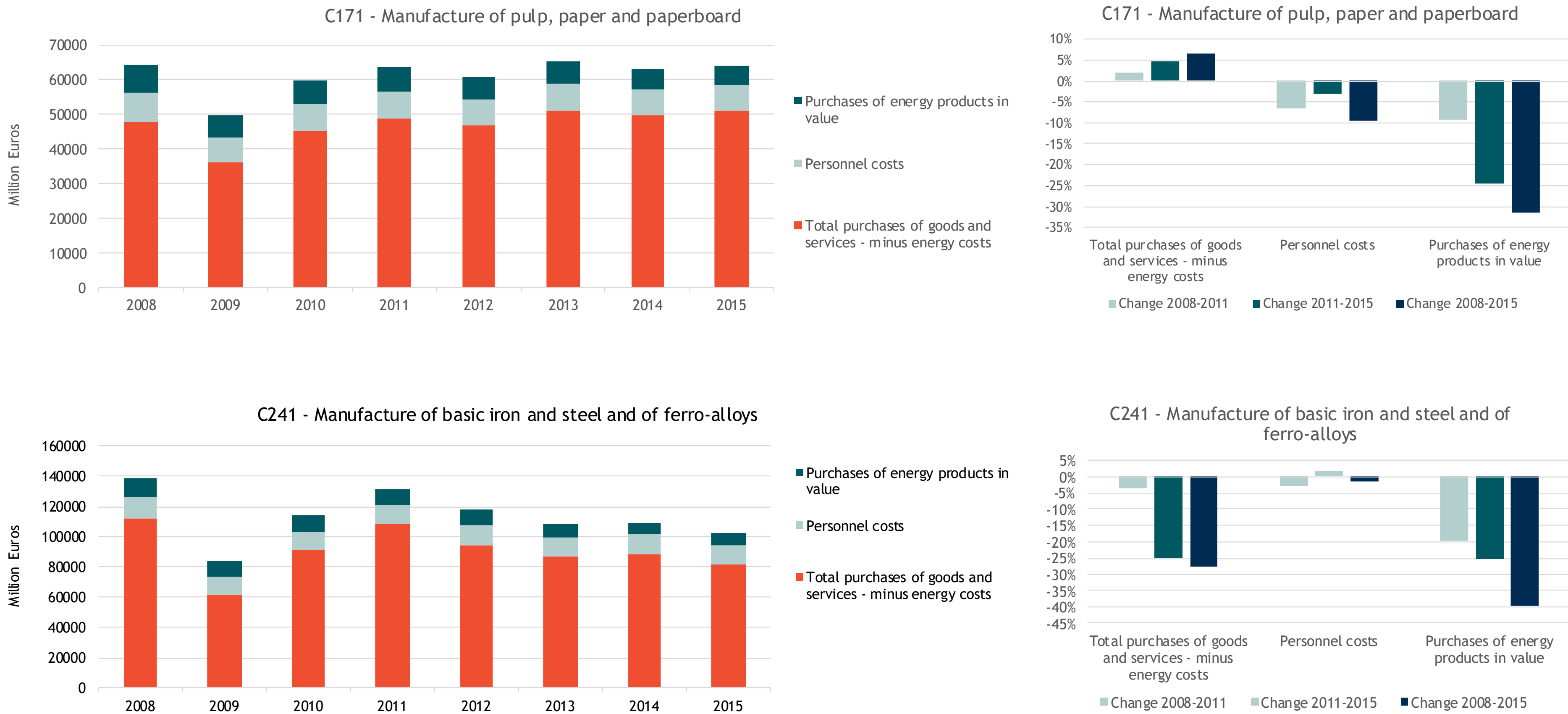
4.3.2 Production cost components – a simple decomposition

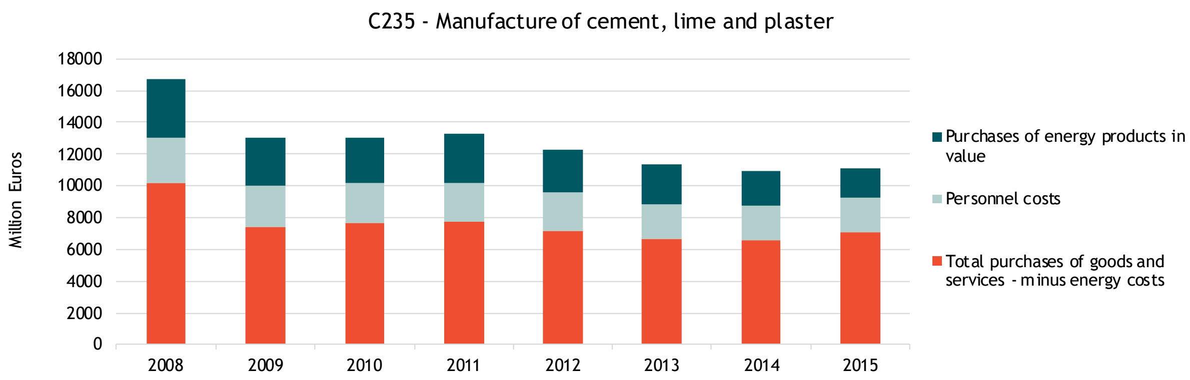
Within this sub-section we provide a simple decomposition of these effects. In section 4.6 of this chapter we provide a more sophisticated decomposition analysis of energy costs and the factors in their change.

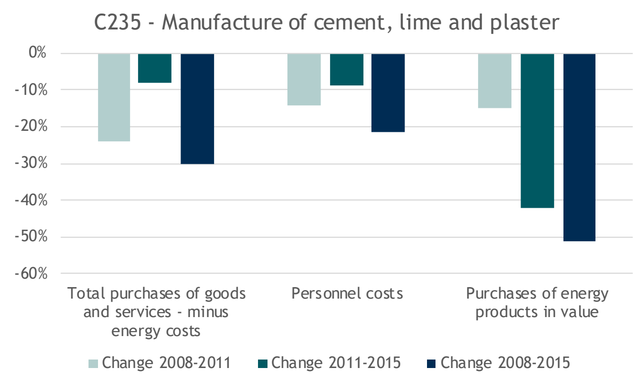
To understand the trends in energy cost shares it is also important to further decompose the trends in total production costs, to understand how energy costs have changed relative to other costs. Against this backdrop, we present examples from three energy-intensive branches namely the pulp, paper and paperboard, iron and steel, cement, lime and plaster sectors and glass to illustrate the effects (Figure 4-3).

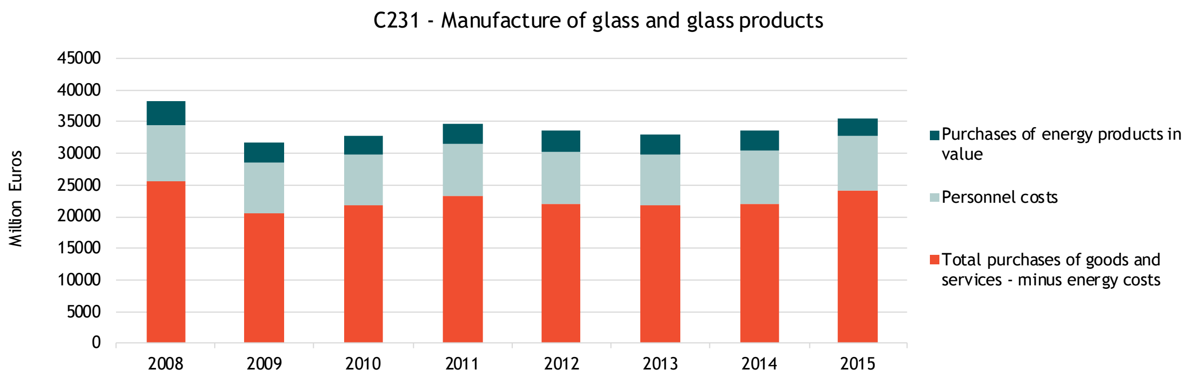
- In the period 2008-2015 in the paper and pulp sector, energy costs decreased by more than 30%. Whilst other purchase costs increased, they only increased by around 7%, and personnel costs decreased by around 10% in the same period. The result of these changes is that the share of other purchase costs increased in the sector and the share of energy costs declined by much more than personnel costs;
- For iron and steel the factors are a little different, as purchases of other goods and services also declined significantly over the period (-27%), and personnel costs by a smaller amount (-2%). The relative change for energy costs of -40% means that the result, of a declining share of energy costs in total costs, is the same as for pulp and paper, but with personnel costs becoming much more important in this sector;
- For cement, lime and plaster, all costs have decreased. In particular purchase of energy products decreased by 50% from 2008 to 2015, against -30% for purchase of goods and services and -20% for personal costs;
- For glass, costs are rather constant since 2009. Energy costs have continuously decreased over the period (mainly before 2011) by -15%. The other costs have increased since 2011.

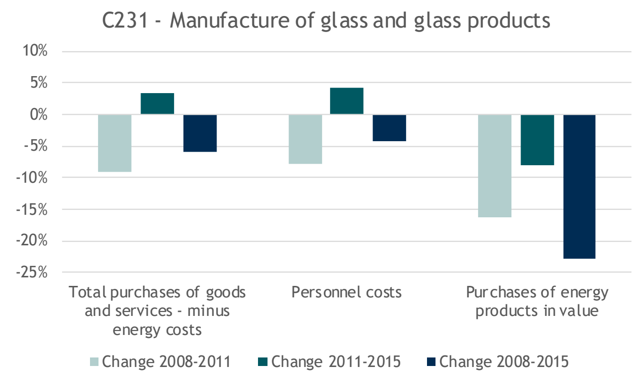
Figure 4-3: Absolute and relative changes in main production cost components, for the C171 (Paper and pulp) and C241 (Iron and steel) sectors, C235 (Cement, lime and plaster) over 2008-2015, EU aggregates











Source: Own calculations based on Eurostat SBS

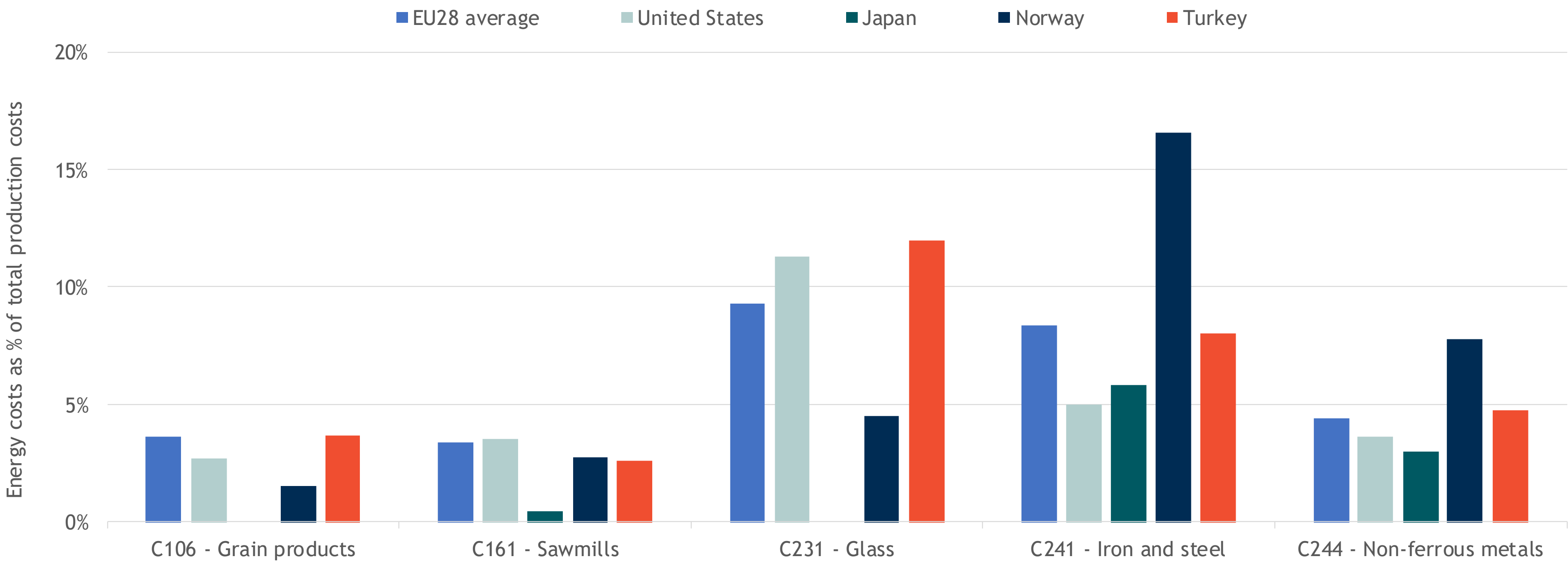
4.3.3 Energy costs – International comparison

As energy cost shares are essential to understand the competitiveness impact of energy costs, it is useful to compare energy costs for EU countries with its trading partners. Unfortunately, as noted in the previous section, specific data on energy cost shares is relatively limited across the main G20 and other trading partners.

Figure 4-4 presents results for the handful of sectors and countries for which equivalent energy cost and production cost data is available. This includes countries that constitute around 40% of the total trade between the EU and the G20, i.e. the United States (28%), Japan (6%) and Turkey (7%), plus Norway. From this figure we can draw the following observations:

- In the Grain products (C106) sector the EU average energy cost share is higher than their equivalents in the United States and Norway, but at a similar level to Turkey. Grain production in the US is highly mechanised and able to take advantage of large economies of scale;
- For Sawmills (C161) costs in the EU are a little lower than those in the US on average, but higher than in the other countries;
- For Glass (C231) EU cost shares are lower than in both the US and Turkey, but higher than in Norway;
- In the Iron and Steel (C241) and Non-ferrous metals (C244) sectors EU energy cost shares are lower than Norway and comparable to Turkey, but compare unfavourably with those in the United States and Japan.

Figure 4-4: Energy costs as share of total (operational) production costs, 2008-2015 average, by sectors, for available data



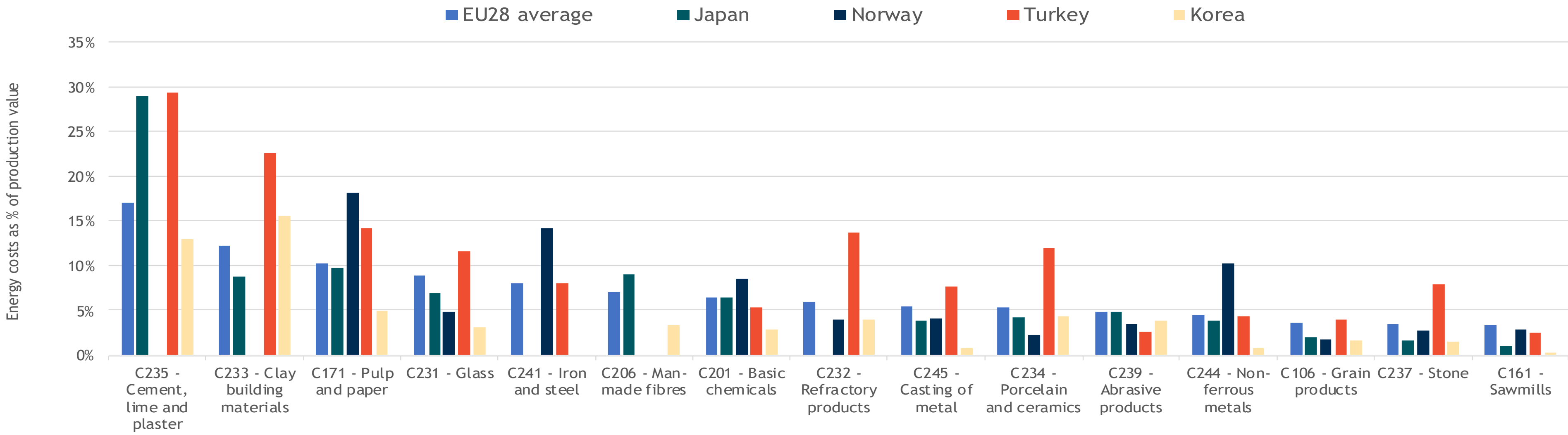
Source: Own calculations based on Eurostat SBS, IHS

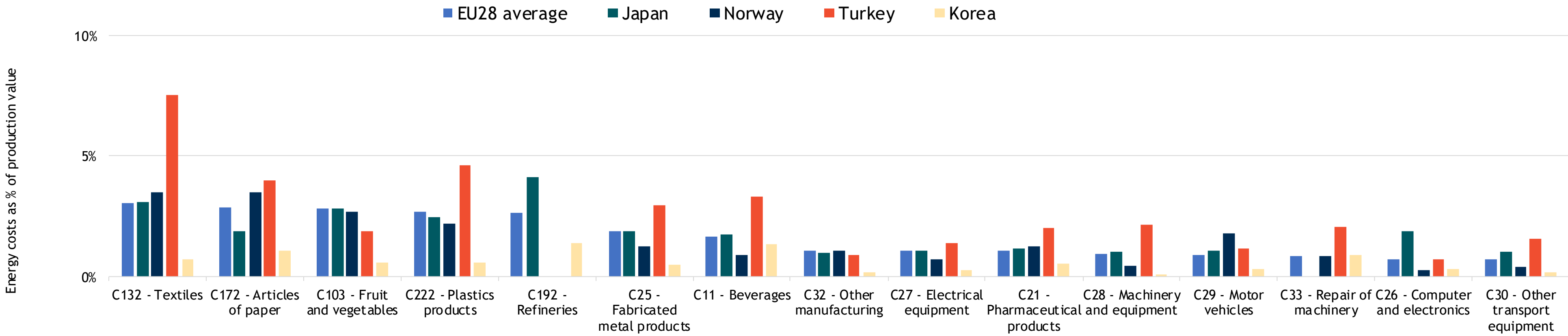
By using production value[39] rather than production costs as the basis of the comparison the international analysis can be expanded to include South Korea and other sectors. This is shown in Figure 4-5 which presents, for the selected sectors and countries for which data is available, average energy costs as share of production value for the period 2008-2015. Figure 4-5 shows that compared to:

- **Japan:** in most cases EU industry on average is typically facing higher burdens from energy costs in total production costs than competitors in Japan. The main exceptions are the sectors of computer and electronics (C26); cement, lime and plaster (C235) and refineries (C192);
- **Norway:** the comparison with the EU varies considerably per sector, in some sectors the energy cost shares are much lower than in the EU (Grain (C106), Glass (C231), Refractory Products C232), but in some much higher (Pulp and paper (C171), Basic chemicals (C201), Iron and steel (C241)and Non-ferrous metals C244);
- **Turkey:** EU energy cost shares were in general lower than those of Turkey. Exceptions to this, where energy costs were lower in Turkey, were fruit and vegetables (C103), basic chemicals (C201), abrasive products (C239), non-ferrous metals (C244) and repair of machinery (C33);
- **Korea:** EU energy cost shares were on average higher than South Korea across all sectors except Clay building materials (C233). The price differences are biggest for sawmills (C161) and for the machinery and equipment (C28) sectors.

[39] **Production value** measures the amount actually produced by the unit, based on sales, including changes in stocks and the resale of goods and services. The production value is defined as turnover, plus or minus the changes in stocks of finished products, work in progress and goods and services purchased for resale, minus the purchases of goods and services for resale, plus capitalised production, plus other operating income (excluding subsidies). Income and expenditure classified as financial or extra-ordinary in company accounts is excluded from production value.

Figure 4-5: Energy costs as share of production value, 2008-2015 average, by sectors, for available data





Source: Own calculations based on Eurostat SBS, IHS

4.4 Analysis of energy intensity

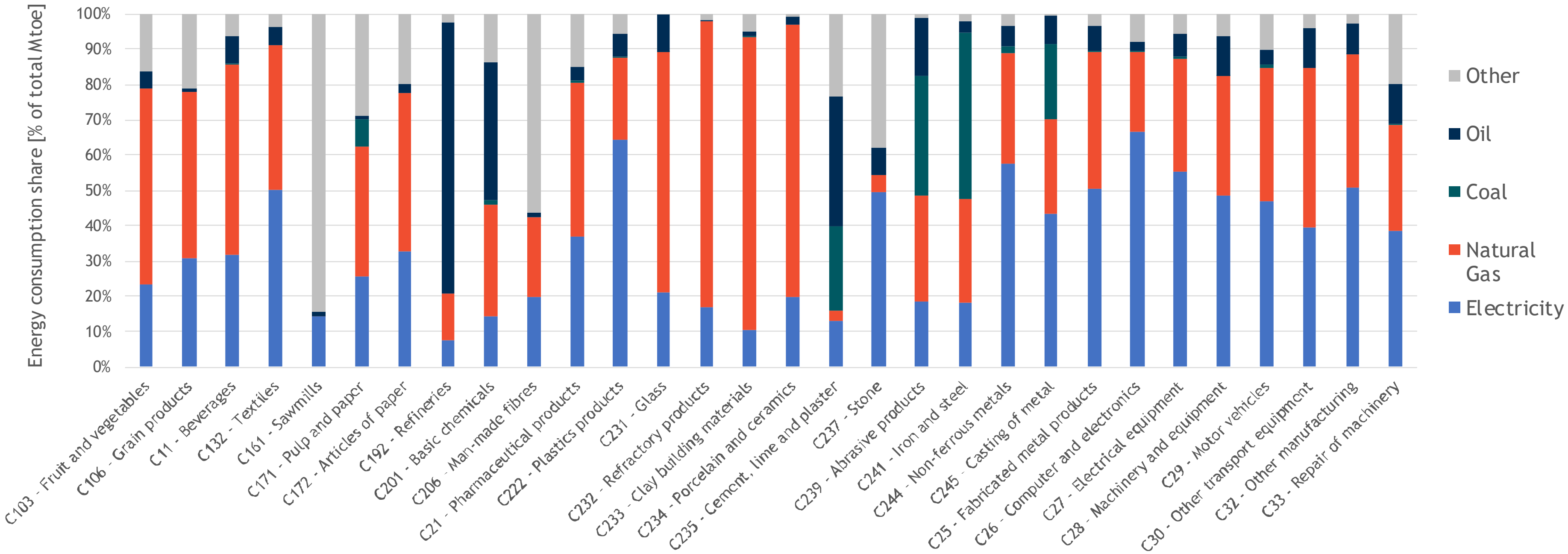
Energy consumption and energy cost shares per energy carrier

The two most important factors when analysing energy costs are energy prices and the quantity of energy consumed.

Figure 4-6 shows the average importance of fuels per sector in terms of the importance of each energy carrier in consumption and how via prices this translates to its importance to total energy costs (Figure 4-7). The figures show that:

- For some sectors, electricity consumption has a bigger influence on total energy costs than other energy carriers. This can be explained by its relatively high price compared to the other fuels. It is influential across all sectors but particularly in pharmaceuticals (C21), non-ferrous metals(C244) and Computers and Electronics (C26), where it contributes more than 80% of energy costs;
- Natural gas consumption is also important in most sectors, but it has less influence on energy costs, being a major influence on glass (C231), beverages (C11) and iron and steel (C241);
- Oil and coal have relatively small impact on energy costs even when consumption is high. Energy costs from oil are relevant mainly for refineries (C192 R); cement, lime and plaster sector (C235); basic chemicals (C201). Coal is important for iron and steel sector (C241); abrasive products (C239); cement, lime and plaster sector (C235); and, casting of metal (C245);
- “Other energies”, in particular biomass can represent an important share for some sectors such sawmills (with more than 80% of the energy consumed), man-made fibres (with 57%), stone (with 38%) and pulp and paper (with 29%).

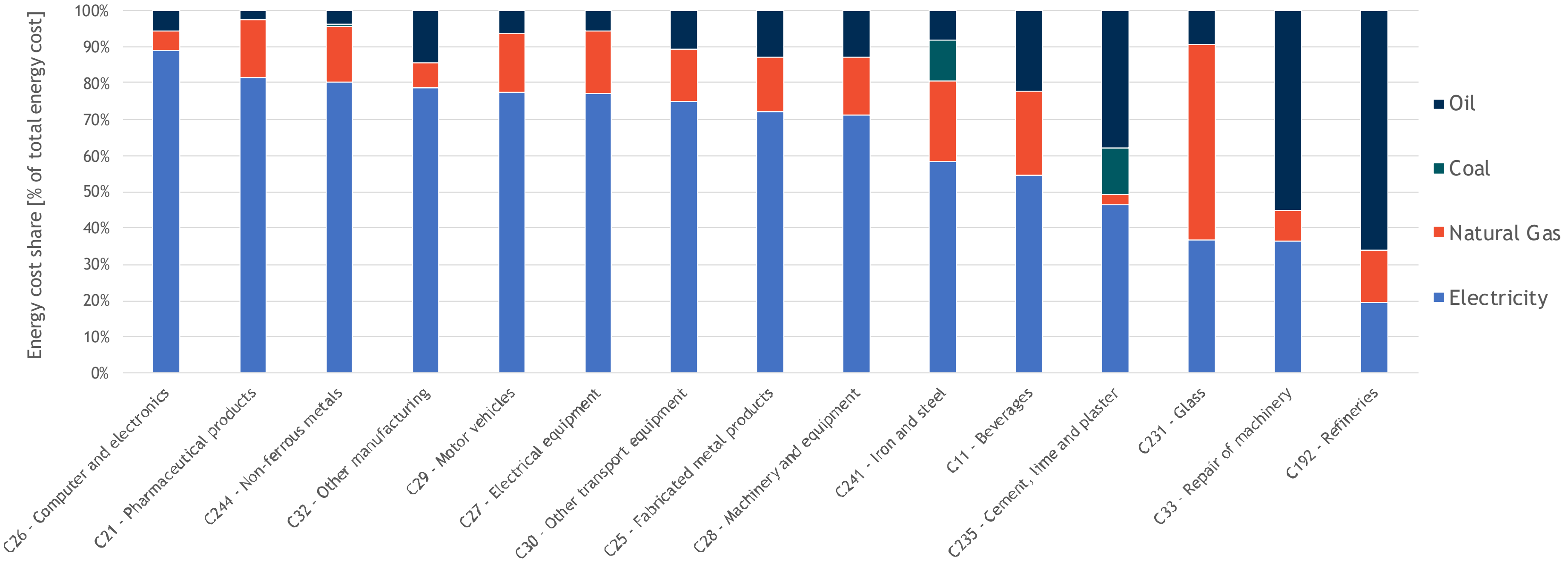
Figure 4-6: Breakdown of the energy consumption per energy carrier, EU, 2008-2015 averages



Source: Own calculations based on national sources

Note: “other” combines biomass and heat energy consumption

Figure 4-7: Average energy cost shares per sector - based on available data points, split by energy carrier, 2008-2015 averages



Source: Own calculations based on national sources

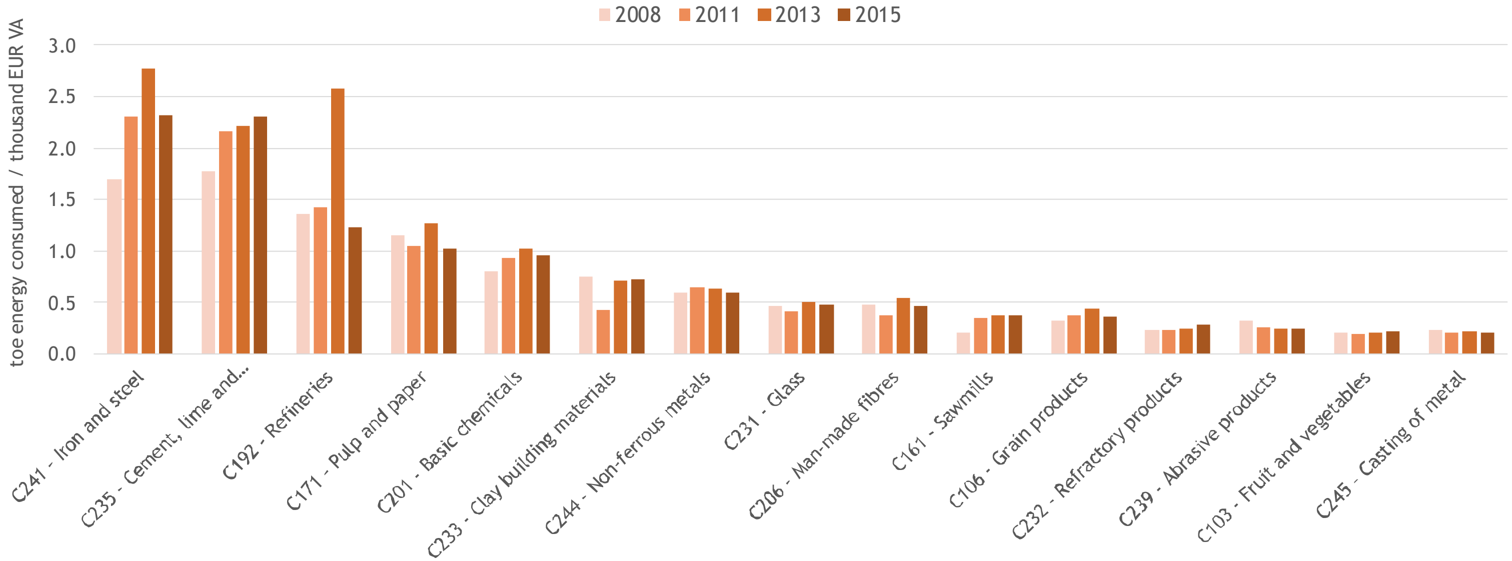
Energy intensity:

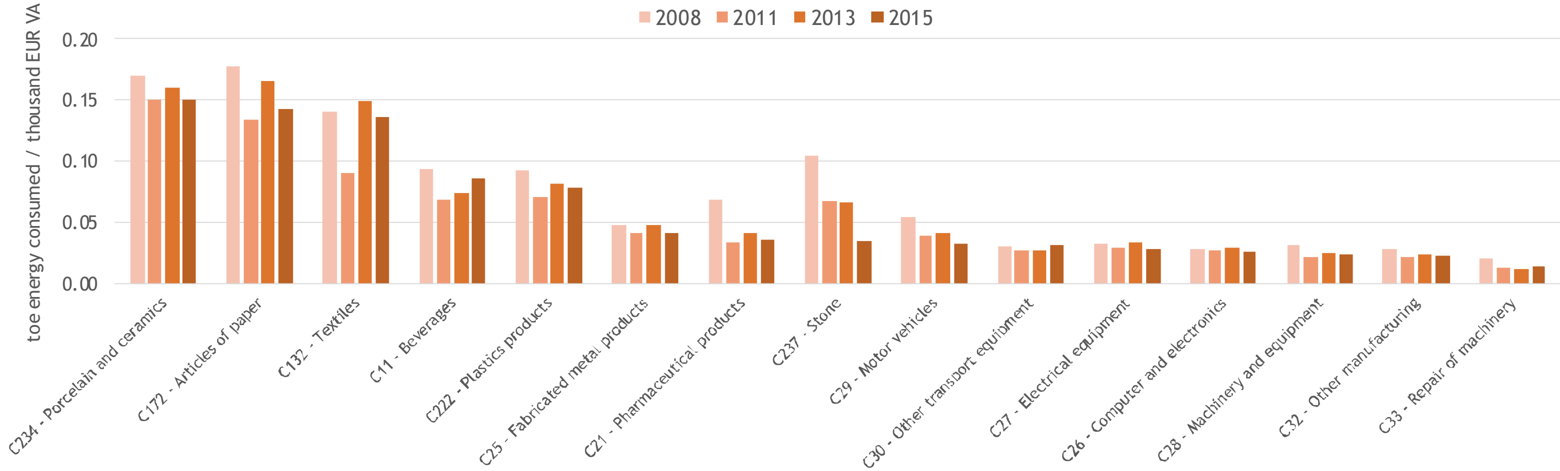
Energy intensity (energy consumption per thousand euros GVA) is an approximation across sectors of the energy efficiency of production. As it is denominated in terms of GVA produced it is not a direct measure of the physical energy efficiency of production, as it is subject to price effects and other factors, but it is a commonly used approximation as production volume data is not comparable across sectors, and often also unavailable.

Figure 4-8 presents the energy intensity of the main industrial sectors and clearly shows that:

- Energy use varies considerably depending on the sector. The iron and steel sector and the cement, lime and plaster sector are the most energy intensive sectors, typically requiring more than 2 toe/energy consumption per thousand Euros of GVA. These are followed by the refineries sector and the pulp and paper sector, which require over 1 toe/energy consumption per thousand Euros of GVA;
- In the period 2008-2015 energy intensity in the cement, lime and plaster sector has increased (by around 3.1%/year since 2009) and decreased in the iron and steel sector (-1.9 %/year since 2009). This decreasing trend is also observed in the next most intensive sectors namely refineries sector and the pulp and paper sector;
- In the period 2008-2015, energy intensity has also increased in grain products, sawmills, basic chemicals;
- The energy intensity of the refineries, iron and steel and man-made fibres sectors has been most volatile.

Figure 4-8: Energy intensity of EU industrial sectors 2008-2015 [toe energy consumed per thousand Euros of GVA], data based on limited number of EU Member States





Source: Own calculations based on Eurostat SBS, national sources

4.4.1 Energy intensity international comparison

Energy intensity is also an important benchmark for international competitiveness. By comparing across countries an impression can be formed of the energy efficiency of a sector in a country. This complements the understanding of the role of energy cost shares. An analysis of international energy intensity is provided in Figure 4-9, some of the key observations that can be made are:
Data quality is poor across all sectors with often only one or two other international comparators available. Turkey (TR) has the most complete data of international comparators and the EU has lower energy intensity than Turkey in the majority (but not all) sectors;

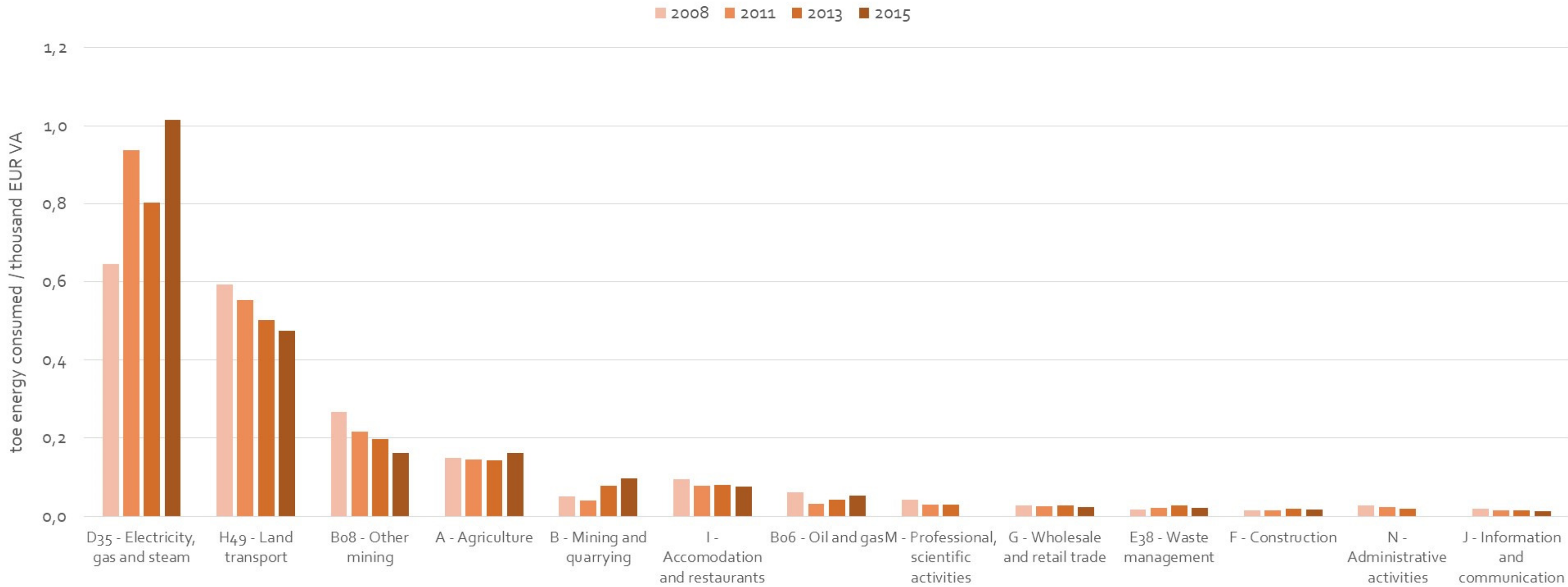
- Comparing the EU with the US there is considerable variation per sector for which data is available, with the EU being less energy intensive in sectors such as Beverages (C11), Glass (C231), Fabricated metal products (C25), and the US being less energy intensive in sectors such as Basic Chemicals (C201), Man-made fibres (C206) and computers and electronics (C26);
- The EU is less energy intensive than China (CN) in every sector for which data is available, except for refineries.

Figure 4-9: Energy intensity per sector, average values for 2008-2015

Source: Own calculations based on Eurostat, IHS, national sources

For non-manufacturing sectors, the highest energy intensities are observed in air transport* (H51), electricity, gas and steam (D35) and land transport (H49) (Figure 4-10).

Figure 4-10: Energy intensity per sector for non-manufacturing, average values for 2008-2015



Source: Own calculations based on Eurostat, national sources

**NOTE : air transport is dropped from this graph above due to methodological issues.*

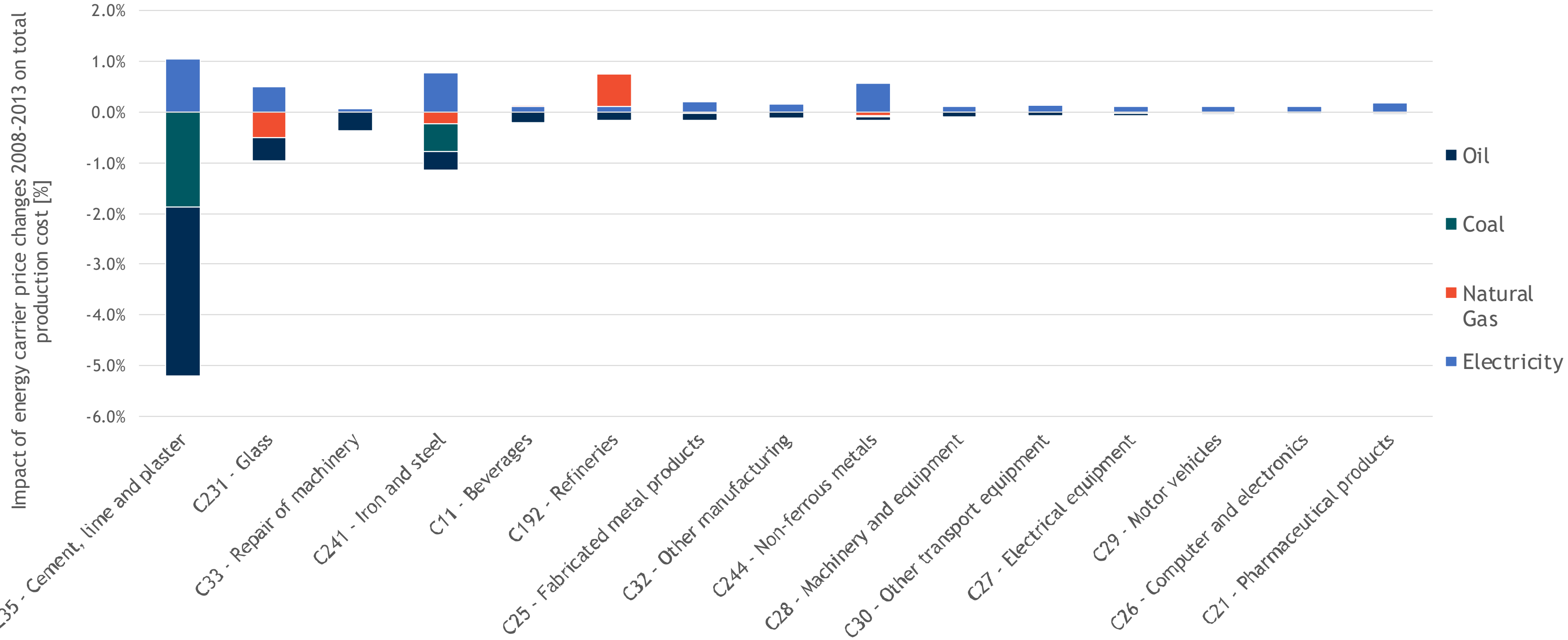
4.4.2 Energy price sensitivity analysis

The estimated impact of the observed changes in energy prices per energy carrier and per sector, in the period 2008-2015 are described in Figure 4-11 as a share of their impact on total (operational) production costs[40].

- The net effect of energy price changes on total production costs is estimated to be 1% or less in all but one sector, Cement, lime and plaster (C235) where declining oil and coal prices have led to an overall 4% decline in production costs;
- Weighted average electricity prices increased in every sector, leading to an increase in total production costs of between 0.07%-1.05% across the sectors. The impact was particularly acute in Iron and steel (C241), and Cement, lime and plaster (C235);
- Weighted average natural gas price variations had some impact on a few sectors which have benefitted from price changes such as C231 Glass (-0.51%) and C241 Iron and steel;
- (-0.23%), partly helping to offset increasing prices of electricity;
- Sectors using coal and oil have profited from price changes. The price changes in these energy carriers have been profitable in particular for the Cement, lime and plaster (C235) sector and to a lesser extent Iron and steel (C241).

[40] The impact of the evolution of prices is computed by multiplying the energy carrier price with the share of purchases of energy in total (operational) production costs and the share of the considered energy carrier in these purchases of energy. The computation is performed on the same member states for each year, those for which all required data are available over the period. The energy consumption mixes are assumed to be constant over time to avoid a bias in the results.

Figure 4-11: Estimated sector level impact of changes in price of energy carriers 2008-2015 on total production cost of sector



Source: Own calculations based on national sources

4.5 Profitability of EU industry

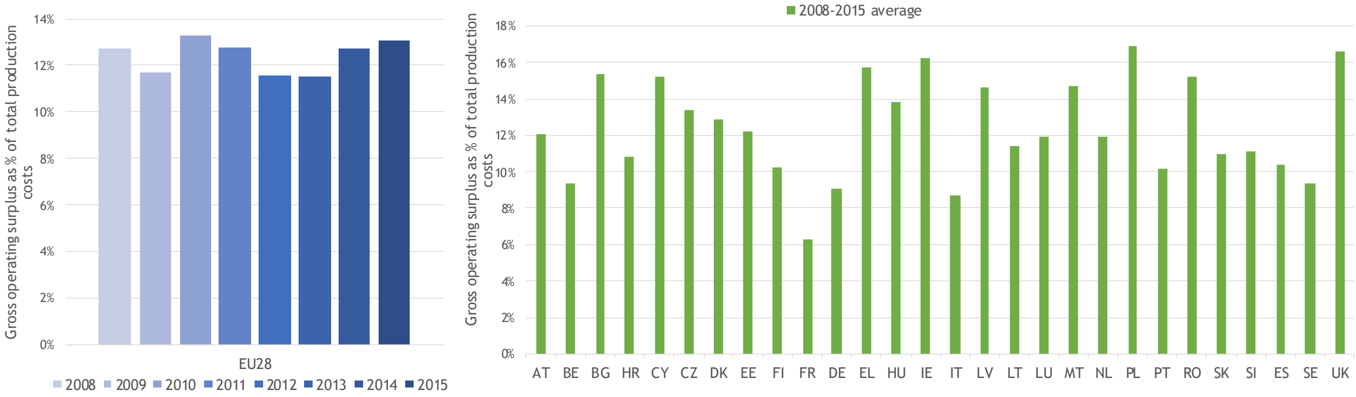
The competitiveness of an industry is also related to the margins that can be achieved. Value added is the sum of returns to labour and capital. This is effectively the sum of personnel costs and gross operating surplus. The gross operating surplus reflects the margins achieved, hence acting as a proxy for profit.

4.5.1 EU28 profitabilty analysis

Figure 4-12 shows the EU28 average gross operating surplus as percentage of production cost for the years 2008-2015 and a breakdown per Member State concluding that:

- In the EU28, in this period, average gross operating surplus was approximately in the range of 11-13% per annum. The trend has not been clearly upward or downward, but rather showing slight oscillation;
- There are large differences in gross operating surplus as a percentage of production cost between Member States. Poland, the UK and Ireland have the highest surpluses, over 16%. These are closely followed by Greece, Cyprus, Bulgaria and Romania. The lowest surpluses are found in France, Italy, Belgium and Sweden.

Figure 4-12: Gross operating surplus as % of total production costs, average across all sectors at EU28 and Member State level, 2008-2015.

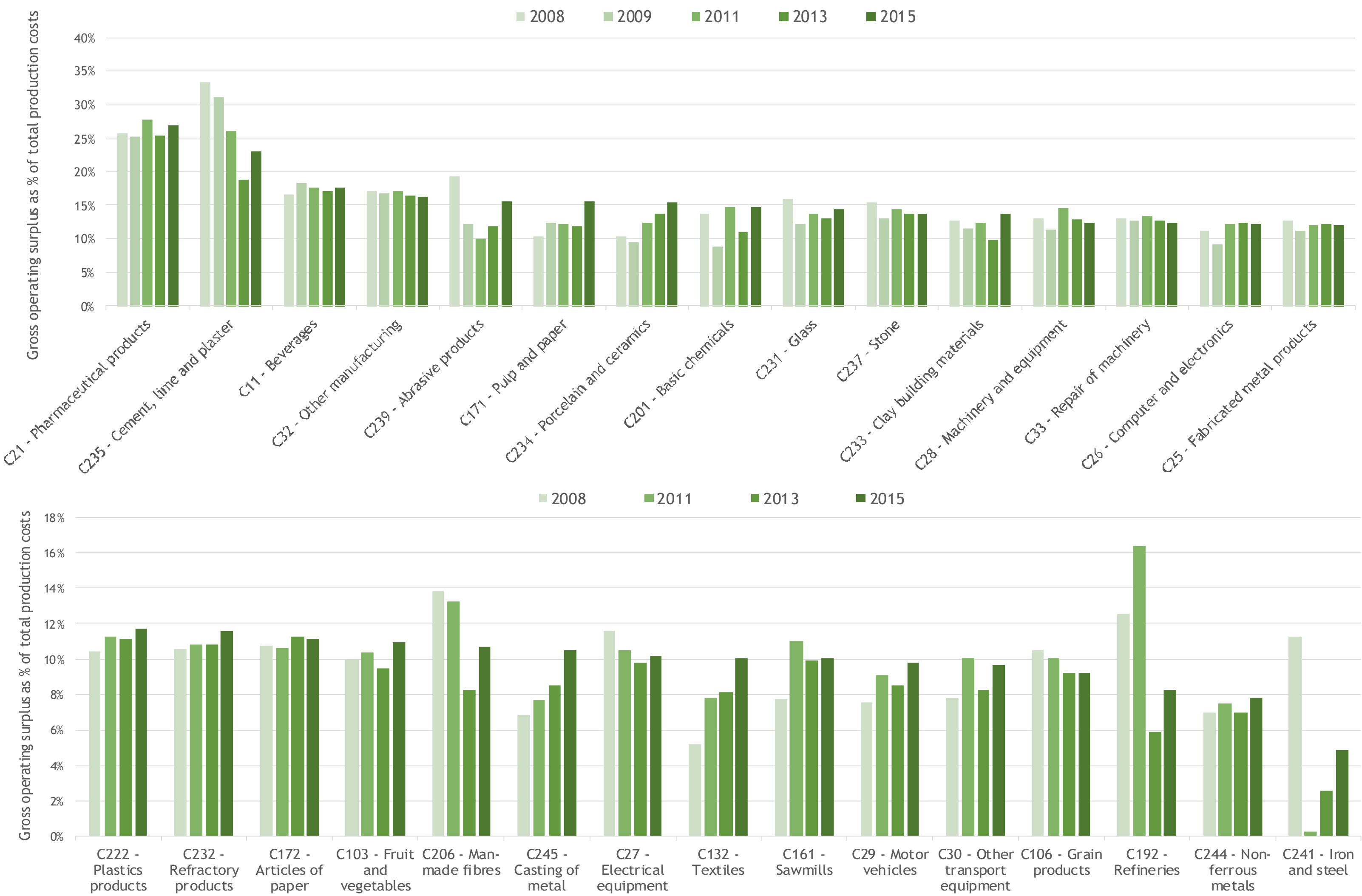


Source: Own calculations based on Eurostat SBS

The figure above presented results as an average for all sectors. In Figure 4-13 the trends for a range of sectors are presented, this shows that:

- EU sector average gross operating surplus as percentage of production cost was mainly between 5-15%. In the sectors of pharmaceuticals (C21); cement, lime and plaster (C2350, beverages (C11) and other manufacturing (C32) average gross operating surplus was higher. Iron and steel (C241)was an exception on the lower side, with an average gross operating surplus of 3.2%, and in one year (2009) a negative surplus (loss);
- Between 2008-2015 average gross operating surplus has increased and decreased for a number of sectors alike. The highest change in this period is found in the textiles sector (C132) where the gross operating surplus has increased over 94% since 2008. High increases are observed for casting of metal (C245), pulp and paper (C192), and porcelain and ceramics (C234) (around 50%). The most significant declines on the other hand are observed in the iron and steel (C241) sector (-57%), and then in the refineries' (C191), cement, lime and plaster (C235), and motor vehicles (C29) (around -30%).

Figure 4-13: 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



Source: Own calculations based on Eurostat SBS

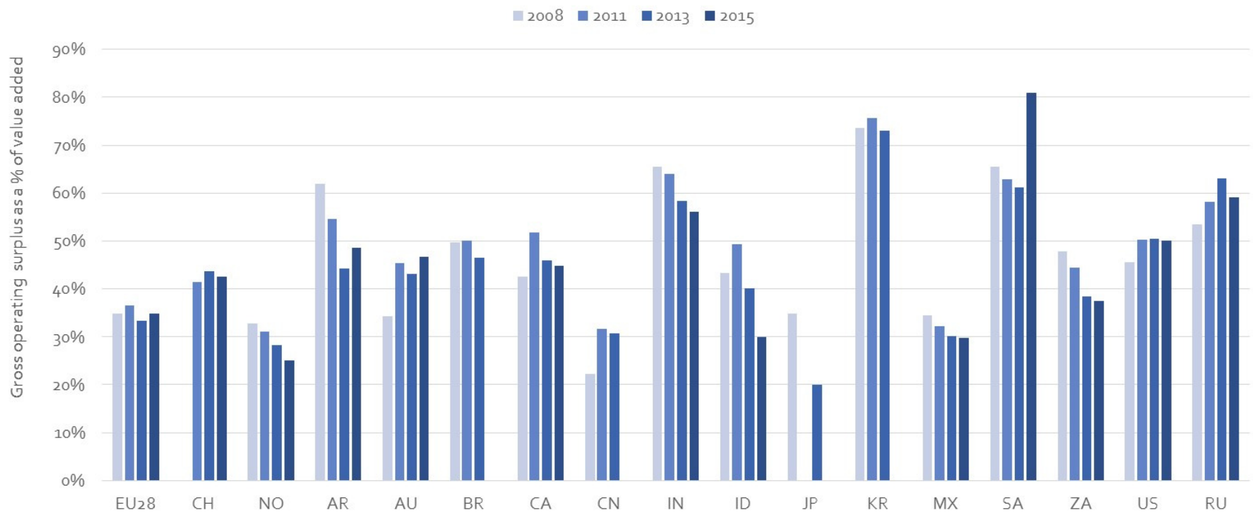
4.5.2 *Profitability international comparison*

In addition to the previous the analysis on value added and gross operating surplus, an intenational comparison can reveal if international competitors are also facing similar competitive pressures on margins.

Figure 4-14 provides such an international comparison of gross operating surplus as the share of total production costs (average across all sectors) for the period 2008-2015.

- The average EU28 gross operating surplus is lower than that of most of the countries for which it has been calculated namely Switzerland (CH), Argentina (AG), Australia (AU), Brazil (BR), Canada (CA), India (IN), Indonesia (ID), South Korea (KO), Mexico (ME), South Africa (ZA), the US, Russia (RF). In other words, the EU gross operating surplus in that period has only been higher than in Norway (NO), China (CN) and Japan (JP);
- From the countries for which the whole time-series is available Saudi Arabia (SA), Russia, and South Korea have the highest surpluses, above 55% in every year;
- The trend differs per country. For most of the countries the gross operating surplus has decreased in this period (i.e. EU28 – albeit very little, Norway, Argentina, Brazil, India, Indonesia, Japan, South Korea, Mexico and South Africa). The trend has been upward in Switzerland, Australia, Canada, China, South Africa, Russia and the US.

Figure 4-14: Gross operating surplus as % of value added (at factor cost), average across all sectors, international comparison 2008-2015



Source: Own calculations based on Eurostat SBS

4.6 Decomposition analysis of energy costs (Sub-task 2.3a)

Changes in energy costs over time are driven by a range of factors. The aim of this sub-task is to provide some insight into the key drivers of energy costs, and to assess the extent to which changes in energy costs have contributed to changes in the total cost of production over recent years for the selected industrial sectors, some of which are energy-intensive[41].

[41] See Table 4-9 for full list of industry sectors that were considered.

To isolate the impact of fundamental drivers of energy costs (by EU Member State and industry sector) over 2010-2015[42], we carry out a decomposition using the Log Mean Divisia Index (LMDI). The LMDI was first used by Ang et al (1998)[43] and is one of many methods of index decomposition analysis applied in the academic literature to assess changes in energy consumption and costs. The results from the additive LMDI show, for a given percentage change in energy costs over the period 2010-2015, the extent to which this change is attributable to changes in each driver over the same period.

As shown below, energy costs can be defined as the product of industry output[44], energy consumption per unit of output (i.e. energy intensity), and the price of energy consumed:

$$Energy\ costs = Output\,(constant) \times \frac{Energy}{Output\ (constant)} \times Price\ of\ energy$$

$$\Delta Energy\ Costs\ = (real)\ output\ effect + \ (real)\ energy\ intensity\ effect + price\ effect$$

Consistent with the equation above, using the LMDI method, the key drivers of energy costs that are isolated and quantified are:

- **Real output effects** - the effect of changes in production;
- **Real energy intensity effects** - the effect of changes in energy per unit of output over time due to energy efficiency measures, behavioural changes, industry structural change;
- **Fuel price effects** - the effect of changes in current coal, gas and electricity prices.

The result of this bottom-up calculation of energy costs (by industry sector and Member State) is compared to the Eurostat SBS 'Purchases of Energy Products' data. The difference between the calculated change in energy costs and the change in energy costs according to published SBS data is isolated and presented as residual effect. This residual effect captures drivers of change in energy costs that are unidentifiable from the available energy consumption and price data.

The output, energy intensity, fuel price and residual effects are estimated for a selected group of industrial sectors (some of which are energy-intensive) in each Member State[45]. In the section below, we describe in more detail these three drivers of energy costs, how they are estimated and where the required data is sourced from.

4.6.1 The real output effect

The real output effect incorporates the effects on energy costs resulting from changes in the level of industry production. This might include, for example, the effect of an economic recession, a boost to trade resulting from exchange rate movements, an increase in demand for a product, or reduced production due to international competitive pressures.

[42] As energy consumption data is only available over 2010-2015, the analysis has been restricted to only cover that time period.
[43] Ang et. al (1998), 'Factorizing changes in energy and environmental indicators through decomposition' *Energy, 1998, vol. 23, issue 6, pages 489-495*
[44] Industry production (gross output) is used as the activity indicator. Alternative activity indicators include GVA, however, the issue with using GVA as an activity indicator is that, if intermediate consumption of energy falls (e.g. due to energy efficiency improvements), then, by definition, GVA will increase, as the total cost of energy would be lower for the same level of output. This would lead to a bias in the results, as we would underestimate the output effect on emissions. To better isolate the impact of production output on emissions it is preferable to use the indicator which most closely trends with material output.
[45] Refer to Table 4-9, which shows the full list of sectors (ranked in order of the share of energy costs in total production costs, consistent with Figure 4-1).

We use constant price gross output data (by industry sector), to measure the effect of changes in productive activity on energy costs in each industry sector. This metric is calculated using current price turnover data from Eurostat SBS, deflated using sector-specific deflators (at the NACE 2-digit level) from Eurostat. This measure is not a perfect reflection of changes in physical output, but it is a close proxy. By using constant price data (deflated using sector-level deflators), we control for changes in sectoral price, and this indicator therefore only reflects changes in real production volumes.

4.6.2 The real energy intensity effect

Of the three contributing factors to industrial energy costs, energy intensity of output is perhaps the most interesting, as this measure incorporates the effects of:

- (actual) energy efficiency measures;
- changes in industry structure;
- weather patterns and temperature effects; and
- behavioral changes.

Due to data limitations at the NACE 3-digit level, we did not isolate the impact of each of these individual components but we do provide an estimate of the overall effect of changes in energy intensity on energy costs over 2010-2015.

To estimate energy intensity by industry sector, by Member State, and in each year over the period 2010-2015, we take the ratio of total energy consumption per unit of real output. For Member States where energy consumption data is unavailable, the energy intensity effect was estimated based on changes in the average intensity for that sector, using weighted averages for EU countries where data is available. Therefore, in those countries where data is unavailable, the sectoral energy intensity effect is assumed to be the same as the EU average. The sum of the energy intensity effects and the output effects reflect the total impact on energy costs due to changes in energy demand.

4.6.3 The energy price effect

The energy price effect captures the effect of changes in weighted-average energy prices on energy costs faced by firms. The prices used for the analysis are in current terms and exclude all recoverable tax and levies (such as VAT). This indicator therefore reflects changes in the ultimate (current) energy prices faced by each industry sector. The price effects are estimated by combining estimates of the energy mix at a sectoral level and energy price data (by fuel type) over the period 2010-2015. Energy price data is available from Eurostat by consumption band (but not buy industry sector) and so, for each industry sector and for each fuel type, an assumption is made about the energy consumption band that most industrial production would fall into[46] (refer to Table 4-5 and Table 4-6 in Section 4.2).

To calculate the effects of energy prices on industry energy costs at the Member State level, we weight the prices of individual fuels, using an estimate of the fuel consumption shares in each sector (refer to Figure 4-6). As no data is available for 'other' fuel prices (biomass and heat), we implicitly assume that the price of 'other fuels' grows in line with the weighted-average energy price (considering coal, oil,

[46] Allocating industry sectors specified at the NACE 3-digit level to energy consumption bands specified by gross annual energy consumption is not straightforward; for many industries there is variation in total energy consumption at the plant level, so it is highly likely that different manufacturing plants will face different energy prices, even if they belong to the same industry sector and are located in the same Member State. For the decomposition analysis we are interested in changes in energy prices (and costs) over time, and so the mapping from industry sector to consumption band does not have a large bearing on the results in so far as the energy consumption bands reflect similar energy price trends over time. For example, at the EU28 level, electricity prices excluding recoverable taxes and levies increased by between 13% and18% in bands IA to IE over the period 2010-2015.

natural gas and electricity prices). The fuel shares that are used to weight the price indices are based on EU average shares over the period for each industry sector. Due to data limitations, the price effect does not take account of fuel switching over time. Furthermore, whilst the calculation does take account of industry-specific fuel consumption shares, it does not take account of Member State-specific fuel share characteristics. For each industry sector, the same fuel shares are used as weights across all EU Member States.

To calculate a representative price for each industry sector at the EU28 level, the Member State level prices are weighted by the total value of production (by Member State). Thus, the EU28 level results for each industry sector reflect a double-weighting of price: (i) (fixed) fuel shares are used to derive a representative weighted-average fuel price for each industry and each Member State (ii) (dynamic) Member State production shares are used to weight the Member State -level price effects, to derive an EU average price effect for each industry sector.

Differences in the price effect across sectors reflect differences in the fuel mix of each sector, as well as plant-level differentials in prices (as plants with higher energy requirements are typically offered discounted rates). As the EU28 level results are production-weighted, differences at the EU28 price effect can also reflect shifts in the location of production (i.e. the weights).

4.6.4 The residual

There are some inconsistencies between the historical energy costs data that is available from different sources. For this analysis, it is important to isolate and quantify the key drivers of energy costs at a sectoral level. To do this, we use published data for each component of the decomposition: energy price data for the relevant consumption band from Eurostat, energy consumption data from the ODYSEE/MURE database and other national data sources, and gross output data from the Eurostat SBS. Given the data limitations, we believe that this approach is the most robust way to quantify the relative impact of the various drivers of energy costs.

However, the result of our bottom-up calculation of energy costs (by sector) is, in some cases, different to the published Eurostat SBS data for ‘Purchases of Energy Products’ and so there appears to be a large unexplained component. The mis-match between our component calculation and the ‘Purchases of Energy Products’ data from the Eurostat SBS is isolated and is saved as a residual term. The residual, in part, captures the effect of fuel switching over the period, as our decomposition calculations assume fixed fuel shares over 2010-2015. However, it is unlikely that fuel switching alone accounts for much of the data discrepancy.

The unexplained residual component is not attributed to any of the effects, as it is impossible to identify the reason for this data discrepancy. The data discrepancy is likely to arise from issues with the underlying data. As mentioned in the section above, there are a lot of missing data, in particular, for the energy consumption series. In these cases, data gaps are filled using sectoral energy-intensity figures for those countries where data is available. In some cases, this means relying on trends in Germany and a few other countries to predict the wider sectoral trends at the EU28 level. It is therefore possible that our residual term is partly picking up some energy intensity effects that were impossible to identify from the limited energy consumption data that was available. On the other hand, the data inconsistencies could be explained by inconsistencies in the Eurostat SBS data, which bases industry sectoral trends on results from a survey of businesses. These data discrepancies are important to be aware of when interpreting the results and making comparisons to the results reported earlier in this chapter.

The residual term is isolated and quantified for the decomposition analysis. For the purposes of this analysis, the change in energy costs over time is thus defined as:

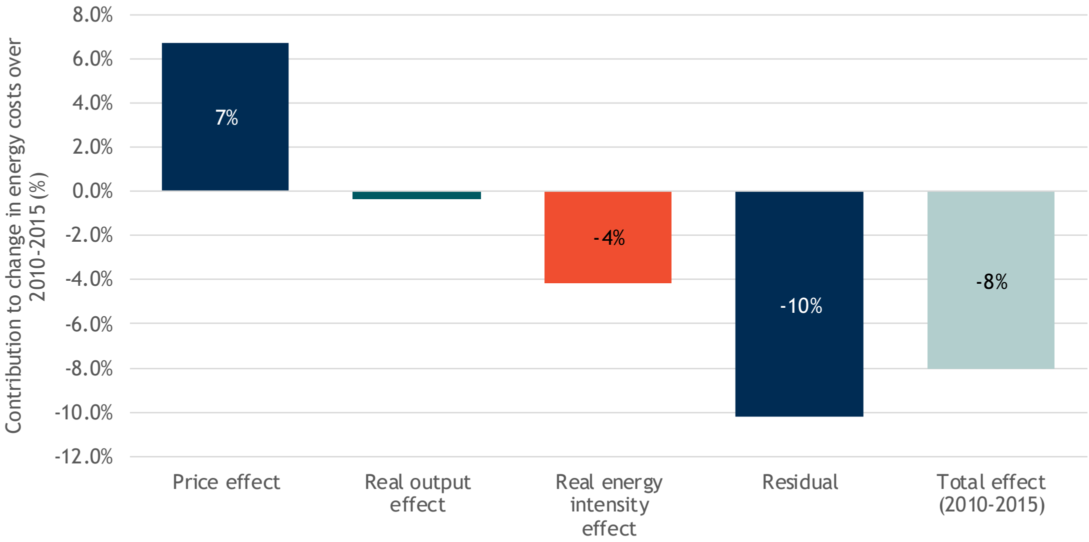
$$\Delta Energy\ Costs\ = (real)\ output\ effect +\ (real)\ energy\ intensity\ effect + price\ effect + residual$$

4.6.5 Results

The drivers of changes in energy costs across different industry sectors are diverse. As shown in Figure 4-15, at an aggregate level across all the industry sectors considered, the SBS data suggests there has been an 8% reduction in energy costs over the period 2010-2015. To some extent, energy intensity improvements have balanced increases in energy prices, but, as is clear from Figure 4-15, much of the reduction in energy costs over the period is unexplained (when compared to the component data that is available). For the selected list of manufacturing sectors, over the period 2010-2015, we find that, at the aggregate level:

- energy price increases contributed to a 7% increase in energy costs;
- changes in levels of production (real output) had close to zero impact on energy costs;
- reduced energy-intensity contributed to a 4% energy cost saving;
- other unexplained (residual) factors are accountable for a 10% energy cost saving.

Figure 4-15: Breakdown of drivers of the increase in energy costs over the period 2010-2015 (EU28 average across all industry sectors considered)



Source: Own calculations

Note: Estimates for the price, production and energy intensity drivers are not themselves compound growth rates for the respective driver (which are not additive) but reflect each driver's contribution to the total change in energy costs over the period. The residual effect is derived as the difference between our bottom-up calculation of energy costs and the 'purchases of energy' data reported in the Eurostat SBS,

When the results are inspected at a higher level of granularity, it becomes clear that the impact of energy cost drivers across sectors are diverse. The decomposition analysis on industry energy costs was also carried out at the Member State level[47], and much of the variation can be explained by Member State-specific drivers i.e. where growth in energy prices, industry production and energy intensity have not followed EU average trends. The results that are presented here at the EU28 level. The difference in drivers of EU average energy costs at a sectoral level therefore partly reflect:

- *differences* in the location of production (e.g. if a high share of production takes place in a Member State where energy prices grow at a higher rate than the EU average, this will be reflected in the price effect);
- *changes* in the location of production (e.g. if production grows at a faster rate in countries where energy prices are lowest, the price effect will be reduced, purely because production has shifted to countries with lower energy prices).

Table 4-9 below presents results for the decomposition analysis, for each industry sector considered. Charts of results by Member State and by sector are available in Annex G and in the accompanying workbook.

Table 4-9: Decomposition of energy cost drivers at the EU28 level over the period 2010-2015

Code	Description	Price effect	Real output effect	Real energy intensity effect	Residual (unexplained component)	Total effect
	High energy-intensity sectors					
C235	Manufacture of cement, lime and plaster	0%	-13%	-2%	-21%	**-37%**
C233	Manufacture of clay building materials	7%	-3%	-8%	-2%	**-5%**
C171	Manufacture of pulp, paper and paperboard	7%	-7%	3%	-22%	**-19%**
C231	Manufacture of glass and glass products	8%	-1%	-3%	-4%	**0%**
C241	Manufacture of basic iron and steel and of ferro-alloys	8%	-10%	0%	-28%	**-29%**
C206	Manufacture of man-made fibres	7%	-25%	17%	-27%	**-27%**
C232	Manufacture of refractory products	6%	1%	-20%	8%	**-5%**
C201	Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms	2%	-17%	23%	-19%	**-11%**
C239	Manufacture of abrasive products and non-metallic mineral products n.e.c.	6%	4%	-18%	23%	**15%**
C245	Casting of metals	11%	-1%	-2%	-18%	**-9%**
C234	Manufacture of other porcelain and ceramic products	10%	1%	-23%	14%	**1%**
C192*	Manufacture of refined petroleum products	N/A	N/A	N/A	N/A	**N/A**
C244	Manufacture of basic precious and other non-ferrous metals	10%	6%	-1%	-17%	**-3%**
C237	Cutting, shaping and finishing of stone	-5%	-23%	-30%	35%	**-23%**
C161	Sawmilling and planing of wood	8%	11%	4%	-18%	**5%**
	Lower energy-intensity sectors					
C106	Manufacture of grain mill products, starches and starch products	17%	6%	-12%	0%	**11%**

[47] For results at the Member State level, refer to accompanying workbook.

Code	Description	Price effect	Real output effect	Real energy intensity effect	Residual (unexplained component)	Total effect
C222	Manufacture of plastics products	12%	-3%	-3%	-1%	**6%**
C172	Manufacture of articles of paper and paperboard	11%	-1%	-11%	-10%	**-10%**
C103	Processing and preserving of fruit and vegetables	11%	9%	-5%	-5%	**10%**
C11	Manufacture of beverages	5%	1%	-13%	5%	**-1%**
C132	Weaving of textiles	3%	-11%	-31%	-4%	**-44%**
C25	Manufacture of fabricated metal products, except machinery and equipment	3%	3%	-21%	8%	**-8%**
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	13%	3%	-23%	13%	**6%**
C32	Other manufacturing	11%	5%	-11%	-15%	**-10%**
C33	Repair and installation of machinery and equipment	7%	8%	-22%	4%	**-3%**
C27	Manufacture of electrical equipment	8%	3%	-27%	7%	**-9%**
C28	Manufacture of machinery and equipment n.e.c.	10%	9%	-26%	11%	**4%**
C26	Manufacture of computer, electronic and optical products	18%	3%	-3%	-16%	**2%**
C30	Manufacture of other transport equipment	17%	10%	-14%	1%	**13%**
C29	Manufacture of motor vehicles, trailers and semi-trailers	13%	23%	-17%	3%	**21%**

Source: Own calculations

Note: The residual captures the inconsistency between the SBS energy cost data and the overall change in energy costs, as derived using data from other sources (i.e. the product of energy prices, from Eurostat, and energy consumption, from ODYSEE and others).

* Energy consumption time-series data for C192 (Manufacture of refined petroleum products) is particularly limited. The decomposition analysis is therefore not carried out for this sector as the robustness of the result would be compromised by the severe data limitations.

Price effects

The results from the decomposition analysis show that, across almost all industry sectors analysed at the EU28 level, increases in current energy prices contributed to a 5%-10% increase in current energy costs over the period 2010-2015. This price effect mostly reflects increases in electricity prices, with electricity accounting for the largest share of energy consumption for many of the sectors included in the analysis. Notably, the results reflect an increase in network costs and tax paid on electricity by industry, as the wholesale price of electricity fell over this period (refer to Chapter 3). Gas is another important energy source for many energy-intensive industries and gas prices remained relatively stable in current terms over the period.

Whilst the energy price effect was positive among all energy-intensive industry sectors at the EU28 level, there were a few sectors which showed markedly different energy price trends.
In one of the medium energy-intensity sectors considered, *Cutting, shaping and finishing of stone (C237)*, changes in energy prices are estimated to have contributed to a 5% reduction in energy costs over 2010-2015. The reason that the price effect is negative for this sector is mostly explained by shifts in production away from regions with high energy costs. In this sector, annual turnover in Spain and Italy

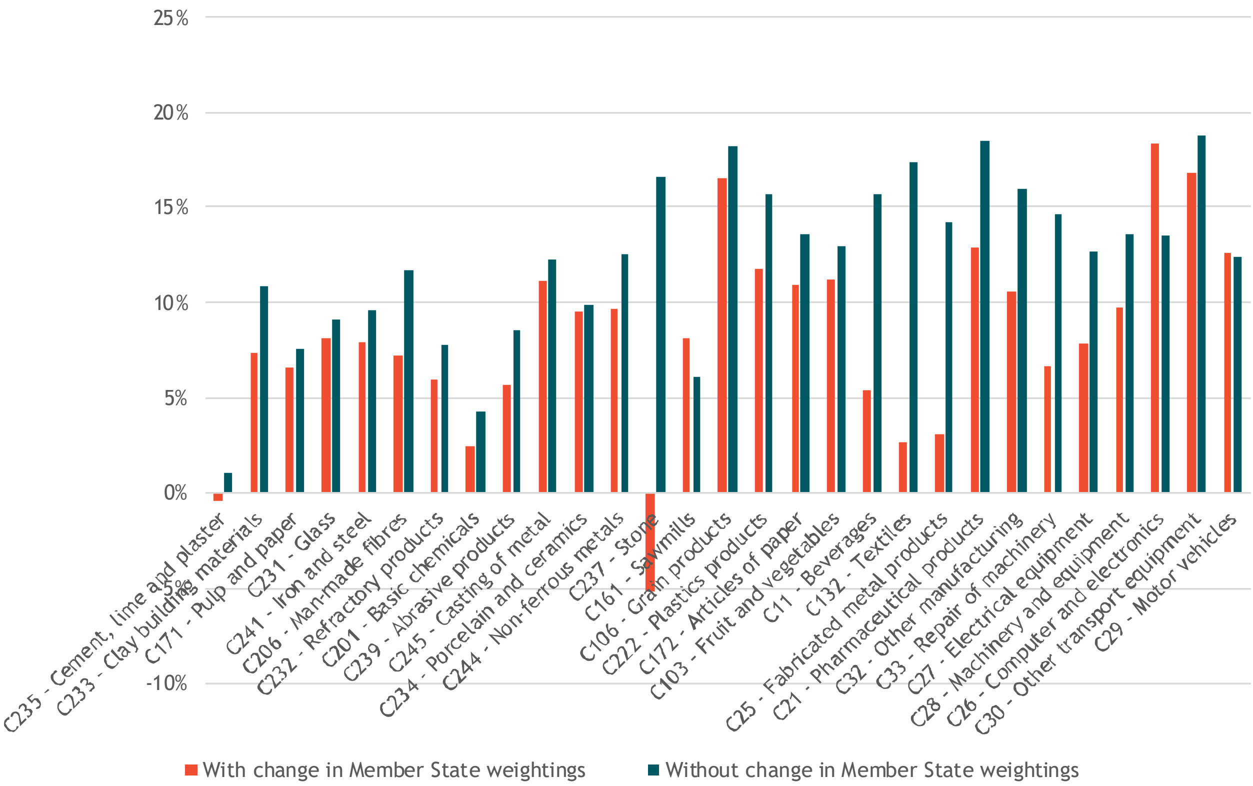
fell considerably (by around €2.4bn) over the period 2010-2015[48]. Electricity prices faced by *Cutting, shaping and finishing of stone (C237)* in both Spain and Italy are estimated to have been around 30-40% higher than the EU average. The relatively high electricity prices faced by this sector in Spain and Italy may partly explain why production shifted out of these countries over that period. However, *Cutting, shaping and finishing of stone (C237)* is not a particularly energy-intensive activity and it is noted that falls in production within this industry sector over the period 2010-2015 were also experienced in most other EU Member States. This shift in the location of production away from Italy and Spain also explains why the energy price effect for this sector was negative. Although production in this sector fell over 2010-2015 among most EU Member States, a higher *share* of EU production is now located in Member States with lower electricity costs.

Figure 4-16 shows the energy price effect at the EU level under the assumption of constant Member State weights over 2010-2015, compared to the estimated energy price effect, when changes in Member State weights over time are taken into account. The difference between the orange and green bars in this chart reflects the impact on the price effect due to changes in the location of production within Europe. Industry sectors where the orange and green bars are most different, reflect cases where there have been large shifts in the shares of production among EU Member States (or shifts in shares of production among Member States with very different energy prices). From this chart, it is immediately evident that the negative energy price effect estimated for *Cutting, shaping and finishing of stone (C237)* at the EU28 level is fully explained by regional shifts in the share of production.

As shown in Figure 4-16, other sectors where geographical shifts in production were an important determinant of the price effect at the EU level included *Weaving of textiles (C132), Manufacture of beverages (C11)* and *Manufacture of fabricated metal products (C25)*. In all but two industry sectors (namely *Manufacture of computer, electronic and optical products (C26)* and *Sawmilling and planing of wood (C161))* regional production shares fell most in those countries where energy prices increased most. This result may indicate that firms are re-locating production to regions with lower energy price pressures. However, it could also be the case that these shifts in production shares are explained by other factors (e.g. growth in other raw material costs).

[48] Turnover in sector C237 actually fell in most Member States, to varying degrees. The fact that turnover fell less in Member States with lower energy prices meant that the price effect at the EU28 level was small or negative, because of changes in weighting.

Figure 4-16: The 'energy price effect' with and without changes in the weights applied to Member States



Source: Own calculations

Note: Industry sectors are ordered according to energy intensity, with Cement, lime and plaster (C235) identified as the most energy-intensive sector.

Industry sectors where the energy price effect was more modest, include:

- *Manufacture of beverages (C11);*
- *Weaving of textiles (C132);*
- *Manufacture of cement, lime and plaster (C235;)*
- *Manufacture of fabricated metal products, except machinery and equipment (C25);*
- *Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms (C201)*

In each of these cases, increases in energy prices contributed to a 0-5% increase in energy costs over 2010-2015 at the EU level. In these sectors, the reason for the low price effect is largely because production took place in Member States where energy price rises were more modest and/or because production shifted to Member States where energy prices are lower. In the case of *Manufacture of beverages (C11)*, for example, growth in output was highest in France (a country with relatively low industry electricity prices), while declines in output occurred in Denmark and Greece (countries with higher electricity prices). In *Manufacture of cement, lime and plaster (C235)*, which is one of the most energy-intensive sectors, another reason for the low energy price effect is because oil consumption is estimated to account for 37% of total energy consumption in this sector and, whilst other energy prices increased over 2010-2015, oil prices fell considerably.

The fall in oil prices also impacted *Manufacture of basic chemicals (C201)*, where oil costs also account for a significant proportion (around 40%) of total energy costs. However, in this sector, the benefits of lower oil prices were outweighed by the effect of increases in production in countries with relatively high industry electricity prices (Germany and Belgium) and reduced production in France, where industry electricity prices are below the EU average.

The estimated price effect was largest in *Manufacture of computer, electronic and optical products (C26)*. In this sector, electricity costs account for over 80% of total energy costs. Germany, France and the UK account for around two-thirds of the total value of production in the sector and are also among the EU countries that have experienced the largest increases in current electricity prices over 2010-2015[49].

Real output effects

For around half of the sectors included in the analysis, the real output effect was positive. It is noted that the real output effect was negative for most of the more energy-intensive industry sectors and was positive for most of the less energy-intensive industry sectors, reflecting that reductions in sectoral energy costs for high energy-intensity industry sectors are partly explained by increases in economic activity (as measured by turnover), and vice-versa for the less energy intensive industry sectors.

The output indicator is presented in constant price terms (using sector deflators at the NACE 2-digit level) and so changes in this indicator reflect real changes in the volume of production. Those sectors and Member States that saw the largest falls in real output over 2010-2015 include:

- *Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms (C201)* in France;
- *Manufacture of man-made fibres (C206)* in the UK, the Netherlands, Belgium and Spain;
- *Manufacture of cement, lime and plaster (C235)* in Spain, Italy and Greece;
- *Cutting, shaping and finishing of stone (C237)* in Italy and Spain.

The reductions in real output in the non-metallic minerals sectors in Spain and Italy may be partly explained by reduced domestic demand for mineral products, as construction sector activity in these countries has contracted following the global financial and economic crisis. It is noted that the relatively high electricity prices faced by these sectors in Spain and Italy, in particular, could also explain the large fall in output (as this might be the reason for production shifts to countries outside Europe where costs are lower and industry is more competitive). However, in Spain, the fall in production over this period has not been as severe as the fall in domestic demand and Spanish exports of non-metallic minerals have increased, suggesting that Spanish industry remains internationally competitive and/or is experiencing squeezed margins but continuing production, with the expectation that demand may pick up again in the future.

The sectors with the largest positive output effects included *Manufacture of motor vehicles (C29)* and *Manufacture of other transport equipment (C30)*, where increases in real output[50] contributed to a 23% and 10% increase in energy costs, respectively, at the EU28 level. These are examples of sectors that are less affected by energy price increases, as energy costs contribute to a relatively small share of total production costs, and manufacturers compete on quality as well as price. There was also a large real output effect in *Processing and preserving of fruit and vegetables (C103)* and *Sawmilling and*

[49] Electricity prices (excluding recoverable tax and levies) faced by sector C26 (Manufacture of computer, electronic and optical products) are estimated to have risen by 22%, 32% and 58%, respectively, in Germany, France and the UK over the period.
[50] Gross output in these sectors increased most noticeably in Germany and the UK, which each experienced annual growth in constant price output of over 3% pa.

planing of wood (C161), where constant price turnover at the EU level increased by €5.9bn and €3.9bn, respectively. In the case of *Processing and preserving of fruit and vegetables (C103)*, the effect was mostly driven by growth in the UK (and, to a lesser extent, by growth in Germany, Belgium, Spain, Italy and Poland). By contrast, in *Sawmilling and planing of wood (C161)*, growth in output has concentrated in Finland and Germany.

Energy-intensity effects

Of all of the drivers of energy costs that have been isolated and quantified, energy-intensity effects are the least robust of our estimates as, in many cases, we are reliant on data (or estimations) for around five countries, where both energy consumption and gross output data is available, to proxy trends in energy-intensity at the EU level. This is particularly the case for the industry sectors that are defined at the NACE 3-digit level. The unexplained residual component that is isolated in Table 4-9 captures changes in energy intensity due to fuel switching and could also be partly capturing other energy intensity effects.

Our EU28-level estimates from the available energy consumption data suggest that, in most cases, the energy intensity of manufacturing industries fell over the period. This is likely to be partly due to improvements in energy efficiency (either due to behavioural change, use of more energy efficient equipment or changes in the fuel mix) but could also be explained by changes in weather[51] or structural changes within each industry sector. By undertaking the analysis at a high level of sectoral detail (at the NACE 3-digit level), the scale of the structural effect is more limited. However, it is noted that there can still be considerable heterogeneity in production within sectors at the NACE 3-digit level. Examples of structural changes that are captured by this indicator would include changes in the prevalent production process in the steel sector[52] or changes in the types of chemicals that are manufactured in the basic chemicals sector.

It is likely that a large part of the energy intensity effect is attributable to changes in the efficiency of the manufacturing process and other structural effects. The efficiency improvements may reflect new investments to improve cost-competitiveness when energy prices are increasing[53], as well as a response to policies (such as the carbon price, energy efficiency loans and grants, energy audit or energy management systems and a package of other measures that have been offered to energy-intensive industry sectors, to incentivise energy efficient investments and reduce energy cost pressures).

One particularly interesting finding is that, among the sectors that are defined as 'less energy-intensive', there is a universal reduction in (real) energy intensity over the period 2010-2015. This energy intensity improvement is not always the case, however, in the most energy-intensive sectors (which would arguably have most incentive to reduce energy consumption, given that energy costs make up a larger portion of their total production costs). For the most energy-intensive industry sectors

[51] The impact of weather is likely to be small as, unlike in households and the commercial sector, only a small proportion of total energy consumed by industry is used for space heating and cooling purposes (and, furthermore, there was not a substantial change in weather patterns over the period considered).

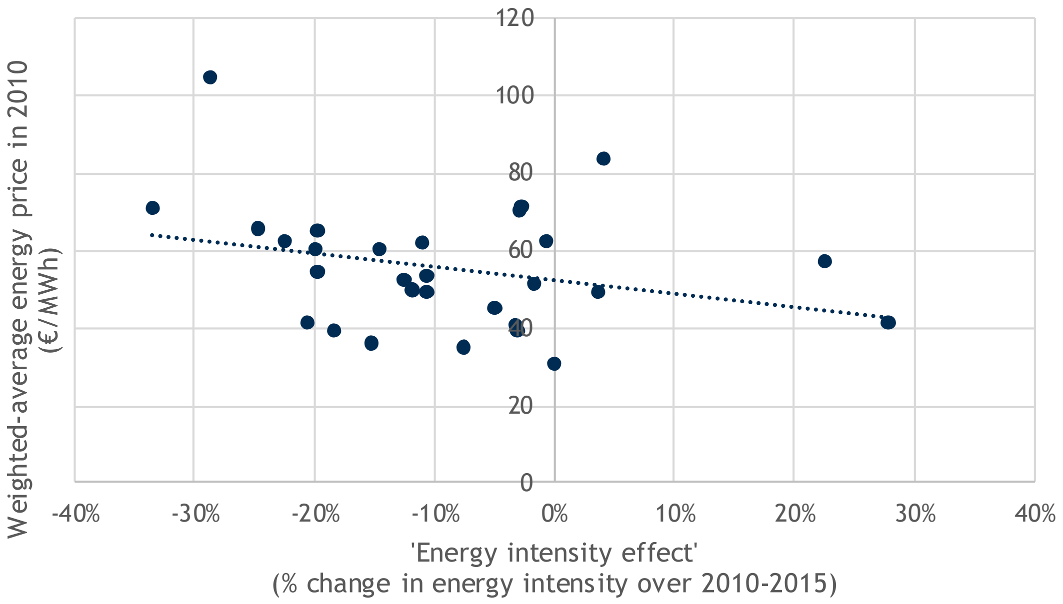
[52] Steel production in the EU uses either the Basic Oxygen Furnace (BOF) or Electric Arc Furnace (EAF) process. While both production processes are energy-intensive, the energy requirements are very different. The main energy costs to the BOF process is coking coal, while electricity is the primary energy cost for the EAF process. Changes to the structure of the steel manufacturing sector therefore could substantially affect energy intensity and energy costs.

[53] Results from a cross-sectional econometric analysis, shows that the price elasticity of demand for energy among industrial consumers is -0.2. That is, for every 1% increase in energy prices, energy consumption falls by 0.2%. This price-induced energy savings effect may partly explain the reduced energy intensity within the sectors. For most of the sectors considered, current energy prices increased by 5-10% over the period 2010-2015 and we therefore deduce that around 1-2% of the energy-intensity improvements are likely due to efficiency improvements by firms in response to the increase in current energy prices over the period.

(which are typically defined at NACE 3-digit level), the energy consumption data is more sparse, meaning that our estimates of the energy intensity effect in these cases are less reliable.

As shown in Figure 4-17, there is some evidence of larger improvements in energy intensity over 2010-2015 among those sectors that faced higher energy prices in 2010 (suggesting price-induced efficiency improvements), although the correlation between the two is not particularly strong.

Figure 4-17: Correlation between energy price in 2010 and energy intensity effect over 2010-2015, at a sectoral level



Source: Own calculations

The sectors that have seen the largest energy cost savings due to estimated energy intensity improvements include:

- *Weaving of textiles (C132):* 31% reduction in energy costs due to reduced energy intensity;
- *Manufacture of basic pharmaceutical products and pharmaceutical preparations (C21):* 23% reduction in energy costs due to reduced energy intensity;
- *Cutting, shaping and finishing of stone (C237):* 30% reduction in energy costs due to reduced energy intensity;
- *Manufacture of other porcelain and ceramic products (C234):* 23% reduction in energy costs due to reduced energy intensity;
- *Manufacture of electrical equipment (C27):* 27% reduction in energy costs due to reduced energy intensity;
- *Manufacture of machinery and equipment n.e.c. (C28):* 26% reduction in energy costs due to reduced energy intensity;
- *Repair and installation of machinery and equipment (C33):* 22% reduction in energy costs due to reduced energy intensity;
- *Fabricated metal (C25):* 21% reduction in energy costs due to reduced energy intensity

Of the sectors listed above where estimated energy intensity improved considerably (by over 25%) over 2010-2015, only two sectors, namely *Manufacture of other porcelain and ceramic products (C234)* and

Cutting, shaping and finishing of stone (C237), are highly energy-intensive. The reason that we have not seen the same scale of energy intensity improvements in the other energy-intensive industry sectors could be because energy costs form such a large component of total production costs and, to remain competitive in international markets, these sectors have already been forced to use the most energy-efficient machinery and processes to remain internationally competitive. If that is the case, then there may be little scope to improve the efficiency of these processes any further. Alternatively, the results could reflect that firms belonging to these industry sectors are not investing in Europe any more, but in other parts of the world. However, energy intensive sectors in general have long-lived production assets, so sharp changes are likely to only occur if there are structural changes.

In some sectors, the change in energy intensity may also be due to structural change. An interesting case, where energy intensity improved considerably over the period 2010-2015 was in *Manufacture of basic pharmaceutical products and pharmaceutical preparations (C21)*. The fact that energy intensity improved considerably in this sector but fell in the related chemicals sector suggests that structural change in the types of products that are being manufactured could have an important role in explaining changes in energy intensity.

In many of the sectors with large energy intensity improvements, output also increased over the period and this increase in output is likely to have driven efficiency improvements due to economies of scale, and increased resources to invest in new, more efficient equipment. This is the case, for example, in: *Manufacture of machinery and equipment n.e.c. (C28)* and *Repair and installation of machinery and equipment (C33)*, where gross output was 8% higher in 2015 than in 2010. It is also the case, but to a lesser extent, in *Manufacture of electrical equipment (C27)* and *Fabricated metal (C25)*, where constant price output was 3% higher in 2015 than in 2010.

By contrast, EU gross output fell considerably (by €3.9bn, 23%) in *Cutting, shaping and finishing of stone (C237)* and to a lesser extent (by €2.3bn, 14%), in *Weaving of textiles (C132)*. In these cases, the change in energy intensity is mostly driven by shifts in production, away from Member States where production is more energy-intensive. It is also likely to be due to less efficient equipment coming out of service, leaving the newer, more energy-efficient plants in the market.

In a number of sectors, the energy intensity effect has contributed to an increase in energy costs:

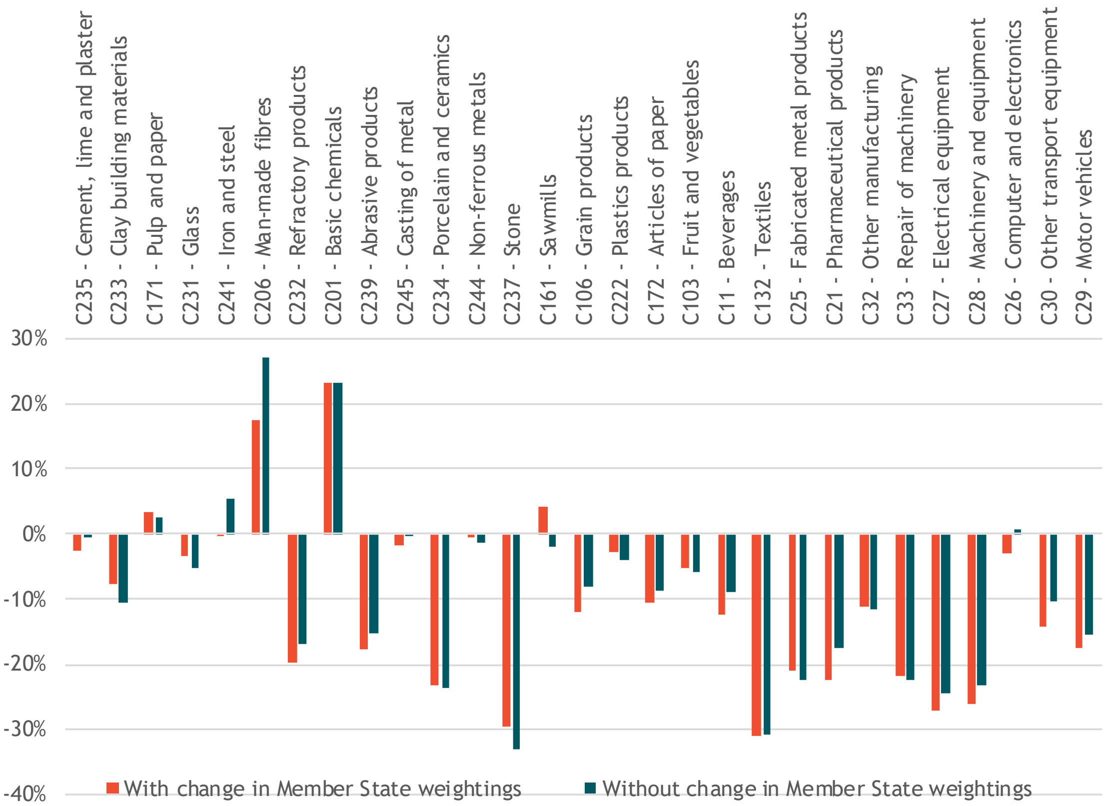
- *Sawmilling and planing of wood (C161)*: 4% increase in energy costs due to increased energy intensity;
- *Manufacture of pulp, paper and paperboard (C171)*: 3% increase in energy costs due to increased energy intensity;
- *Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms (C201)*: 23% increase in energy costs due to increased energy intensity;
- *Manufacture of man-made fibres (C206)*: 17% increase in energy costs due to increased energy intensity.

The reason that energy-intensity has seemingly increased in these industry sectors may be partly explained by relative growth across different firms/products in the EU, due to the heterogeneity of products within the sectors considered. For example, *Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms (C201)* is a particularly diverse industry sector and includes a wide variety of processes and products. This sector is also one of the most energy-intensive. In multi-stage supply chains, manufacturing processes are complex and varied, with the sector producing more than 30,000 distinct products[54] and different chemical companies combining different manufacturing processes and production of multiple products. The manufacture of petrochemicals, such as ethylene, and inorganic compounds, such as chlorine, are particularly energy-intensive, with the latter involving an electrolysis process. By contrast, the manufacture of natural dyestuffs and cosmetics use processes that are significantly less energy-intensive[55]. The trend in energy-intensity for this sector increased most noticeably in 2011, where it is likely that the structure of the aggregate sector was affected by the global economic downturn and changes in demand for certain chemical products. The energy intensity of *Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms (C201)* has further increased since 2013. This could be due to large falls in the feedstock and energy costs for the manufacture of ethylene (driven by the fall in oil prices and other costs in the EU), which has improved the competitiveness of EU companies.[56] The fall in production costs for this manufacturing process may have contributed to a relative increase in production of this particularly energy-intensive chemical product.

In *Manufacture of pulp, paper and paperboard (C171)* the increase in EU energy-intensity is relatively recent, with a fall in energy intensity observed within this sector over 2010-2012, followed by a gradual increase in energy intensity since 2013. By contrast, in *Sawmilling and planing of wood (C161)*, a relatively homogenous sector, there is a large increase in energy-intensity in 2011, followed by relative improvements in intensity over 2012—2015. One possible reason for this trend is due to lower investment in energy-efficient equipment at the time of the global economic downturn (2009-2010), which drove a decline in energy-efficiency immediately afterwards, in 2011. If this is the case then, over time, as investment picks up, energy efficiency may continue to improve.
The impact of different rates of regional growth across sectors on average EU energy-intensity (through changes to regional weights) is shown in Figure 4-18. The results show that there is not much evidence that changes in the location of production has affected the weighted-average energy intensity effect for the EU28, however, this is partly because of limited industry energy consumption data available at the Member State level (particularly for the more energy intensive sectors). In Manufacture of man-made fibres (C206) we estimate that over 5% of the increase in average EU intensity over the period is attributable to relocation of production effects[57] i.e. higher growth in EU Member States where production is more energy-intensive. However, it is likely that this effect is due to shifts in patterns of demand for certain energy-intensive products that are produced in specific Member States, given the relative diversity of this industry sector. It is unlikely to be due to relative growth in firms with high productive inefficiencies, as these energy inefficiencies lead to higher production costs and reduce the potential scale of growth in output.

[54] Ecofys (2015), 'Electricity Costs of Energy Intensive Industries: An International Comparison' https://www.ecofys.com/files/files/ecofys-fraunhoferisi-2015-electricity-costs-of-energy-intensive-industries.pdf
[55] EEF (2018), 'Sector Bulletin: Chemicals', available from: https://www.santandercb.co.uk/s3fs-factsheets/eef_santander_sector_bulletin_chemicals.pdf
[56] Cefic Economic Outlook Press Release (July-2018), available from: http://www.cefic.org/Documents/RESOURCES/Chemical%20Trends%20Report/Cefic_Economic_Outlook_July_2018.pdf
[57] This is likely to be an underestimate of the true effect from regional shifts in production, as data is missing for most EU Member States and, in these cases, average energy-intensity figures across the Member States where data is available is instead used.

Figure 4-18: The 'energy intensity effect' with and without changes in the weights applied to Member States[58]



Source: Own calculations

Note: Industry sectors are ordered according to energy intensity, with Cement, lime and plaster (C235) identified as the most energy-intensive sector.

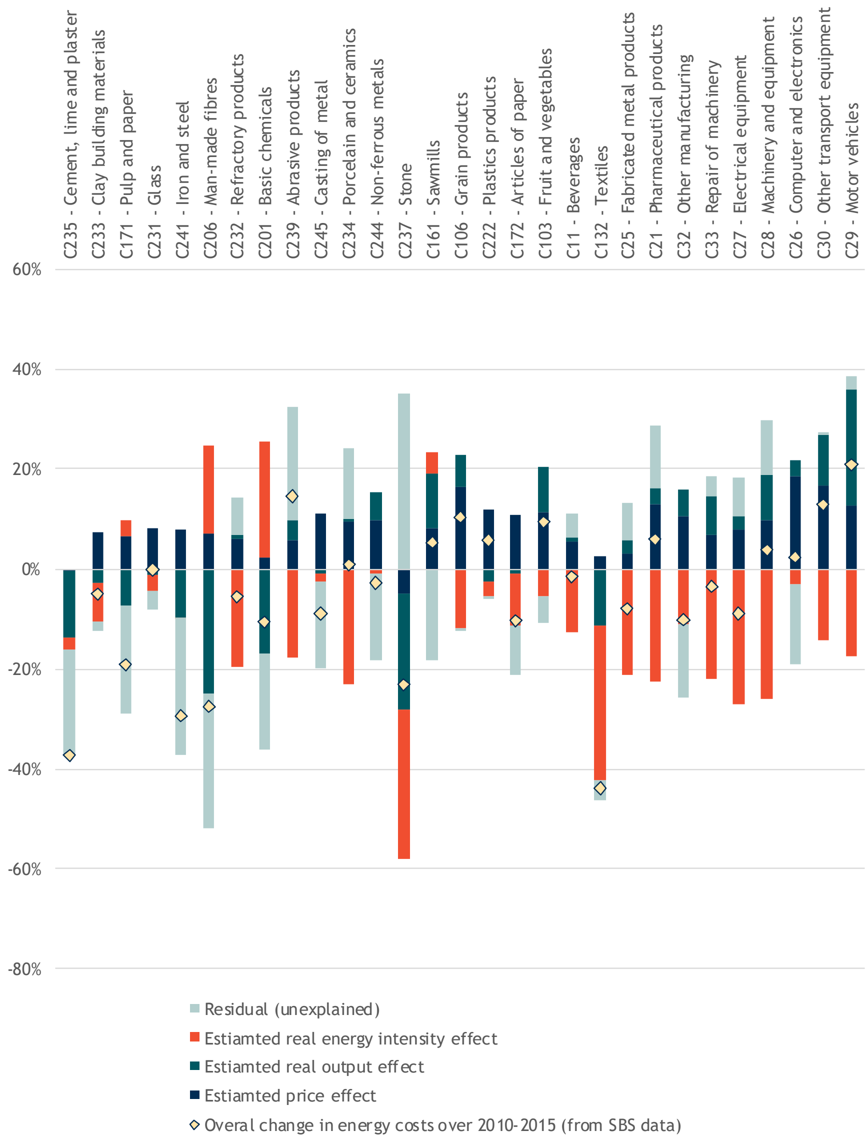
The residual

As explained above, there is, in some cases, a large discrepancy when comparing the component calculation of energy costs (based on available price and energy consumption data) to the 'Purchases of Energy Products' data from Eurostat SBS. This unexplained effect is isolated and presented as a residual term. Figure 4-19 presents the scale of this estimated residual (the unexplained change in industry energy costs) over the period 2010-2015 against our estimates of the other energy cost drivers. The dark blue, dark green and orange shading reflects the impacts on industry energy costs due to identified changes in industry energy prices, changes in industry output and changes in industry energy intensity, respectively. The pale blue bar shows the residual term and captures the discrepancy between the estimated change in energy costs from the Eurostat SBS data versus the estimated change in energy costs from a bottom-up component calculation. The yellow diamond shows the net change in energy costs over the period 2010-2015 according to the Eurostat SBS data (i.e. the summation of the price effect, the output effect, the intensity effect and the residual term). From inspection of Figure 4-19, it is immediately evident that, while there is no systematic under or over- prediction, the magnitude of the residual is often large and, in a number of cases, dominates the overall estimated impact. This is particularly that case in some of the more energy intensive industries, that are defined at the NACE 3-digit level. It is likely that this is due to issues with the reliability of data, particularly because, in many cases, the EU28 energy intensity effect is calculated using energy consumption data that is only

[58] This is likely to be an underestimate of the true effect from regional shifts in production, as data is missing for most EU Member States and, in these cases, average energy-intensity figures across the Member States where data is available is instead used.

available for a small number of Member States. It is noted, however, that the residual is often still large for individual countries, such as Germany, where more complete data is available.

Figure 4-19: Component drives of change in energy costs and unexplained residual at EU28 level over 2010-2015 (%)



Source: Own calculations

Note: Industry sectors are ordered according to energy intensity, with Cement, lime and plaster (C235) identified as the most energy-intensive sector.

4.7 Decomposition analysis of production costs (Sub-task 2.3b)

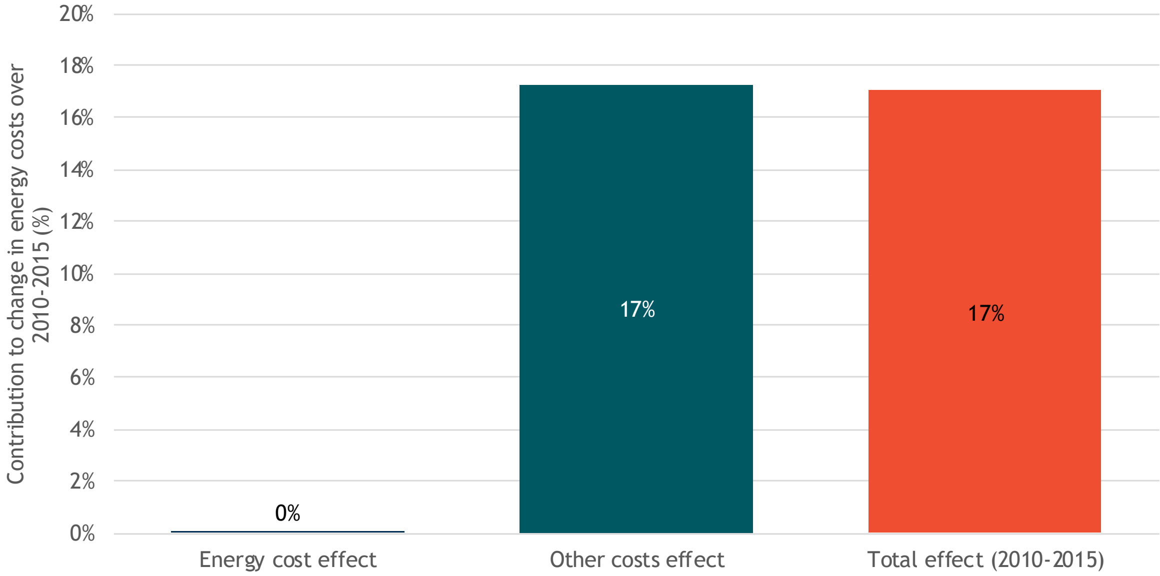
In addition to the decomposition of energy costs, in this section we present a decomposition of total production costs to show the extent to which changes in total production costs over recent years have been driven by changes in energy costs. The decomposition of production costs is based on Eurostat SBS data for energy purchases and total production costs and so, by definition, no residual term is left over.

$$Total\ production\ costs = Energy\ costs + Other\ costs\ of\ production$$

$$\Delta Total\ production\ costs = \Delta Energy\ costs + \Delta Other\ costs\ of\ production$$

As shown in Figure 4-20, at an aggregate level, the increase in total industry production costs over the period 2010-2015, is almost entirely explained by increases in other (non-energy) costs. The table below presents the results at the EU28 level. The energy cost effect reflects the extent to which changes in energy costs have affected total costs of production in each industry sector.

Figure 4-20: Breakdown of drivers of the increase in production costs over the period 2010-2015 (EU28 average across all industry sectors considered)



Source: Own calculations

Table 4-10: Decomposition of changes in total industry sector costs into energy cost drivers vs other cost drivers over the period 2010-2015

Code	Description	Main energy carrier used by sector	Energy cost effect	Other cost effect	Total effect
		High energy-intensity sectors			
C235	Manufacture of cement, lime and plaster	Oil	-8%	-7%	-15%
C233	Manufacture of clay building materials	Natural Gas	-1%	2%	1%
C171	Manufacture of pulp, paper and paperboard	Natural Gas	-2%	9%	7%
C231	Manufacture of glass and glass products	Natural Gas	0%	9%	9%
C241	Manufacture of basic iron and steel and of ferro-alloys	Natural Gas	-3%	-8%	-10%
C206	Manufacture of man-made fibres	Natural Gas	-2%	-7%	-9%
C232	Manufacture of refractory products	Natural Gas	0%	-3%	-3%
C201	Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms	Natural Gas	-1%	7%	7%
C239	Manufacture of abrasive products and non-metallic mineral products n.e.c.	Natural Gas	1%	10%	11%
C245	Casting of metals	Electricity	-1%	11%	11%
C234	Manufacture of other porcelain and ceramic products	Natural Gas	0%	14%	14%

Code	Description	Main energy carrier used by sector	Energy cost effect	Other cost effect	Total effect
C192	Manufacture of refined petroleum products	Oil (chemical feedstock); Natural Gas (energy input)	1%	-15%	-14%
C244	Manufacture of basic precious and other non-ferrous metals	Electricity	0%	17%	17%
C237	Cutting, shaping and finishing of stone	Electricity	-1%	-20%	-21%
C161	Sawmilling and planing of wood	Electricity	0%	22%	22%
		Lower energy-intensity sectors			
C106	Manufacture of grain mill products, starches and starch products	Natural Gas	0%	23%	23%
C222	Manufacture of plastics products	Electricity	0%	18%	18%
C172	Manufacture of articles of paper and paperboard	Natural Gas	0%	11%	11%
C103	Processing and preserving of fruit and vegetables	Natural Gas	0%	25%	26%
C11	Manufacture of beverages	Natural Gas	0%	6%	6%
C132	Weaving of textiles	Electricity	-2%	-2%	-3%
C25	Manufacture of fabricated metal products, except machinery and equipment	Electricity	0%	9%	9%
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	Natural Gas	0%	17%	17%
C32	Other manufacturing	Electricity	0%	15%	15%
C33	Repair and installation of machinery and equipment	Electricity	0%	14%	14%
C27	Manufacture of electrical equipment	Electricity	0%	10%	9%
C28	Manufacture of machinery and equipment n.e.c.	Electricity	0%	22%	22%
C26	Manufacture of computer, electronic and optical products	Electricity	0%	-6%	-5%
C30	Manufacture of other transport equipment	Natural Gas	0%	28%	28%
C29	Manufacture of motor vehicles, trailers and semi-trailers	Electricity	0%	42%	42%

Source: Own calculations

Note: Energy costs are taken from the 'Purchases of Energy Products' data (from Eurostat SBS). Other costs comprise 'personnel costs' and 'costs of goods and services, net of energy costs', calculated from the Eurostat SBS data. Results are rounded to the nearest percentage point and cases where the energy cost effect and the other cost effect do not sum to the total effect are due to rounding.

The effect of changes in energy costs on total production costs are relatively small among most of the industry sectors included in the analysis (and is estimated to have had between +1% to -8% impact on total costs of production over 2010-2015). In almost all cases, the effect of changes in energy costs on total production costs over 2010-2015 is smaller in magnitude than other cost drivers. The only exception to this rule is in the most energy-intensive sector, *Manufacture of cement, lime and plaster (C235)*, where over half of the reduction in total production costs is explained by a large negative energy cost effect over 2010-2015. In that sector, average EU28 energy costs fell substantially over the period, primarily due to reductions in gross output, but also partly due to small improvements in energy intensity. The decline in gross output in this sector is also apparent in the reduction in other non-energy costs, due to reduced requirements for material and labour inputs.

Among the other energy-intensive industries, there are a number of cases where reductions in energy costs drove a reduction in total costs of production of over 1% over the period 2010-2015, namely:

- *Manufacture of basic iron and steel and of ferro-alloys (C241);*
- *Manufacture of clay building materials (C233);*
- *Manufacture of pulp, paper and paperboard (C171);*
- *Manufacture of man-made fibres (C206);*
- *Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms (C201);*
- *Casting of metals (C245);*
- *Cutting, shaping and finishing of stone (C237.)*

In *Manufacture of basic iron and steel and of ferro-alloys (C241)*, where energy costs are an important component of total production costs, the dampening effect on energy costs due to reduced levels of output in the sector offset the upward pressure on energy costs from price effects. Current energy costs in this sector have fallen considerably over the period according to the data from Eurostat SBS, due to other (unexplained) factors, as captured by the residual term. Total production costs have also fallen in this industry sector, due to reductions in the costs of raw materials and other inputs to production. The -3% energy cost effect for the aggregate sector masks the fact that firms within this sector are facing increasing cost pressure from higher energy prices coupled with no evident energy intensity improvements.

In *Manufacture of clay building materials (C233)*, a fall in real output in the sector contributed to a 3% fall in energy costs, while an improvement in energy intensity drove an estimated 8% reduction in energy costs. Among many of the other sectors listed above, where energy costs fell over the period, it is harder to identify the drivers of these trends. In most cases, energy prices contributed to a 5-10% increase in energy costs. The overall reduction in energy costs across these sectors was explained by falls in real output, identified improvements in energy intensity and other unexplained factors.

Among the less energy intensive sectors, *Weaving of textiles (C132)* is an interesting case, where substantial efficiency improvements and structural change over recent years have led to a 3% reduction in costs of production over the period 2010-2015 (of which around half of the cost saving is explained by reduced energy costs). The large negative energy cost effect is mostly explained by substantial improvements in energy intensity. Even though *Weaving of textiles (C132)* is not particularly energy-intensive, lower energy costs due to improvements in energy intensity, as well as falls in real output, have contributed to a 2% reduction in production costs for the sector over the period 2010-2015. There was also a reduction in other non-energy costs faced by this sector, which also partly reflects the decline in industry output and decline in demand for intermediate goods and services.

There are a number of sectors where non-energy costs have driven a large increase in total production costs over the period 2010-2015. In the following sectors, there is little to no change in energy costs but over 20% increase in other non-energy costs, which drives similarly large increases in total production costs:

- *Manufacture of grain mill products, starches and starch products (C106);*

- *Manufacture of motor vehicles, trailers and semi-trailers (C29);*
- *Processing and preserving of fruit and vegetables (C103);*
- *Manufacture of other transport equipment (C30);*
- *Sawmilling and planing of wood (C161);*
- *Manufacture of machinery and equipment n.e.c. (C28).*

4.8 The evolution of energy cost shares (Sub-task 2.3b)

This section presents analysis of the reasons behind changes in energy costs shares (the ratio of energy costs to production costs) across selected industry sectors. Table 4-11 shows the percentage change in energy costs and the percentage change in total production costs over the period 2010-2015, as well as the percentage point change in the ratio of energy costs in total production costs over this period.

Table 4-11: Changes in energy costs and total production costs over 2010-2015 at the EU level

Code	Description	Main energy carrier used by sector	Change in energy costs (%)	Change in total production costs (%)	Percentage point change in ratio of energy costs in total costs
			High energy-intensity sectors		
C235	Manufacture of cement, lime and plaster	Oil	-37%	-15%	**-5.8 pp**
C233	Manufacture of clay building materials	Natural Gas	-5%	1%	**-0.7 pp**
C171	Manufacture of pulp, paper and paperboard	Natural Gas	-19%	7%	**-2.7 pp**
C231	Manufacture of glass and glass products	Natural Gas	0%	9%	**-0.7 pp**
C241	Manufacture of basic iron and steel and of ferro-alloys	Natural Gas	-29%	-10%	**-2.0 pp**
C206	Manufacture of man-made fibres	Natural Gas	-27%	-9%	**-1.6 pp**
C232	Manufacture of refractory products	Natural Gas	-5%	-3%	**-0.2 pp**
C201	Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms	Natural Gas	-11%	7%	**-1.1 pp**
C239	Manufacture of abrasive products and non-metallic mineral products n.e.c.	Natural Gas	15%	11%	**+0.2 pp**
C245	Casting of metals	Electricity	-9%	11%	**-1.1 pp**
C234	Manufacture of other porcelain and ceramic products	Natural Gas	1%	14%	**-0.6 pp**
C192	Manufacture of refined petroleum products	Oil (chemical feedstock); Natural Gas (energy input)	31%	-14%	**1.3 pp**
C244	Manufacture of basic precious and other non-ferrous metals	Electricity	-3%	17%	**-0.7 pp**
C237	Cutting, shaping and finishing of stone	Electricity	-23%	-21%	**-0.1 pp**
C161	Sawmilling and planing of wood	Electricity	5%	22%	**-0.5 pp**
			Lower energy-intensity sectors		
C106	Manufacture of grain mill products, starches and starch products	Natural Gas	11%	23%	**-0.3 pp**

Code	Description	Main energy carrier used by sector	Change in energy costs (%)	Change in total production costs (%)	Percentage point change in ratio of energy costs in total costs
C222	Manufacture of plastics products	Electricity	6%	18%	**-0.3 pp**
C172	Manufacture of articles of paper and paperboard	Natural Gas	-10%	11%	**-0.6 pp**
C103	Processing and preserving of fruit and vegetables	Natural Gas	10%	26%	**-0.4 pp**
C11	Manufacture of beverages	Natural Gas	-1%	6%	**-0.2 pp**
C132	Weaving of textiles	Electricity	-44%	-3%	**-1.5 pp**
C25	Manufacture of fabricated metal products, except machinery and equipment	Electricity	-8%	9%	**-0.4 pp**
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	Natural Gas	6%	17%	**-0.1 pp**
C32	Other manufacturing	Electricity	-10%	15%	**-0.3 pp**
C33	Repair and installation of machinery and equipment	Electricity	-3%	14%	**-0.2 pp**
C27	Manufacture of electrical equipment	Electricity	-9%	9%	**-0.2 pp**
C28	Manufacture of machinery and equipment n.e.c.	Electricity	4%	22%	**-0.1 pp**
C26	Manufacture of computer, electronic and optical products	Electricity	2%	-5%	**+0.1 pp**
C30	Manufacture of other transport equipment	Natural Gas	13%	28%	**-0.1 pp**
C29	Manufacture of motor vehicles, trailers and semi-trailers	Electricity	21%	42%	**-0.1 pp**

Source: Own calculations

Note: Energy costs are taken from the 'Purchases of Energy Products' data (from Eurostat SBS). Other costs comprise 'personnel costs' and 'costs of goods and services, net of energy costs', calculated from the Eurostat SBS data. Results are rounded to the nearest percentage point and cases where the energy cost effect and the other cost effect do not sum to the total effect are due to rounding.

The ratio of energy costs in total production costs ($\frac{Energy\ costs}{Total\ production\ costs}$). is a useful measure for assessing energy cost impacts at the firm level, controlling for changes in levels of production which would affect both the numerator (energy costs) and the denominator (total production costs) in the equation.

As shown in Table 4-11, while there is wide variation in the percentage change in energy costs over the period, with around half of the sectors experiencing an increase in energy costs over 2010-2015 and the other half experiencing a decrease in energy costs over this period, the ratio of energy costs in total production costs has fallen among nearly all sectors. This suggests that, even though energy costs have increased among some sectors, they have not increased by as much as other non-energy costs of production over the same period. For most of the less energy-intensity industries, the ratio of energy costs in total production costs fell by -0.1pp to -0.6pp. For the more energy intensive sectors, there were typically larger reductions in the ratio of energy costs to total production costs. Particularly large reductions in the energy cost ratio were seen in *Manufacture of cement, lime and plaster (C235), Manufacture of pulp, paper and paperboard (C171), Manufacture of basic iron and steel and of ferro-alloys (C241), Manufacture of man-made fibres (C206) and in Weaving of textiles (C132),* where the share of energy costs in total production costs fell by over 1.5pp to 5.8pp.

According to the SBS data, *Manufacture of computer, electronic and optical products (C26)* was the only sector in which energy costs increased at a faster rate than other non-energy costs of production over the period 2010-2015.

	Reduction in energy costs over 2010-2015	Increase in energy costs over 2010-2015
Energy costs grew at a slower rate than non-energy costs of production	• Fabricated metal products (C25) • Repair and installation of machinery (C33) • Cutting and shaping stone (C237) • Weaving of textiles (C132) • Beverages (C11) • Refractory products (C232) • Cement, lime and plaster (C235 • Clay building materials (C233) • Electrical equipment (C27) • Other manufacturing (C32) • Paper and paperboard (C172) • Pulp, paper and paperboard (C171) • Glass (C231) • Iron and steel (C241) • Basic and non-ferrous metals (C244) • Chemicals (C201) • Man-made fibres (C206) • Casting of metals (C245)	• Other transport equipment (C30) • Fruit and vegetables (C103) • Plastics products (C222) • Grain mill products, starches (C106) • Motor vehicles (C29) • Sawmilling and planing of wood (C161) • Machinery and equipment n.e.c. (C28) • Pharmaceutical products (C21) • Other porcelain and ceramic (C234)
Energy costs grew at a faster rate than non-energy costs of production	-	• Computer, electronic and optical (C26) • Abrasive, non-metallic minerals n.e.c. (C239) • Manufacture of refined petroleum products (C192)

4.9 Ex-post analysis of the impacts of energy prices on industry energy costs and competitiveness (Sub-task 2.3c)

To complement the decomposition analysis, an ex-post assessment was used to assess the impact of international differences in energy prices on EU industry competitiveness over the period 2008-2016 (at the NACE 2-digit level). To do this, we developed a counterfactual scenario where we assumed gas and electricity prices in the EU are aligned with the overall lower gas and electricity prices faced by the EU's main trading partners. By comparing results from this counterfactual scenario to true historical data at the EU level, we isolated the impact that energy prices have had on EU industry competitiveness over the recent historical period. The energy price data for the international comparison is taken from the IEA and excludes recoverable energy taxes (such as VAT).

<u>E3ME</u>

For the ex-post assessment of the hypothetical scenario where energy prices are aligned to the prices faced by the EU's trading partners, we used the E3ME model. As a macro-econometric model, E3ME uses an extensive historical database[59] and was therefore well placed to carry out ex-post economic analysis. E3ME is built around an input-output structure with a detailed representation of industry interdependencies. The input-output framework in E3ME shows, for each industry sector in each EU Member State, the cost of energy relative to total production costs. The input-output framework thus reflects industry-specific exposure to competitiveness risks from international variation in energy costs.

[59] Energy price data in E3ME is from the International Energy Agency (IEA) and has been checked for consistency against the Eurostat data.

The E3ME model also includes a series of price equations (estimated for each sector and country) which reflect different cost pass-through rates among sectors and reflect how energy costs ultimately affect prices of the goods and services produced. Import and export prices and bilateral trade equations are also estimated in each sector and country. More information about E3ME is available in Annex F.

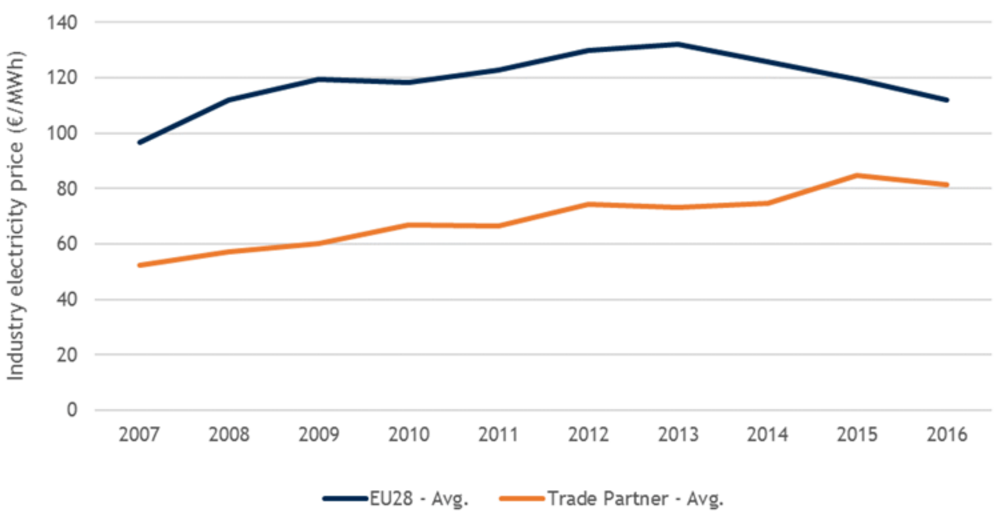
The counterfactual scenario

The counterfactual scenario represents a hypothetical state, where EU gas and electricity prices over the period 2008-2016 are aligned to the gas and electricity prices faced by the EU's major trading partners. For this counterfactual scenario, we calculate the trade-weighted average energy prices (by total trade) from the EU's top 15 competitor countries over the period 2008-2016[60].

A comparison of the counterfactual scenario to true historical data shows how the difference in energy prices faced by EU industry (compared to energy prices faced by key competitor countries) has affected costs of production for industry (industry unit costs), industry prices and the balance of trade with external trading partners over the period 2008-2016.

Figure 4-21 and Figure 4-22 below show the weighted average electricity and gas prices faced by countries in the EU, compared to the weighted average prices among the EU's major trading partners. The charts clearly show that, on average, the EU's main trading partners face lower gas and electricity prices than those faced by industry sectors in the EU. However, the differential in energy prices among EU vs non-EU industries is closing, with electricity prices, on average, 30% higher in the EU than in non-EU trading partners by 2016, and average industry gas prices almost reaching parity with prices faced by non-EU counterparts by 2016.

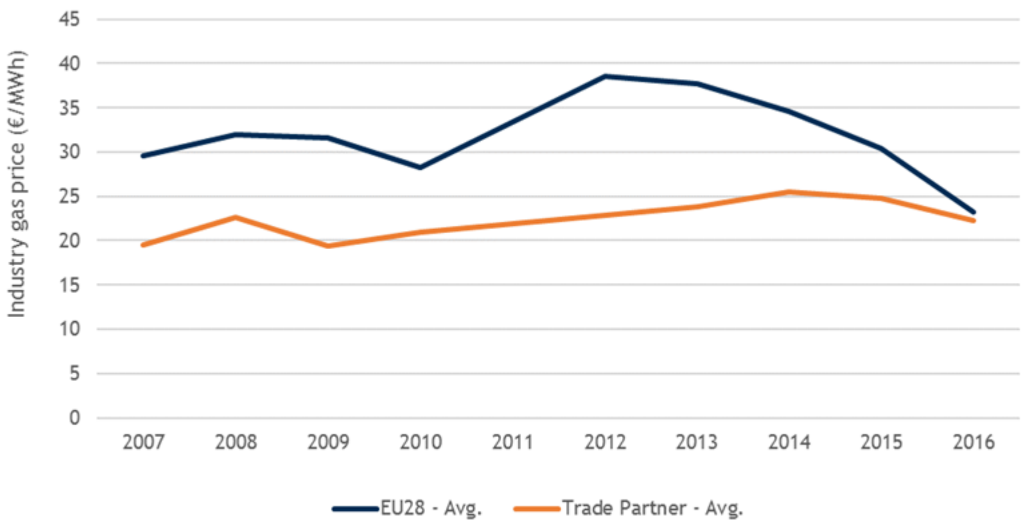
Figure 4-21: Average industry electricity prices in the EU and among non-EU trade partners (current prices)



Source: Own calculation based on Task 1 results

60 A trade-weighted average electricity price is used for the counterfactual scenario. Trade weights applied are as follows: USA (24%); China (22%); Switzerland (10%); Russia (8%); Turkey (6%); Norway (5%); Japan (5%); South Korea (4%); India (3%); Brazil (3%); Canada (3%); Saudi Arabia (2%); Mexico (2%); Singapore (2%); United Arab Emirates (2%).

Figure 4-22: Average industry gas prices in the EU and among non-EU trade partners (current prices)

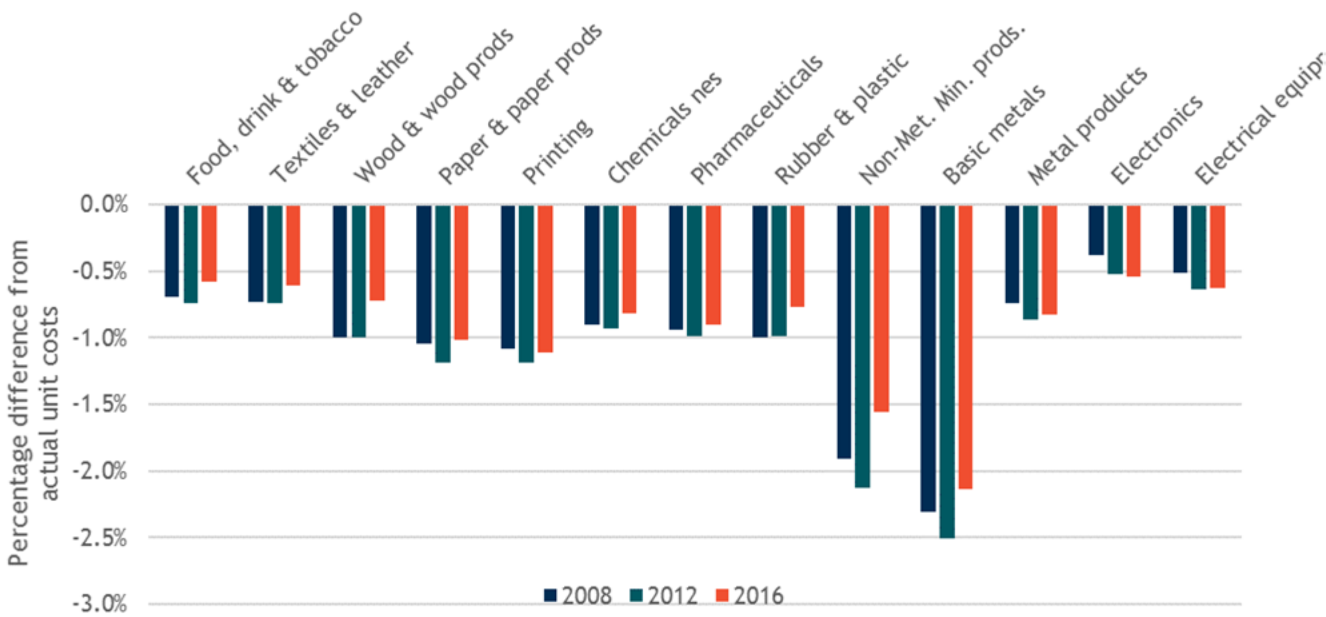


Source: Own calculation based on Task 1 results

By comparing the key competitiveness indicators in the counterfactual scenario (where gas and electricity prices are comparable to those faced by industry sectors in the EU's major trading partners) to the historical data for the EU, we isolate the impacts of changes in energy cost on industry competitiveness.

Figure 4-23 below illustrates how industry unit costs would have evolved, had industry gas and electricity prices matched the prices faced by the EU's main trading partners over the recent historical period. Industry unit costs refer to the costs of production (i.e. the sum of material costs, energy costs and labour costs). Non-metallic minerals and basic metals are the sectors that are most affected. In these sectors, unit costs would have been around 2.0-2.5% lower, had energy prices in the EU been analogous to the average price faced by the EU's trading partners over 2008-2015. As these industries are among the most energy intensive, they are most exposed to the competitiveness pressures from international energy price differentials. In most other industry sectors, where energy costs account for a lower share of total production costs, the effect of international energy price differentials on industry cost competitiveness has been more limited. For these industry sectors, unit costs would have been around 0.5-1.0% lower, if gas and electricity prices had followed those prices observed in key competitor countries.

Figure 4-23: Impact on EU industry unit costs in a counterfactual scenario where EU energy prices over 2007-2016 are comparable to energy prices faced by the EU's main trading partners



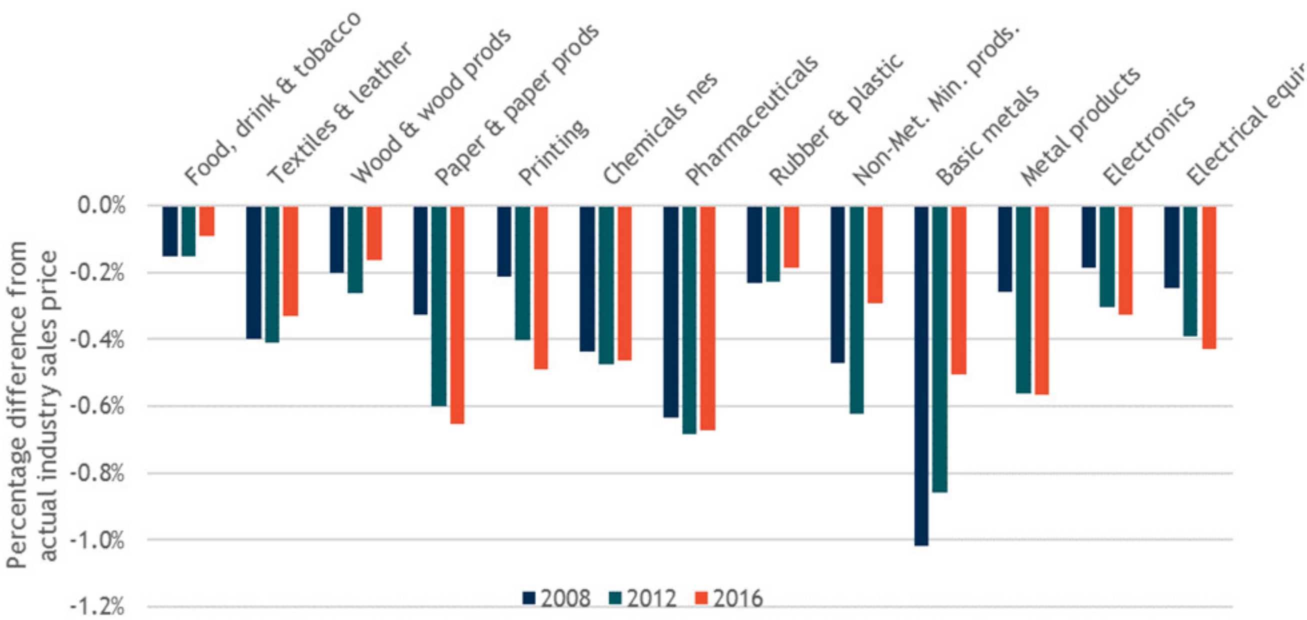
Source: Own calculation

The effect of lower unit costs on industry sales prices in the counterfactual scenario is shown Figure 4-24. The ratio between industry unit costs and sales prices shows the extent to which costs are passed on to consumers (the cost pass-through rate). The results suggest wide variation in these cost pass-through rates. In the electrical equipment sector, for example, unit costs are around 0.5% lower in the counterfactual scenario and sales prices are just under 0.5% lower, suggesting a relatively high cost pass-through rate. In the basic metals sector, by contrast, unit costs are around 2%-2.5% lower in the counterfactual scenario, but sales prices are around 1% lower, reflecting a low cost pass-through rate in the short term. The reason for the differences in cost pass-through across sectors is due to differences in the market structure of different industries. In perfectly competitive market structures with many homogenous firms, there would be high rates of cost pass-through, as firms would be price takers and margins would be low. In markets where there is greater product differentiation and fewer firms, individual firms may or may not pass-on costs[61].

Figure 4-24 shows that the price of goods manufactured in the EU would have been, on average, between 0.2% and 0.8% lower over 2008-2016 had EU energy prices matched the energy prices observed in key partner countries.

[61] In some cases, EU industry sectors (e.g. basic metals) may not feel that they have been able to pass on cost increases (by increasing product prices) in recent years, due to international competition. In these cases, the higher energy prices faced by EU firms have instead led to squeezed supplier margins in the EU relative to their international counterparts. This has been cited as one of the reasons that some basic metals manufacturing plants in the EU have closed in recent years (e.g. the 2015 steel crisis in the UK saw reduced capacity at major plants in Redcar, Scunthorpe, Scotland and South Wales).

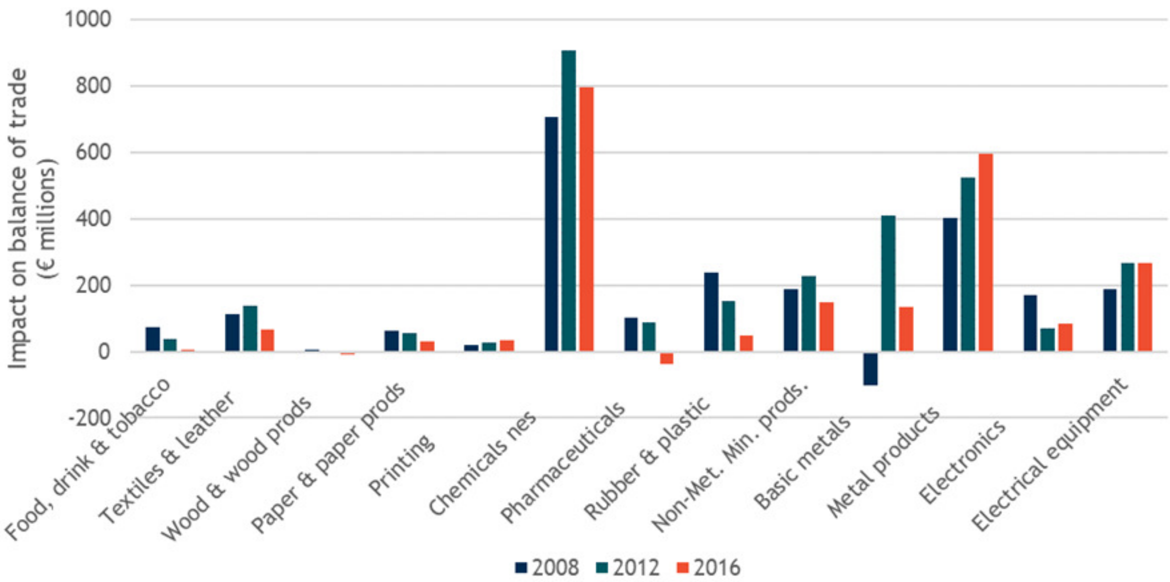
Figure 4-24: Impact on EU industry prices in a counterfactual scenario where EU energy prices over 2007-2016 are comparable to energy prices faced by the EU's main trading partners



Source: Own calculation

We extended the analysis to consider the likely impact of these historical energy price differentials on the balance of trade. Our results show that, across all industry sectors, the balance of trade has been negatively affected by the fact that countries in the EU have, on average, faced higher gas and electricity prices than among key trade partners. The impacts on the balance of trade are estimated to have been largest in the chemicals sector (which is a highly traded sector) and in the metal products and basic metal sectors (where the international energy price differentials have had most impact on unit costs and competitiveness). The annual EU trade balance in chemicals and metal products is estimated to have been around €800m and €500m lower, respectively, over the period 2007-2016, purely due to the competitiveness effects associated with higher EU energy prices relative to international energy prices.

Figure 4-25: Impact on EU balance of trade in a counterfactual scenario where EU energy prices over 2007-2016 are comparable to energy prices faced by the EU's main trading partners



Source: Own calculation

5 Task 3 - Analysis of the impact of regulated end-user prices on electricity and gas markets

5.1 Approach, methodology and data

5.1.1 Objective and scope

The aim of this task is to assess the impact of regulated electricity and gas prices in energy markets in EU Member States. The scope of this assessment is limited to the retail electricity and gas markets for households and non-households in the EU. In each of these market segments, an EU-level assessment compares key market indicators between groups of Member States that have regulated or liberalised retail energy prices. Comparing the market functioning of these groups enables a better understanding of the functioning of electricity and gas market and the impact of price regulation. To this end, we have gathered data from a variety of sources, created a database and performed several analyses to assess the impact of regulated electricity and gas prices on markets, consumers and tariff deficits.

The specific objectives of this task were to:

- Identify gas and electricity markets which still apply regulated prices for household and/or non-household consumers, to describe the type of regulation implemented in each concerned country and to analyse the evolution of the number of consumers under regulated prices as well as the volumes of electricity and gas consumed under regulated prices;
- Analyse the impacts of regulated prices on competition with a focus on the variation of the energy component of end-user prices across countries, the number of suppliers and the trends;
- Assess the evolution in the quality of services. This assessment includes consumers' satisfaction with existing offers, the possibility to switch easily from one supplier to another and the impact of regulated prices on vulnerable consumers;
- Assess the impact of regulated prices on investment and propensity to invest;
- Assess the impact of regulated prices on tariff deficits in selected Member States, based on the share of the volume of electricity or natural gas under regulated prices.

This chapter focuses on the cross-country analysis performed, while the country level analysis is included separately in the annexed **Task 3 country factsheets**. These country factsheets look in detail at the market functioning of each Member State (MS) and complement the assessment in this chapter.

5.1.2 Data gathering

In total, over 100 indicators were identified to conduct detailed analyses related to the impacts described above. The annexed Excel file "**Task 3 tool**" provides an overview of the 55 indicators selected. Note that for most of these indicators, information has been collected both for electricity and gas, as well as for households and non-households. Where possible, time series have been included though, in some cases, information was only available for one year.

Data sources

The main used data sources were a combination of open sources and data received via DG ENER. These include:

- **Eurostat**[62] – For indicators such as the inability to keep homes adequately warm; government debt; interest rates; retail and wholesale prices;
- **World Bank data**[63] – Selected Worldwide Governance Indicators including government effectiveness and regulatory quality;
- **Platts data**[64] – Information on new installed electricity generation capacity (additions);
- **Eurobserv'ER Annual Overview Barometer**[65] reports – Information on renewable energy investments (CAPEX) per technology, per year and per Member State. This includes besides wind, geothermal, solar also biomass split up in biogas, renewable urban waste and solid biomass. It may be noted that Eurobserv'ER is based on BNEF[66] databases, which may include a higher level of disaggregation to sources and instruments, as well as estimates of marine energy and hydropower investments;
- **Consumer market scoreboard data**[67] **(collected by DG JUST) –** This database provides data on the quality of services. Indicators such as the perceived ease of switching suppliers, the satisfaction with the number of suppliers to choose from, the ability of consumers to compare products or services, the percentage of people who experienced problems and those who complained, trust of consumers in suppliers/providers to respect the rules and regulations protecting consumers, etc;
- **CEER data** – This includes data on the status of regulated prices, their evolution over time and the impact of this evolution on competition. Indicators are for example the number of suppliers, the market share of the three largest firms, the number of suppliers with more than 5% market share, market concentration (Herfindahl-Hirschman Index), the existence and type of price regulation and the share of consumers/consumption with regulated tariffs, the existence of social tariffs, the number and share of households receiving social tariffs (or other supporting measures), the annual switching rates;
- **ACER MMR underlying data** – underlying data for the ACER/CEER gas and electricity market monitoring reports. ACER have often added value to CEER data by filling gaps and/or compiling indicators in different ways from the raw data.

Data on retail prices and wholesale prices are those calculated or gathered under task 1. The identified source for each indicator is included in the Excel file entitled "Task 3 tool" accompanying the report.

Data limitations

The final selection of indicators was largely influenced by the data availability. Even within the selected indicators, data availability remained an issue. The main issues included:

- **Data available only for one year**. While the aim was to obtain a time series, in some cases data was only available for one year, these data points have still been included in the database. In these cases, no longitudinal analysis is possible;

[62] Eurostat is available at: http://ec.europa.eu/eurostat/data/database
[63] The World Bank's Worldwide governance indicators are available at: http://info.worldbank.org/governance/wgi/#home
[64] Platt's data is available at: https://www.platts.com/
[65] EurObserv'ER Annual Overview Barometer can be assessed here: https://www.eurobserv-er.org/16th-annual-overview-barometer/
[66] Bloomberg New Energy Finance (BNEF) Renewable energy projects and Asset finance databases: https://www.bnef.com/projects/search and https://www.bnef.com/assetfinancing/ (registration required).
BNEF tracks data worldwide (including all EU states), providing information on technical details of renewable energy plants, financial details (owners/equity providers, lenders, public participation and instruments used. Investment from corporations are only tracked if they are >1MW. Small scale investment (rooftop solar PV <1MW capacity) is usually reported aggregated, divided in commercial and residential use and based on estimates.
[67] Note that from 2013 onwards, the survey was carried out every other year and this is reflected in the data compiled in the database.

- **Data available for a limited number of years, or with gaps**. Certain indicators have been collected at different intervals (i.e. initially annually, but then every other year), generating gaps in the time series. This data is presented as is, providing transparency;
- **Data not available for all Member States**. While most data sets were complete across the EU28, in some cases there were also gaps or it was not clear from the database whether the information was not applicable to the country or missing. This has led to small gaps in the country assessments;
- **Data not available for all sectors**. While ideally all indicators should contain separate data per sector (households vs. non-households) as well as per type (electricity vs. gas), many indicators are only available for households and electricity only. Therefore, more information is available for the household electricity market than for other markets;
- **Need for data validation of the CEER database**. CEER data has been reviewed by the CEER Secretariat and a number of NRAs. However, not all NRAs performed the validation, and CEER's own review was limited. CEER data was often gathered with slight differences in methodologies (i.e. not as a time series) and/or included comments on specificities to the data that have not been included in the database. Furthermore, the database sometimes does not go back to 2008 because NRAs were not queried on the specific topics until more recently. The data needed to be reorganised from various spreadsheets into the desired series of DG Energy's request and time series had to be constructed in some cases. Given these issues, it was submitted to our network of country experts for validation. In case country experts detected mistakes in the CEER data, the data was replaced (in case better data was available) or removed.

5.1.3 Approach

The approach consisted of several steps as follows:

- **Literature review and screening of indicators** – An initial literature review was performed to identify indicators and prioritise the analyses to conduct. This was done via a preliminary screening of indicators, assessing data availability regarding country coverage, timeframe available, energy vector (e.g. gas, electricity) and market segments (e.g. household, non-household) covered. This screening allowed to have a better idea of data availability and informed the indicator selection. The overview of the selected indicators and their data availability is presented in the annex;
- **Defining the database structure** – The database was designed taking into account pragmatism and user-friendliness in Excel. Several features, such as the EU analysis sheet, the ability to select a particular country for the Member State factsheet and the ability to compare different countries over time, were implemented taking the reporting needs into consideration;
- **Data gathering for selected indicators** – Several data sources, as described above, were used to gather the indicators. The European Commission also facilitated several data sets directly to the team;
- **Population of the database** – The relevant data was imported to the database. The structure of the database allows for update of the different indicators already included;
- **Preparation of country factsheets based on the database** – Country analyses were put together combining the indicators from the database and literature review. These are presented in an annex;
- **Validation of CEER data and country factsheets** – The CEER data for each Member State was shared with the respective country expert for validation. The country factsheets, on the other

hand, were validated by representatives of the National Regulatory Authorities (NRAs). Feedback was received for 26 Member States and the database was updated accordingly;

- **Grouping of the Member States** - All Member States were categorized into four different groups (based on the share of consumers under regulated prices for households, Table 5-1, and share of consumption for non-households, Table 5-2): Member States without price regulation since 2008 or before, Member States where price regulation was phased out between 2008 and 2016, Member States where less than 50% of households or non-household consumption under regulated prices in 2016, and Member States where more than 50% of households or non-household consumption are under regulated prices in 2016 (abbreviated as <'08, '08-'16, 5-50%, >50% throughout the report). This split is the basis for the analysis in this report;
- **Assessment of regulated prices** – Weighted averages (referred to as WA in the figures in this report) are calculated for each indicator, for each of the groups of Member States described (WA 5-50%, WA >50%, WA <'08, WA '08-'16). The weights are based on the number of consumers, total consumption or the electricity capacity. Note that the weights are indicator, year, sector and type specific.[68] The weights used depend on the indicator analysed, but are either energy consumption or the number of consumers (per market and consumer type). By comparing the weighted averages for the different indicators, it is possible to assess – to some extent- the potential impact of regulated prices. An analysis of the evolution of the key topics is conducted in addition to the analysis by country groups, in order to identify current dynamics concerning price regulation in the European Union;
- **Reporting** – Reporting is done taking into consideration the key topics on which we wish to assess the impact of regulated prices:
    - Competition;
    - Energy poverty;
    - Quality of services;
    - Investments and tariff deficits.

  All sections contain a separate analysis on the electricity and on the gas market (whenever relevant). In many cases, they also contain a static as well as a time series analysis. The static analysis focusses on the situation in the most recent year in which data was widely available and the time series analysis discusses the developments between 2009 and 2016. Despite this, in many cases the analysis is made for the 2008-2016 period based on underlying data.

While populating and validating the data, the following choices were made for consistency:

- The grouping of the Member States has been done based on the status of price regulation in 2016. Separate assessments were made for households and non-households, and for electricity and gas, leading to four classifications per Member State;
- Countries which by 2016 had a share of household consumers or non-household consumption under regulated prices lower than 5% were categorized as having phased out regulated prices. Consumption is used for non-households due to the greater variation of consumption among non-household consumers, compared to households;
- Use of middle consumption bands[69] for the purpose of cross-country comparison;

[68] The denominator of the weights is calculated as the total of the weight (consumers/consumption/electricity capacity) of all MS for which data was available for a specific indicator in a certain year, sector and type. The denominators of the weights are therefore year, sector and type specific.
[69] DC for the electricity market for household consumers (2.5 MWh – 5 MWh per year), D2 for the gas market for household consumers (20 GJ – 200 DJ per year), ID for the electricity market for non-household consumers (2 GWh – 20 GWh per year) and I3 for the gas market for non-household consumers (10 TJ – 100 TJ per year)

- Social tariffs are defined as price regulation[70] (therefore, Member States with social tariffs are classified as countries with regulated prices);
- Mark-ups were calculated as the difference between the retail price's energy component and the wholesale price for all countries. The country factsheets often provide further detail and national calculations where this were available from the literature, ACER or from the NRA representatives themselves;
- Energy expenditures as share of disposable income have been calculated using the electricity and gas retail prices and the average energy consumptions per household (calculated using the number of households per country and the country energy consumption for the household sector). This was further compared to the household disposable income as reported by Eurostat.

5.2 Price regulation in EU household markets for electricity and gas

5.2.1 Price regulation

Regulated prices are defined as energy supply prices subject to regulation or control by governments or by national or regional regulatory authorities, as opposed to prices being determined purely by supply and demand in the energy market.

The final retail price for consumers consists of three components: network costs, taxes & levies, and energy & supply components. The price of the transmission and distribution component is regulated in all cases [71], as energy networks are regulated as natural monopolies. This is also the case in countries with liberalised energy markets. Similarly, taxes and levies are administratively determined by governmental authorities. Hence, the energy and supply component is the only component of retail prices where it is possible to develop a competitive market that can potentially benefit European consumers. In the wholesale markets generators compete, while in retail markets suppliers compete. Therefore, when assessing regulated prices, the focus is on regulatory interventions into the price of the energy component and the impact this has on market development. We assess the impact of such regulated prices on the functioning of retail electricity and gas markets, on prices and on the expenditure of household consumers.

According to European Energy Regulators, "regulated retail prices can constitute a strong barrier to competition if they are not limited in time or [not] applied to exceptional cases based on socio-economic criteria".[72] The 3rd Energy Package calls for end-user prices that are determined by supply and demand, with no regulated component other than network tariffs, and levies and taxes. The European Commission, in its Energy Union Communication[73], identified regulated retail prices as an obstacle to effective retail competition, discouraging investments and the emergence of new market players. Further, in its Energy Union Framework Strategy, the European Commission proposed to phase-out regulated prices below cost and encouraged Member States to establish a road map for the phasing-out of all regulated prices.[74] The new market design, as defined in the proposed recast for the Electricity

[70] Except the social tariffs in Greece, where a discount is in place for vulnerable consumers instead of a maximum price for energy suppliers

[71] The 1st energy package started the unbundling process, separating the generation, transmission, distribution and supply activities of the European electricity and gas markets. However, it maintained transmission and distribution as regulated activities due to their natural monopoly characteristics.

[72] ACER/CEER (2016), Annual Report on the Results of Monitoring the Internal Electricity and Gas Markets in 2015 - Retail Markets

[73] COM (2015) 080, A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy

[74] COM (2016) 864, Proposal for a directive on common rules for the internal market on electricity

Directive, aims at "ensuring that supply prices are free of any public intervention, and only with duly justified exceptions."[74]

In the case of countries where regulated prices are set at a low level[75], the regulated prices may have several consequences:

- The price paid by energy consumers does not reflect actual market prices, which may result in over-consumption of a de facto subsidised service;
- It leads to an expectation among end-users that energy prices should be lower than their cost-reflective level;
- Low prices might hamper the opening of the market, discouraging new companies from entering;
- Regulated end-user prices will determine the ability of suppliers to make competitive offers on the wholesale market.[76]

However, in a number of Member States, regulated end-user prices are claimed to protect consumers from increases in energy costs[73], and several Member States also employ social tariffs with the intention of protecting vulnerable consumers.[77] In these cases where prices are regulated, "the impact of such measures falls on non-regulated consumers, on electricity companies and/or public finances, where electricity tariff deficits are incurred," as they have to cover the cost of below cost regulated prices.[78] Hence, the intention to protect consumers with regulated prices might come at an overall cost to the wider market functioning.

Overview of price regulation and grouping of Member States

Within the Member States in which end-user price regulation for household consumers still exists, the exact type and range of the regulation differs. In some Member States (e.g. Belgium), the majority of the consumers pays market prices for electricity and gas and only a small group of targeted consumers can benefit from capped energy prices – the so called social tariffs. In other Member States (e.g. France), the large majority of consumers buys their electricity and gas under regulated prices. In order to assess the impact of price regulation in the EU, it is important to acknowledge these differences.

Grouping of Member States in the analysis

Therefore, each market (electricity and gas market per Member State) is placed in one of the following groups:

1. Markets in which more than 50% of the consumers have regulated prices;
2. Markets in which 5% to 50% of the consumers have regulated prices;
3. Markets which fully phased out regulated prices before 2008 (i.e. a maximum of 5% of consumers have regulated prices since 2008);
4. Markets which phased out regulated prices between 2008 and 2016 (i.e. a maximum of 5% of consumers have regulated prices in 2016).

[75] If set too low, regulated end-user prices might not reflect the production costs and increase gross margins resulting in inefficiencies in the energy system.
[76] European Commission (2014), Electricity Tariff Deficit: Temporary or Permanent Problem in the EU? Available from: http://ec.europa.eu/economy_finance/publications/economic_paper/2014/pdf/ecp534_en.pdf
[77] ACER/CEER (2017), Annual Report on the Results of Monitoring the Internal Electricity and Gas Markets in 2016 - Consumer Protection and Empowerment Volume
[78] COM (2015) 080, A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy

The first two groups allow us to differentiate between Member States in which the majority of consumers face regulated energy prices and the Member States in which regulated prices still exist, but play a smaller role or are being phased out. The last two groups allow us to differentiate between Member States which phased out price regulation in 2008 or before (i.e. outside the assessed data period) and Member States which phased out price regulation between 2008 and 2016. The last group is of particular interest in this analysis, as the separation of this group isolates insights on the short-term effect of price deregulation across the market indicators analysed, thereby allowing an analysis of the immediate impact of price deregulation.

In some cases, Member States may have roadmaps for the removal of price regulation, establishing a transitional period where regulated prices co-exist with deregulated ones. In these dual-market structures, consumers may have the opportunity to return to the regulated market until the phase-out deadline, for example until 2020 for Portugal. The separation between countries where the share of consumers with price regulation is the majority (above 50%) or minority (between 5-50%) captures better the countries with dual-market structures that are progressively transitioning to deregulated prices. Nonetheless, the situation for each country is particular, as the share of regulated prices can drop below 50% rapidly or not, such as in Portugal or Spain for electricity. Typically, countries fully phase out regulated prices in the non-household sector before the household one.[79]

Status of price regulation in Member States

Table 5-1 provides an overview of the status of price regulation for household consumers according to the above-mentioned categories for each Member State for the electricity and gas markets. The maps of Figure 5-1 display the information on price regulation from a geographical perspective. The most recent available data is used, from 2016.

[79] ACER/CEER (2016), Annual Report on the Results of Monitoring the Internal Electricity and Gas Markets in 2015 - Retail Markets

Table 5-1: Existence of price regulation for household consumers[80] in the EU28 in 2016 and share of consumers with social tariffs

	Electricity		Gas	
MS	Existence of price regulation	Share of consumers with social tariffs	Existence of price regulation	Share of consumers with social tariffs
AT	Phased out (pre-2008)	0%	Phased out (pre-2008)	0%
BE*	5 - 50%	9%	5 - 50%	9%
BG	> 50%	0%	> 50%	0%
CY	> 50%	4%	NA - No gas market	NA
CZ	Phased out (pre-2008)	0%	Phased out (pre-2008)	0%
DE	Phased out (pre-2008)	0%	Phased out (pre-2008)	0%
DK**	Phased out (2016)	0%	5 - 50%	0%
EE	Phased out (2013)	0%	Phased out (pre-2008)	0%
EL	Phased out (2013)	10%***	> 50%	0%
ES	5 - 50%	8%	5 - 50%	0%
FI	Phased out (pre-2008)	0%	Phased out (pre-2008)	0%
FR	> 50%	10%	> 50%	15%
HR	Phased out (2016)	0%	> 50%	0%
HU	> 50%	0%	> 50%	0%
IE	Phased out (2011)	0%	Phased out (2014)	0%
IT****	Phased out (pre-2008)	2%	Phased out (pre-2008)	2%
LT	> 50%	0%	> 50%	0%
LU	Phased out (pre-2008)	0%	Phased out (pre-2008)	0%
LV	5 - 50%	8%	> 50%	0%
MT	> 50%	10%	NA - No gas market	NA
NL	Phased out (pre-2008)	0%	Phased out (pre-2008)	0%
PL	> 50%	0%	> 50%	0%
PT	5 - 50%	12%	5 - 50%	2%
RO*****	> 50%	11%	> 50%	0%
SE	Phased out (pre-2008)	0%	Phased out (pre-2008)	0%
SI	Phased out (pre-2008)	0%	Phased out (pre-2008)	0%
SK******	> 50%	0%	> 50%	0%
UK	Phased out (pre-2008)	0%	Phased out (pre-2008)	0%

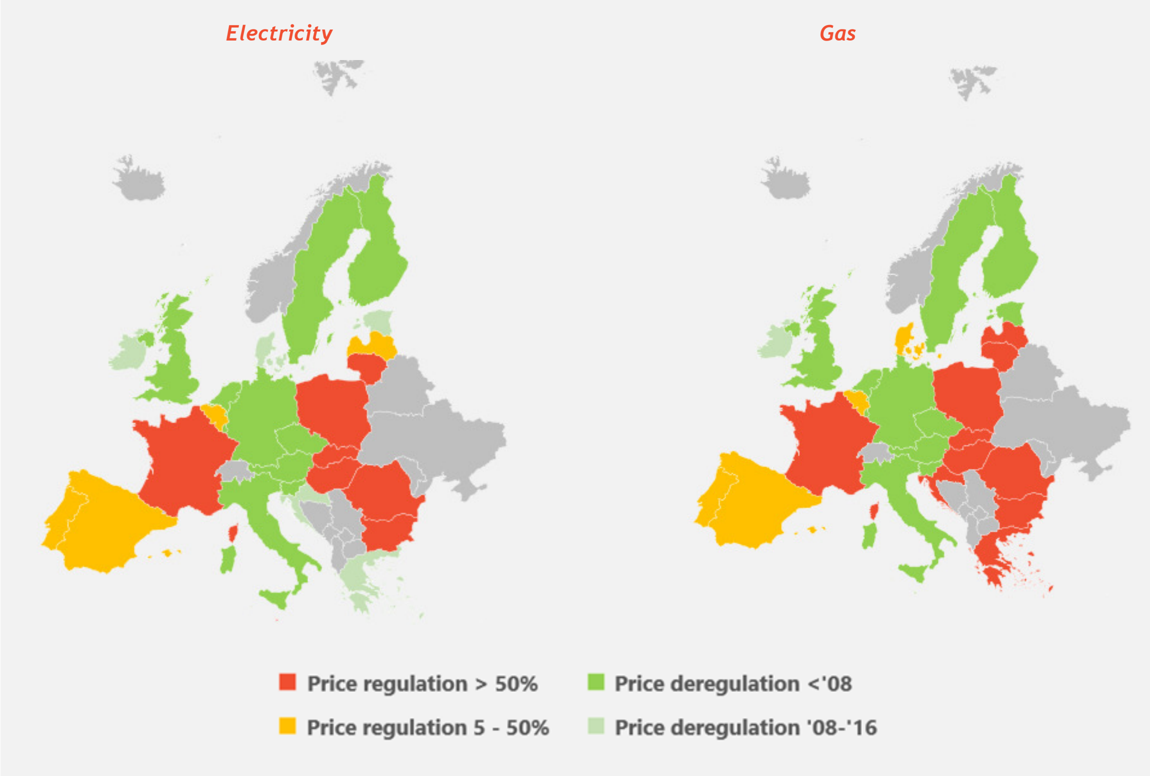
Source: CEER data and NRA representatives

** Belgium is categorized as having price regulation due to the share of households with social tariffs*
*** In 2016, after phase out of regulated prices, 2% of electricity consumers had regulated prices in Denmark. However, this is considered too low to categorise Denmark as a MS with price regulation. Moreover, price regulation was completely phased out in 2017*
**** Social tariffs in Greece are not considered as price regulation as the there is no maximum price for suppliers (subsidies are provided instead)*
***** The share of consumers under regulated prices (social tariffs) is considered too low to categorise Italy as MS with price regulation*
****** Romania implemented a roadmap for phasing out regulated prices. Although virtually all Romanian households are considered still regulated, an increasing share of their consumption was sourced from the liberalized market*
*******Social tariffs in Slovakia based on last reported year (2014)*

The year of deregulation indicates the date of entry into force of legislation for countries which phased out price regulation by 2016 (share below 5% of household consumers with regulated prices).

80 Based on share of household consumers under regulated prices.

Figure 5-1: Household price regulation from a geographical perspective (RP01a/RP03a)



Source: CEER data and NRA representatives

For **electricity**, as shown in Table 5-1 and in Figure 5-1, in nine Member States (Bulgaria, Cyprus, France, Hungary, Lithuania, Malta, Poland, Romania, Slovakia) at least 50% of the consumers have regulated electricity prices. In four Member States, price regulation for electricity is still existent, but is only applicable for a minority of the consumers (5% to 50%): Belgium, Spain, Latvia, Portugal. In ten Member States, price regulation was phased out in 2008 or before (Austria, Czech Republic, Germany, Finland, Italy, Luxembourg, Netherlands, Sweden, Slovenia, United Kingdom). Finally, five Member States (Denmark, Estonia, Greece, Croatia and Ireland) phased out price regulation between 2008 and 2016.

For **gas**, in ten Member States a majority of gas consumers still have regulated prices: Bulgaria, Greece, France, Croatia, Hungary, Lithuania, Latvia, Poland, Romania, Slovakia, while in four Member States this applies to a minority of the consumers (5 to 50%): Belgium, Denmark, Spain and Portugal. Gas price regulation was phased out in 2008 or before in eleven Member States: Austria, Czech Republic, Germany, Estonia, Finland, Italy, Luxembourg, Netherlands, Sweden, Slovenia and United Kingdom, while only Ireland did so between 2008 and 2016.

Thus, the number of Member States which have retail price regulation for between 5% and 100% of the consumers is similar for electricity (thirteen countries) and gas (fourteen countries). But while more Member States phased out price regulation before 2008 in gas markets (eleven Member States) than electricity markets (ten countries), recently electricity markets have seen much more progress towards phasing out regulated prices. Five Member States phased out regulated electricity prices between 2008 and 2016, while only Ireland did so for gas. The consequence is that presently electricity retail markets are less price-regulated than gas ones: fifteen Member States out of twenty-eight do not have price regulation for electricity, against twelve out of twenty-six for gas (as Cyprus and Malta do not have gas markets).

Assessment of the share of consumers and volumes under regulated prices

The classification of price regulation in countries applying price regulation to a majority (more than 50%) of consumers, to a significant minority (5 to 50%), being phase out between 2008 and 2016 or before 2008 enables the analysis of Member State retail energy markets in terms of indicators on the existence of price regulation, including social tariffs, its impact on selected aspects of competition, retail prices, energy poverty and quality of service. Particular emphasis is placed on understanding the evolution of the various markets over time.

The share of consumers under regulated prices is calculated dividing the total number of consumers with regulated prices by the total number of consumers.

For **electricity** the analysis (see Figure 5-2) shows that in Bulgaria, Cyprus, Malta and Lithuania had the highest shares overall, with 100% of the consumers under regulated electricity prices in 2016. Moreover, more than 95% of household consumers in Hungary, Romania and Poland were price-regulated. In France, the 85.8 % of the consumers were under regulated prices. In Belgium, Latvia, Portugal and Spain less than 50% of household consumers had regulated electricity prices in 2016. Thus, the weighted average for the > 50% group is over 92.4%, while for the group with a minority of consumers under price regulation it is 35.8%.

Electricity price regulation for households in Romania and Italy

Price regulation for households in Romania is a special case because its phase out roadmap established an increasing proportion of the electricity supplied to households to be bought under market prices. Thus, while in the end of 2016 virtually all Romanian households were considered to be under regulated prices, the volume of consumption under regulated prices amounted to 34% of total household consumption.[81] Italy is also a particular case, as in parallel to a liberalized market it applies a single buyer model which purchases in the wholesale market the aggregated electricity demand of voluntary protected household consumers.[82] By 2019 the approval of these protected prices by the Italian NRA was scheduled to end.[83]

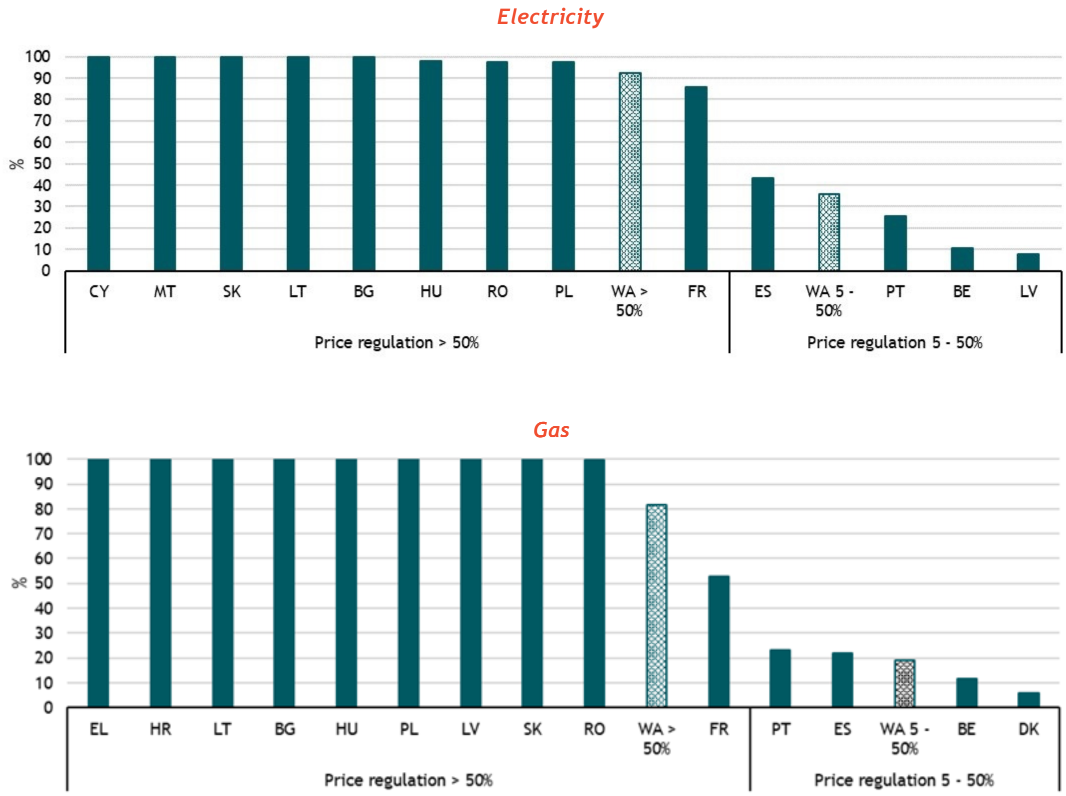
On the **gas** market, nine Member States had between 50 and 100% of the household consumers under regulated prices in 2016 (Bulgaria, Greece, Croatia, Hungary, Latvia, Lithuania, Romania, Poland and Slovakia), thus more than in the electricity market. In Belgium, Denmark, Portugal and Spain, less than 50% of household consumers had regulated gas prices. Although Denmark introduced legislation to phase out regulated gas prices in 2011, by the end of 2016 there was still a remaining share of households under these prices, and thus the country is still classified in the that group for that year. Thus, the weighted average for the > 50% group is 81.6%, while for the group with a minority of consumers under price regulation it is 19.1%.

Hence, the weighted averages of the share of price-regulated consumers in MSs which still applied this regulation in 2016 was higher for electricity than for gas. Bulgaria, France, Hungary, Lithuania, Poland,

[81] Private communication with ANRE NRA representative (2018)
[82] ARERA (2017). Annual Report to the International Agency for the Cooperation of National Energy Regulators and to the European Commission on the Regulatory Activities and the Fulfilment of Duties of the Italian Regulatory Authority for Electricity, Gas And Water
[83] ARERA (2018). Il percorso per la fine della tutela di prezzo nei settori elettrico e gas (1° luglio 2019).

Romania and Slovakia applied retail price regulation to a majority of both electricity and gas household consumers, while Belgium, Portugal and Spain did so for a significant minority of consumers (5 to 50%) in both markets.

Figure 5-2: Share of consumers with electricity and gas regulated prices in 2016 (only Member States in which price regulation was still existent in 2016)



Source: Own calculations based on CEER data and NRA representatives
Note: Data is weighted by the total number of household consumers per country and per energy market. A description of the weighted averages' groups is provided in section 5.1.3.

Evolution of EU price regulation over time[84]

Figure 5-3 presents the evolution of the share of consumers with regulated prices for Member States which phased out price regulation between 2008 and 2016, as well as the weighted averages for the different country groups.

When analysing the share of consumers with **regulated electricity prices** over time in the household sector, we see that in several Member States there is a continuous decrease. For example, Portugal went from over 95% to under 30%, and Spain from around 90% to under 45% of consumers under regulated prices. This evolution is due to specific country factors, such as the phase out of regulated prices in Portugal and Spain. There were also more modest decreases, such as in France and Poland. Finally, other countries such as Lithuania had a stable share of almost 100%. Then, the weighted average of countries with a minority of households under regulated prices decreased strongly, from 93% in 2008 to 36% in 2016.

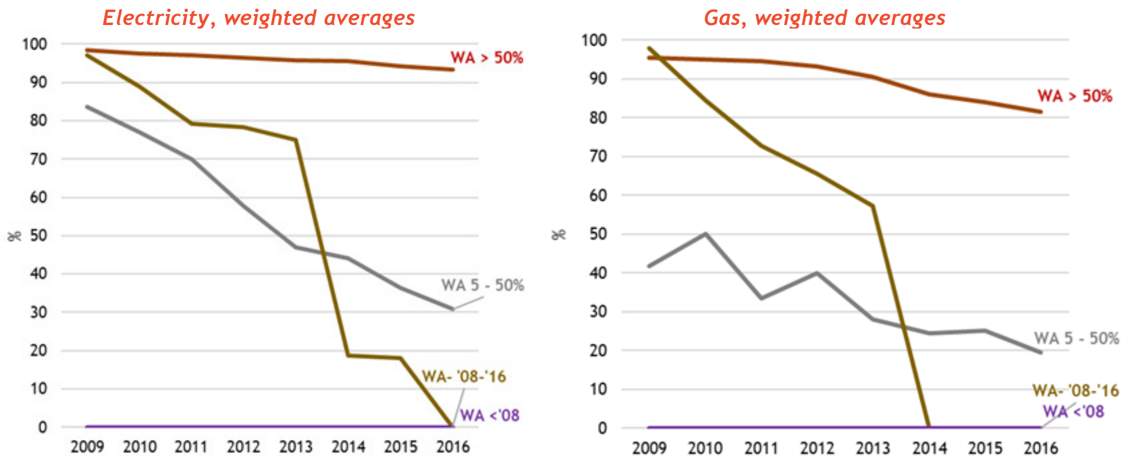
[84] Note that the time dynamic graphs only indicate the 2009-2016 period as this data (and the data on which the weights are based) is mostly available in these years. In the analysis, however, we refer often to 2008 as this data is for some indicators also available (despite not being shown in the graphs)

Concerning the **gas market**, the share of consumers under regulated prices decreased significantly in the 2008-2016 period for countries such as Spain (from 55% to 21%), Portugal (100% to 23%) and Denmark (to 6%). As for electricity, the evolution in each Member State is determined by specific factors: for example in Portugal and Spain the phase out of regulated prices apply here also, while in other already-liberalized markets Member States obligated consumers to transfer away from default supply contracts (such as in Denmark). Furthermore, concerning the countries in the group with a minority share of consumers under price regulation, the weighted average decreased from 62% in 2008 to 19% in 2016.

Overall, the share of household consumers under regulated prices is declining both for electricity and gas, though there is a clear difference in the trends between those countries which still have over 50% consumers under regulation (which have a slower decrease) and those who have only between 5-50% consumers under regulation (which tend to have a sharper decrease in share of consumers under regulation in the assessed period). To be precise, the share of consumers under regulated prices on the electricity market for household consumers decreased from 43% to 31% and from 32% to 24% on the gas market.[85] Detailed information at country level can be found in the Task 3 country factsheets for electricity & gas and for households & non-households.

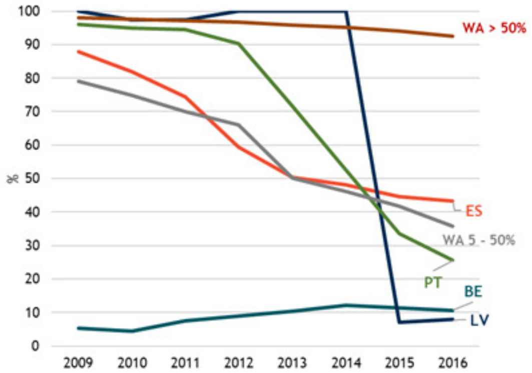
With this dynamic, while since 2013 the share of consumers under regulated prices was already at 0% for countries who phased out such prices before 2008, it also dropped to 0% for countries who did so in the 2008-2016 period both for electricity and gas. Moreover, in both household retail markets the shares decreased rapidly to below that of the group of countries which still have a minority of consumers under price regulation.

Figure 5-3: Share of consumers with regulated prices for country groups and Member States in which price regulation for electricity was still in place in 2016

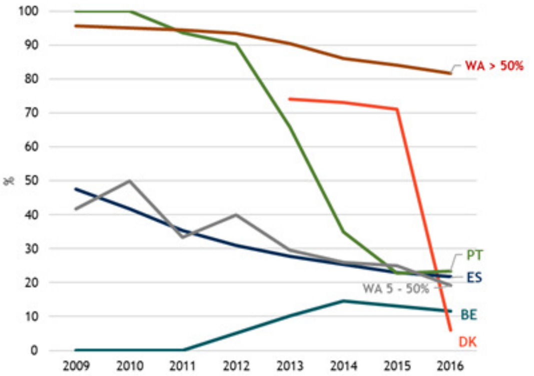


[85] Note that only Member States for which data was available on the number of households under regulated prices in 2016 and in 2008 are considered in this calculation. Thus, one should not interpret the second percentage as the overall percentage of non-household consumers under regulated prices as Member States for which data was not available in 2008 are excluded. These Member States were excluded in order to allow for a comparison between 2008 and 2016 - not to identify the overall share of consumers under regulated prices in the EU.

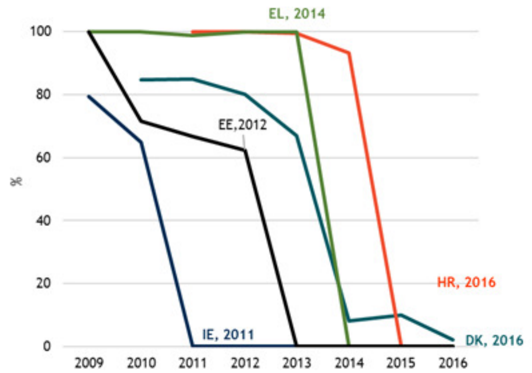
Electricity, MS with 5 – 50% of consumers under price regulation



Gas, MS with 5 – 50% of consumers under price regulation

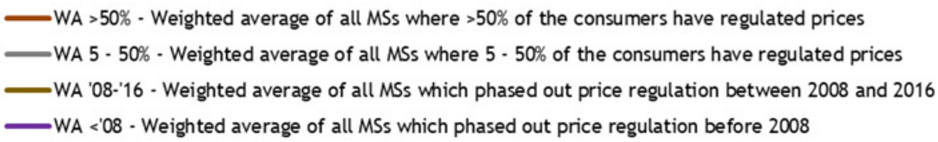


Electricity, MS which phased out regulated prices between 2008 and 2016



Gas, MS which phased out regulated prices between 2008 and 2016

No data for Ireland which is the only MS in this category



Source: Own calculations based on CEER data and NRA representatives

Note: the year in which price regulation was phased out is mentioned in the graphs when relevant.

Data is weighted by the total number of household consumers per country and per energy market. A description of the weighted averages' groups is provided in section 5.1.3.

The country label indicates the phase out year for regulated prices

Application of social tariffs

The Vulnerable Consumer Working Group indicates that social tariffs are a form of price regulation intended to protect vulnerable consumers in a more targeted way than blanket price regulation. Nonetheless, social tariffs may still distort the functioning of retail energy markets. For example, recovering the costs of social tariffs from all electricity or gas consumers may disproportionately increase tariffs for ordinary consumers that are neither vulnerable nor wealthy.[86]

Thus, the new Internal Electricity Market directive proposal of the Clean Energy for All Europeans package includes a five-year transitional period for the phase out of social tariffs, which should

[86] Vulnerable Consumer Working Group (2013) Guidance Document on Vulnerable Consumers.

nonetheless 'pursue a general economic interest, be clearly defined, transparent, non-discriminatory, verifiable and guarantee equal access for Union electricity companies to customers'. After this period Member States may apply social tariffs only for reasons of extreme urgency, and must notify the Commission which may assess the measure and oblige Member States to amend or withdraw the social tariff.[87]

In place of social tariffs, the Commission suggests Member States adopt other solutions for the protection of vulnerable consumers, such as targeted social policies. The Vulnerable Consumer Working Group indicates best practices to tackle energy poverty in general, including besides financial measures (social tariffs, lump sum payments and general social support) also consumer protection, market-centred and energy efficiency measures.[88]

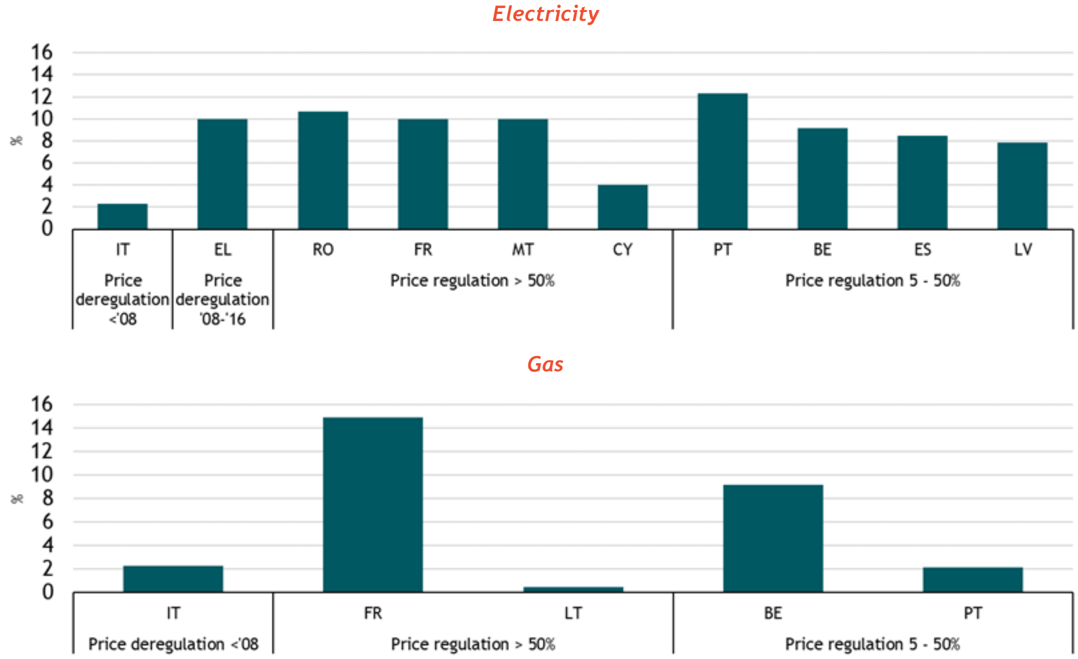
The graphs below show the share of households on social tariffs for both electricity and natural gas. For **electricity,** Greece and Italy phased out price regulation by 2016 but have social tariffs. Then, Belgium, Latvia, Portugal and Spain are the countries with social tariffs from the group with a minority of households (5 to 50%) under social tariffs. Finally, Cyprus, France, Malta and Romania are Member States with widespread price regulation in 2016 which have social tariffs. Most of these countries have more than 8% of households on regulated electricity tariffs (except for Italy at around 2% and Cyprus at 4%). Comprising around 750 thousand households, Portugal has the highest share of households on electricity social tariffs of Europe, at over 12%. Coming with the second highest share is Romania, with over 930 thousand households constituting over 10% of all households. Note that Greece is not considered to have price regulation for electricity because direct subsidies are provided to cover the cost of energy bills, instead of the supply price being regulated.

For **gas,** social tariffs exist in France (covering around 15% of the households) and Lithuania (around 0.5%) for the group of Member States which still had a majority of households under price regulation in 2016. Of the group of countries with a minority of households (5 to 50%) under price regulation, Belgium (9% of households) and Portugal (2%) applied gas social tariffs. Finally, Italy is the only country which phased out price regulation before 2008 but which had social tariffs in 2016, covering 2% of households. Note that Italy is not considered to have regulated prices, except social tariffs, as the share is lower than the 5% threshold applied in this report. In absolute numbers, social tariffs applied to over 1580 thousand households in France, over 440 thousand in Italy and 250 thousand in Belgium.

Social tariffs are thus applied more frequently for electricity (ten countries) than for gas (five countries) and reach a higher share of the household consumers in electricity markets. On the other hand, in absolute numbers more households are covered by gas social tariffs in France than by electricity social tariffs in Portugal (the countries with the highest shares for these respective markets).

[87] Article 5 (3) of European Commission (2016) COM(2016) 864 final/2 - Directive Of The European Parliament And Of The Council On Common Rules For The Internal Market In Electricity.
[88] Vulnerable Consumer Working Group (2016) Working Paper on Energy Poverty.

Figure 5-4: Share of households receiving social tariffs[89] (where available) in 2016 for electricity and gas



Source: Own calculations based on CEER data and NRA representatives

Note: that MS without social tariffs in 2016 are not shown. BG reported a very low share of consumers with social tariffs slightly greater than zero.

Evolution of social tariffs in the EU over time

The evolution of **electricity** social tariffs is very country-specific. While the share of households on social tariffs in Malta, Romania and Spain has decreased by several percentage points from 2008 to 2016, it has increased in Belgium, France, Greece, Latvia and Portugal. The same applies for countries with **gas** social tariffs in 2016: while the share of households receiving such tariffs increased in France from below 4% to 15%, it rose more modestly in Portugal, from none to 2% by 2016, while in Italy it hovered in the 2-3% range.

It is interesting to see that while the share of regulated prices was decreasing for several Member States (see Figure 5-3), it is often the opposite for the share of households on social tariffs (Figure 5-5). For example, in France and Portugal both trends occur in parallel, which may imply that price regulation is becoming more targeted, especially towards vulnerable consumers. Another example is Latvia, where electricity price regulation covering all households was phased out in 2015, simultaneously with the introduction of electricity social tariffs which in the same year reached 8% of households. It can be seen that the process of introducing or phasing out social tariffs and of making price regulation more targeted is strongly influenced by national circumstances: For example, in Portugal a significant phase out of regulated prices preceded the 2016 rise in households under electricity social tariffs, while in Greece the rise in the share of social tariffs precedes the phase out of price regulation of 2013. Due to the limited number of countries and these national circumstances the country factsheets provide a better understanding of the drivers of price regulation phase out or targeting than statistical analyses.

89 Social tariffs are defined as special energy prices for vulnerable consumers.

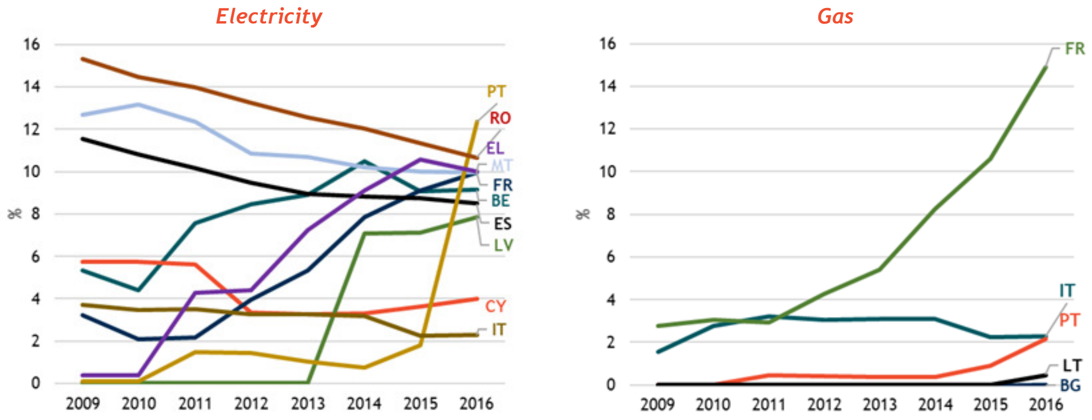
The eligibility criteria and application procedure for social tariffs significantly impact the share of households receiving them

*When **Portugal** started to automatically attribute its social tariff to eligible households in 2016, the share of households under electricity social tariffs passed from around 2% to more than 12% in a year. Also, in electricity, with the deterioration of the financial status households in **Greece** due to the continuous economic crisis, the share of households under social tariffs continuously increased since their introduction in 2011, to 10% in 2016.*

*For gas, **France** changed the eligibility criteria in 2013 to a larger portion of households, leading to an increase in the share of households on social tariffs from 3% in 2011 to 15% in 2016.*

Thus, the penetration of social tariffs depends on national circumstances, making it difficult to derive general substitution ratios towards targeted-price regulation.

Figure 5-5: Evolution of the share of households on social tariffs for electricity and gas (same set of Member States as shown Figure 5-4)



Source: Own calculations based on CEER data and NRA representatives

Note: Data is weighted by the total number of household consumers per country and per energy market.

5.2.2 Impacts of regulated prices on selected aspects of competition

Supplier choice

As indicated, Member States usually transition to deregulated prices over several years, with the household segment being typically the last.[90] In this transition period, several developments interact, including the entry of new suppliers and the expansion of incumbents beyond their historical areas and markets, consumer switching behaviour, and policies incentivizing consumers to move to deregulated prices, such as price premiums on regulated tariffs intended to make the liberalized markets more attractive or price comparison tools.

The assessment of supplier choice is based on the evolution of the number of active suppliers and the evolution of market concentration. The latter is done by assessing the sum of the market shares of the three largest suppliers and the number of main suppliers with market shares above 5%.

[90] ACER/CEER (2016), Annual Report on the Results of Monitoring the Internal Electricity and Gas Markets in 2015 - Retail Markets

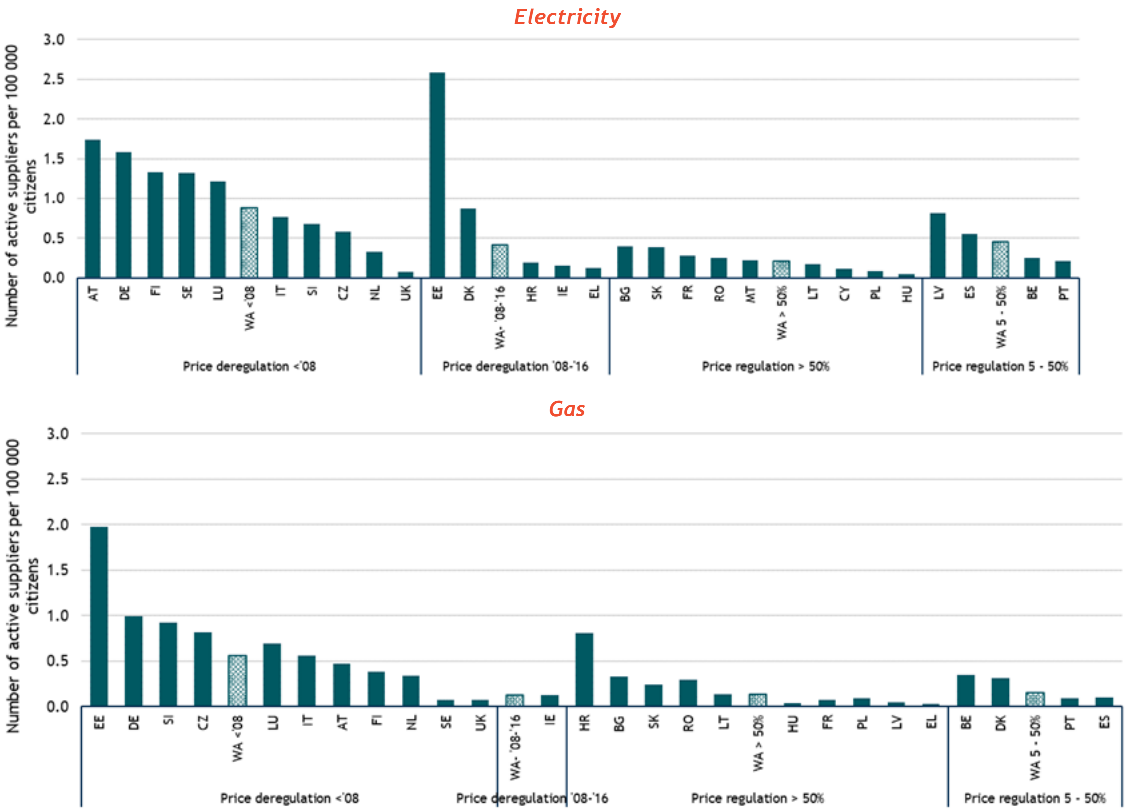
It is important to look at the per capita number of suppliers, as certain countries (such as France, with a large share of households under regulated prices) may have many more suppliers in absolute terms than smaller countries which phased out regulated prices.

Figure 5-6 indicates that in 2016 the countries which had the highest number of active suppliers per capita were those that had already phased out price regulation. Namely, Austria, Estonia and Germany had more than 1.5 **electricity** suppliers per 100 000 citizens, while for **gas** only Estonia surpassed this threshold.

Estonia has the highest level of active suppliers

The Estonian electricity retail market phased out price regulation in 2013, and since then, the number of suppliers with market shares above 5% doubled to 4 in 2016. For gas, Estonia exhibits a high number of suppliers per capita and competition has increased in 2016 with the reduction of the market share of the dominant supplier. However, the size of the population contributes to the high number of suppliers per capita, and Estonia is still dependent on a single non-EU source of natural gas, having thus a particular market.

Figure 5-6: Number of active suppliers per 100 000 citizens in 2016



Source: Own calculations based on CEER data and NRA representatives

Evolution of the number of suppliers in the EU over time

Looking at **electricity** for households, Figure 5-7 indicates that there is a relationship between the phasing out of regulated prices and the number of suppliers per capita in the market. The countries which exhibit more suppliers per capita have consistently phased out price regulation before 2008, and to a lesser extent between 2008 and 2016. As indicated in the following section (5.2.3), the former group exhibits also larger savings from switching suppliers available to household consumers, but also higher energy and supply retail price components and higher mark-ups, both for gas and electricity.

Concerning the weighted averages for the number of **electricity** suppliers per capita, the number of suppliers in Member States which phased out regulated prices before 2008 is the highest, reaching 0.9 suppliers per 100 000 citizens. But after 2012 an increase in the number of suppliers is noticeable in countries which phased out regulated prices between 2008 and 2016, which by 2016 had reached a value of almost 0.45 suppliers per 100 000 citizens. Notice that the fall of the indicator before 2012 is due to the entry of data from Denmark, Greece and Ireland, which brought the average down. Countries with a minority share of households on electricity regulated prices have had a significant increase in suppliers. The group 5%- 50% thus reached 0.45 versus less than 0.25 for the stationary > 50% group.

The household trend for **gas** is also of an increasing number of supplier per capita, although generally there are less suppliers per capita than for electricity. Countries which phased out price regulation before 2008 exhibit the highest number of suppliers since 2011, reaching a weighted average of 0.5 suppliers per 100 000 citizens by 2016. The sustained increase of this group was accompanied by the group of countries which phased out regulation between 2008 and 2016, who by 2016 had 0.13 suppliers per 100 000 citizens. Then, the supplier average for the 5 – 50% group increased even faster since 2009, passing from 0.02 to 0.19 suppliers per 100 000 citizens. The only group which exhibits a stationary trend is those countries with a majority of consumers under price regulation, ending with 0.12 suppliers per 100 000 citizens.

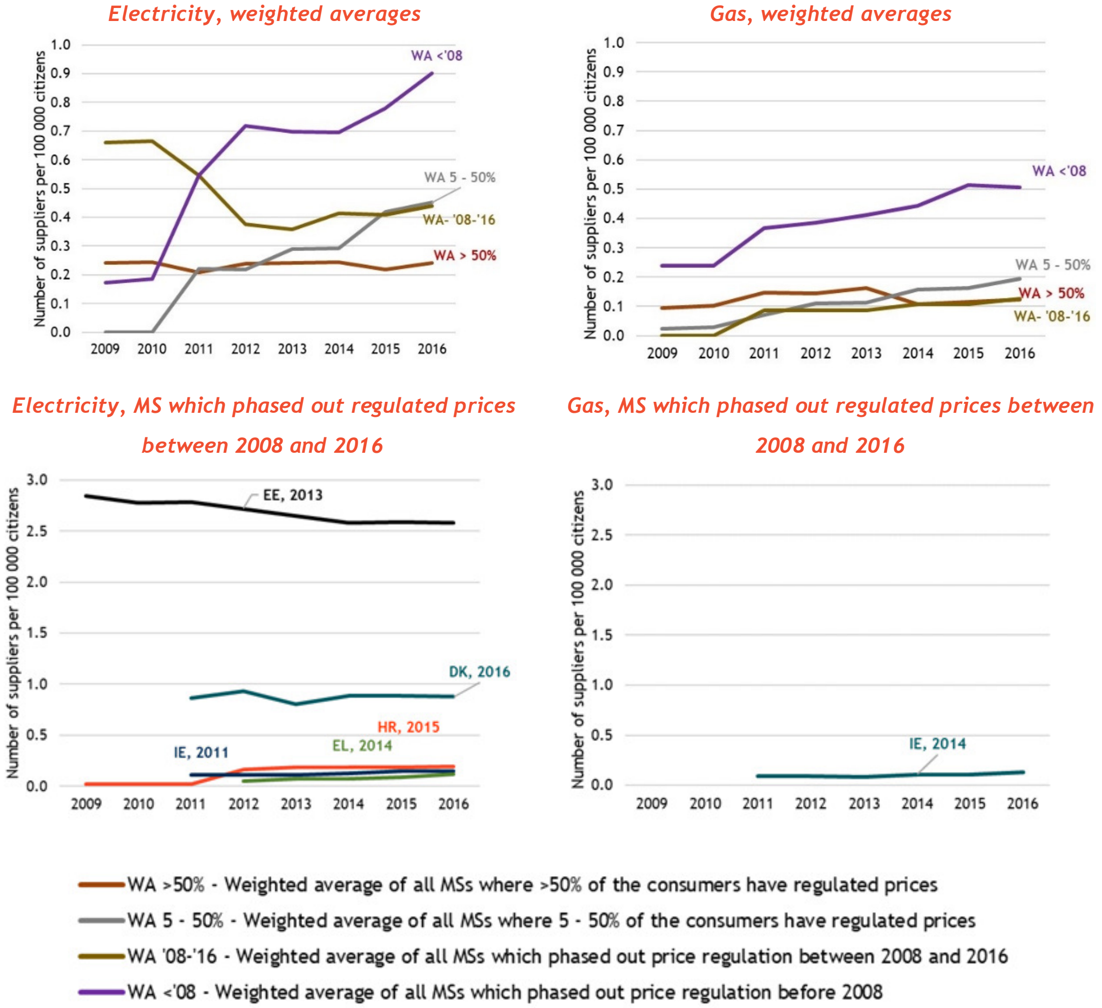
Country-specific factors affecting the active number of suppliers

When assessing the number of suppliers, one must consider the area of activity of these suppliers. By comparing the number of active suppliers per 100 000 citizens, this is partially taken into account. However, when assessing the absolute number of energy suppliers many other specificities can be highlighted. If we assess the absolute number of suppliers, Germany (which has the highest number of electricity suppliers of all countries in the EU) has about 6 times more companies supplying electricity to households than France, which has most electricity suppliers of all Member States with regulated prices.

Yet, it is also the case that in Germany there are many smaller local or regional suppliers, so for a particular location there could be fewer suppliers and less competition than implied. This situation is not unique to Germany. On the other hand, competition can increase while the number of active suppliers remains constant, if local or regional suppliers expand their reach. For example, while the number of active suppliers for electricity in Austria remained constant since 2008, these have expanded beyond their historical areas, increasing supply competition.[91]

[91] Private communication with Austrian NRA representative (2018)

Figure 5-7: Evolution of the number of active suppliers per 100 000 citizens in the weighted averages of all categories and MS which phased out price regulation between 2009 and 2016



Source: Own calculations based on CEER data and NRA representatives
Note: the year in which price regulation was phased out is mentioned in the graphs when relevant.
Data is weighted by the total household consumption per country and per energy market.
The country label indicates the phase out year for regulated prices

Market concentration

The analysis of market concentration indicators by the price regulation groups can indicate whether or not the phase out of price regulation leads to lower supplier concentration in electricity and gas markets, and consequently indicating improved supplier competition and increasing benefits to household consumers. However, the situation for each country must be nuanced according to factors such as the geographical distribution of the suppliers and the expansion of regional or local suppliers beyond their historical areas of operation, on which the country factsheets provide further details.

For **electricity**, only countries that phased out regulated prices before 2008 exhibit a lower market concentration, with the share of the 3 largest electricity suppliers reaching 54% in 2016, while the share remains at around or above 85% for the other groups (Figure 5-8). Nonetheless, the former group shows the highest intra-group variation in market shares, with the 3 largest Luxembourgish suppliers having 95% of the electricity market, while the three largest German ones have 38%.

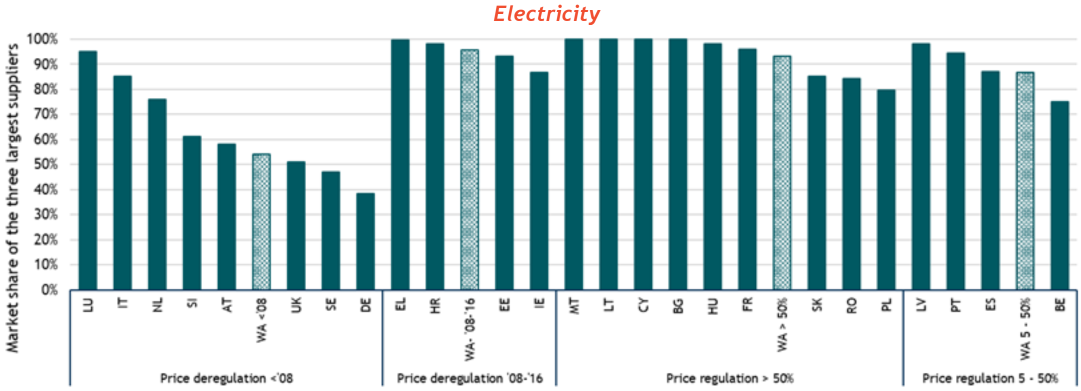
Regarding the number of **electricity** suppliers with a market share higher than 5% (Figure 5-9), in 2016 it was highest in countries with a pre-2008 phase out of price regulation, which have a weighted average of 4.5 such suppliers. Although with a significant variation only Luxembourg and Italy in the group exhibit less than four significant suppliers, and Sweden has seven. For the countries in the other groups the highest number observed is five suppliers for Ireland, Slovakia and Belgium, while Greece, Croatia, Malta, Lithuania, Cyprus and Latvia exhibit one single significant supplier.

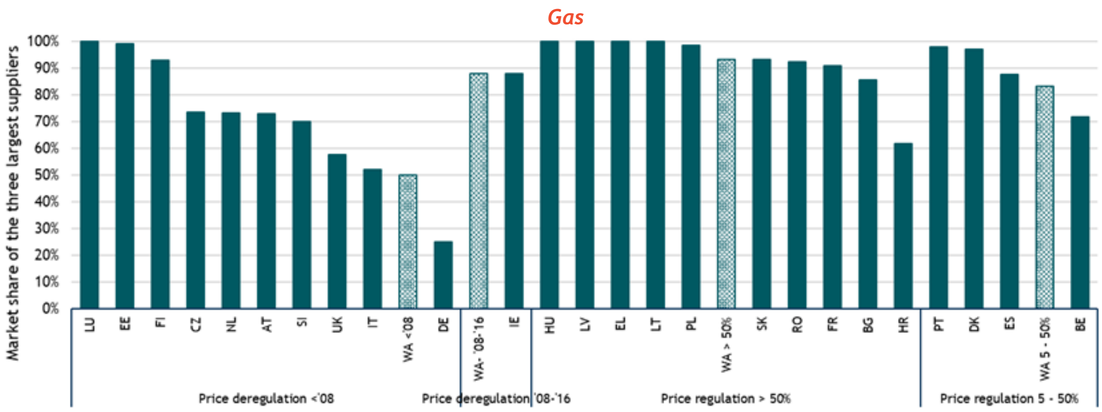
On **gas** markets, countries which phased out regulated prices before 2008 also exhibit the lowest market shares for the largest suppliers, at 50%. The other country groups show market shares of 83% (for the countries with a significant minority of consumers under price regulation) or higher. The countries with a phase out before 2008 exhibit the highest intra-group variation, again with Luxembourg having the highest share (one dominant supplier with 100%) and Germany with the lowest (25%).

The number of significant **gas** suppliers is highest for the countries which phased out price regulation before 2008 and those which still maintain such regulation for a significant minority of households, at 4.2 suppliers for both groups. The former group exhibits a greater variation though, with the UK having six significant suppliers (the highest EU number for gas) and Estonia and Finland only one. For the other groups, Lithuania, Latvia and Poland also have a single supplier with a significant market share.

Hence, the market share of the 3 largest suppliers in countries which phased out price regulation before 2008 supports the indications of increased competition in countries without price regulation, both for electricity and gas. However, this does not apply to countries with a more recent phase out of regulated prices, which exhibit high market concentration and for electricity even similar low number of significant suppliers as countries still with retail price regulation.

Figure 5-8: Market share of the 3 largest suppliers in 2016

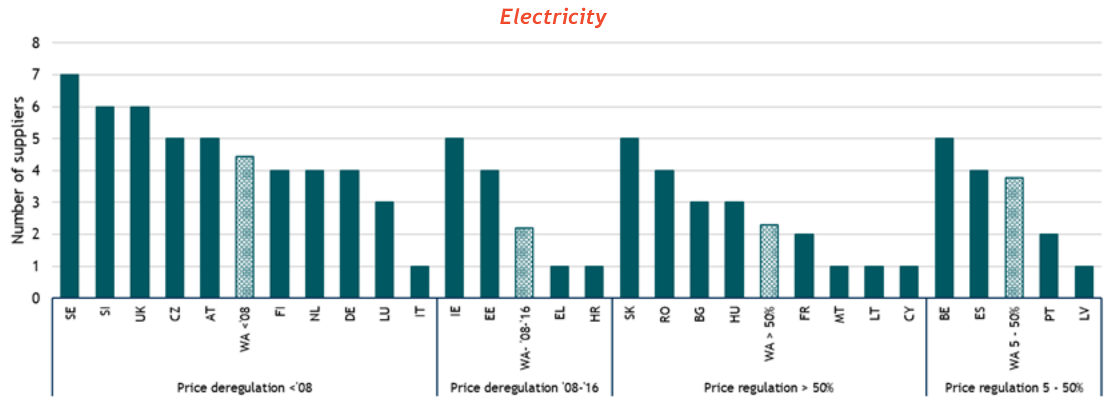


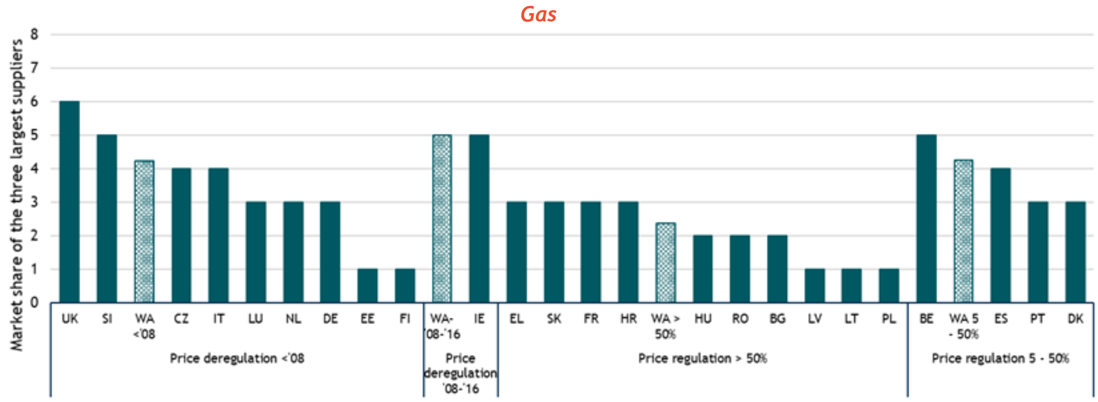


Source: Own calculations based on CEER data and NRA representatives

Note: No data available on electricity for the Czech Republic, Finland and Denmark and on gas for Cyprus, Malta and Sweden

Figure 5-9: Number of suppliers with a market share greater than 5% in 2016





Source: Own calculations based on CEER data and NRA representatives

Note: No data available on electricity for Denmark and Poland and not on gas for Austria, Cyprus, Malta and Sweden

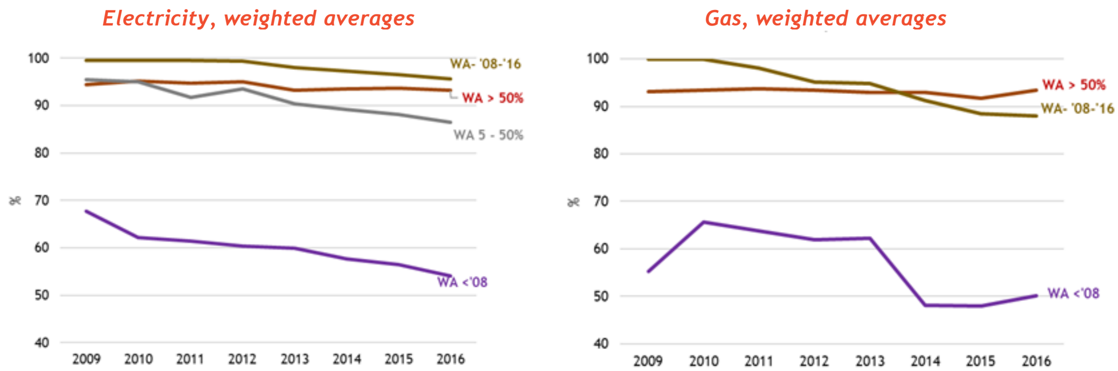
Evolution of market concentration over time

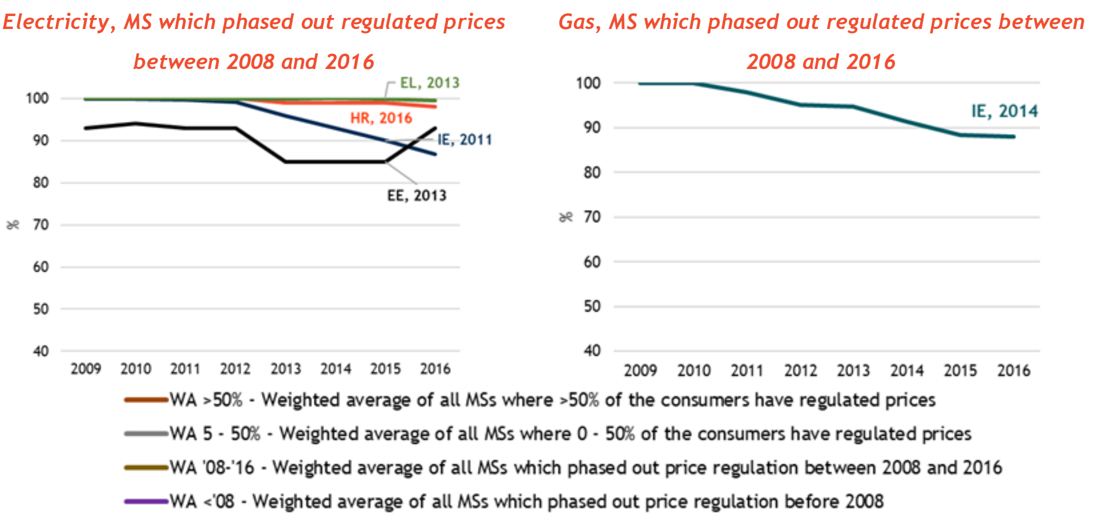
For **electricity**, the group of countries which phased out regulated prices before 2008 exhibit the strongest decrease in market concentration, with the shares of the largest suppliers dropping from 87% to 54% between 2009 and 2016 (Figure 5-10). As for the countries which phased out prices after 2008, the market share of the largest suppliers is higher than in countries with price regulation, and has decreased only slightly faster (100% to 96% between 2009 and 2016) than for the group of countries with a significant minority of households under price regulation (96% to 93%). Yet, when we focus on the Member States which phased out price regulation between 2008-2016, it is shown that the market share of the 3 largest suppliers decreased significantly in Ireland from 2011 onwards – the year in which it started to phase out price regulation. This trend is, however, not observed in the other countries of the group with available data: Croatia, Estonia and Greece. The number of suppliers with a market share above 5% (Figure 5-13) is also highest for the countries which phased out price regulation before 2008 throughout the 2013-2016 period. On the other hand, the increase in the number of suppliers with significant electricity market share is modest for Ireland and Greece, which contributes to the group of countries with recent price regulation phase out having the lowest weighted average. The country group which showed the highest increase for the indicator in the 2013-2016 period is the one with electricity price regulation for 5 – 50% of households, from 3.0 to 3.8 suppliers on average.

For **gas,** the country group with a recent phase out of price regulation (with only Ireland for gas) shows the strongest decrease in the market share of the 3 largest suppliers, from 100% in 2009 to 88% in 2016. Compared to 2010 the countries with a pre-2008 phase out also exhibit a large decrease in the indicator, from 66% to 50%. As for the countries with a majority of consumers under gas retail price regulation, the share of the largest suppliers remained stable, fluctuating around 93%. Yet, when we focus on the Member States which phased out price regulation between 2008-2016, it is shown that the market share of the 3 largest suppliers decreased significantly in Ireland from 2011 onwards – the year in which it started to phase out price regulation. This trend is, however, not observed in other countries. Figure 5-11 indicates that for Ireland (which phased out price regulation only recently) shows an increase in the number of suppliers with a market share greater than 5%, from 4 in 2013 to 5 in 2016. It thus surpassed the groups of countries with more distant price regulation or which kept it for a significant minority (5-50%) of consumers (whose number of significant suppliers remained stable since 2013 and amounted to 4.2 in 2016). Finally, the number of significant supplier is lowest for the countries with dominant price regulation, but has been rising steadily from 2.1 in 2013 to 2.4 in 2016.

Thus, generally the indicators on market concentration in electricity and gas markets have improved since 2013 for almost all country groups. Nonetheless, the electricity market progress of countries with a recent phase out of price regulation was comparatively slow, influenced by Greece and Croatia, which phased out regulated prices for households only in 2014 and 2015 respectively. Thus countries which maintain price regulation for electricity still show better market concentration indicators.

Figure 5-10: Evolution of the average market share of the three largest household suppliers





Source: Own calculations based on CEER data and NRA representatives

Note: Data is weighted by the total household consumption per country and per energy market.

The country label indicates the phase out year for regulated prices

Figure 5-11: Evolution of the number of suppliers with a market share above 5%

Source: Own calculations based on CEER data and NRA representatives

Note: Data is weighted by the total household consumption per country and per energy market.

The country label indicates the phase out year for regulated prices

Consumer engagement

Consumer engagement fosters competition in the market. A proxy to measure consumer engagement is the annual switching rate per country (as shown in the diagrams below). Switching enables consumers to benefit from better deals on offer from alternative companies or to obtain a better deal from their current supplier.[92] The Electricity Directive gives consumers the right to switch energy supplier within a three-week period and without extra charges. However, the Consumer Market Survey[93] identified several barriers to switching ranging from difficulties comparing the offers and tariffs to difficulties estimating potential savings. The perception of the process itself is also a barrier, as some consumers feel that it would be too complicated or that the savings would not justify the trouble linked to changing electricity companies. On the other hand, a low consumer satisfaction with their current supplier may also lead to higher switching rates, being for example one factor (among others) in Spain.[94]

Figure 5-12 shows the actual household switching rates for electricity and gas in 2016, measured in relation to the total number of metering points. Clearly, for **electricity,** countries which had a majority of households under regulated prices exhibited the lowest average switching rates of the European Union, with only France having a higher rate of 5% for electricity. However, countries which had an existing but minority share of households under price regulation exhibited a high average switching rate, possibly even higher than countries which phased out regulated prices. This is explained by the high rates of Portugal, Belgium and to a lesser extent Spain.

For **gas** also only France had a high switching rate (10%) among countries with a majority of households under regulated prices. Similarly as for electricity, also the group of countries with price regulation for 5% to 50% of households exhibits high switching rates, led again by Portugal, Belgium and Spain.

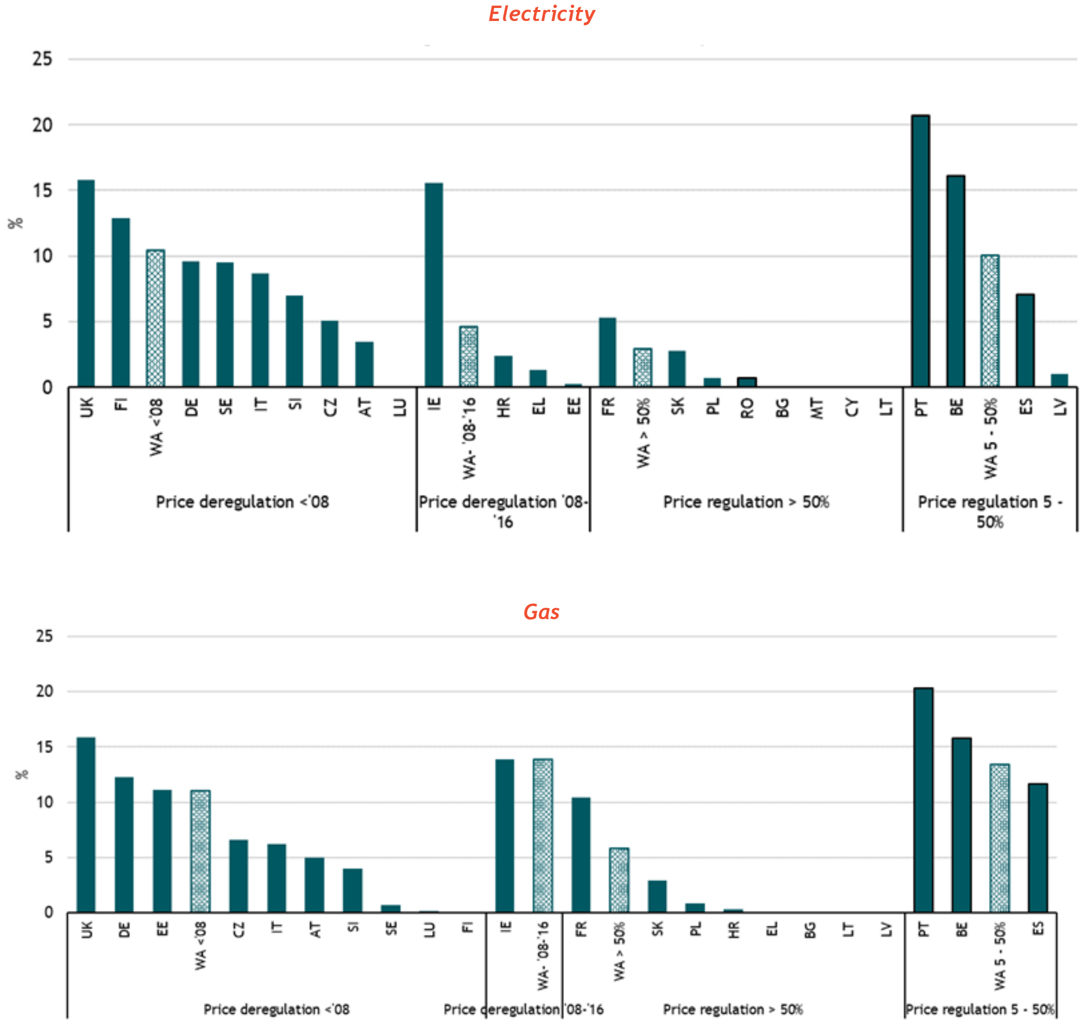
The switching patterns for each price regulation group are thus similar between electricity and gas markets, as are the magnitudes of the switching rates. However, specific country differences can be spotted, especially due to the (in)existence of (for example) developed gas markets in certain countries, such as Finland.

Switching rates in countries with limited price regulation

*By 2015 **Portugal** was going through an accelerated phase-out of regulated prices and implemented measures promoting switching for both electricity and gas. These included among other increased offer transparency, standardization and monitoring, price comparison tools, and supplements to regulated tariffs.[95] **Belgium** consumers dispose of a large choice both of suppliers and offers, with active involvement of regulators and consumer associations in order to increase awareness, price competition and collective switching actions.[96] In **Spain**, besides the measures taken by the regulator, consumer satisfaction also played a role in the high observed switching rates.[94]*

[92] European commission (2016), Second consumer market study on the functioning of the retail electricity markets for consumers in the EU. Executive summary.
93 European commission (2016), Second consumer market study on the functioning of the retail electricity markets for consumers in the EU. Executive summary.
[94] CNMC (2068), Informe anual de supervisión de los cambios de comercializador - Año 2015.
[95] ERSE (2017), Annual Report on the Electricity and Natural Gas Markets in 2016.
[96] Belgium country factsheet.

Figure 5-12: Annual switching rates in 2016



Source: Own calculations based on CEER and VaasaETT data (Switching rates for households in relation to the total number of metering points)

Note: data is missing for NL and HU for electricity and for NL, HU and RO for gas.

Data is weighted by the total household consumers per country and per energy market.

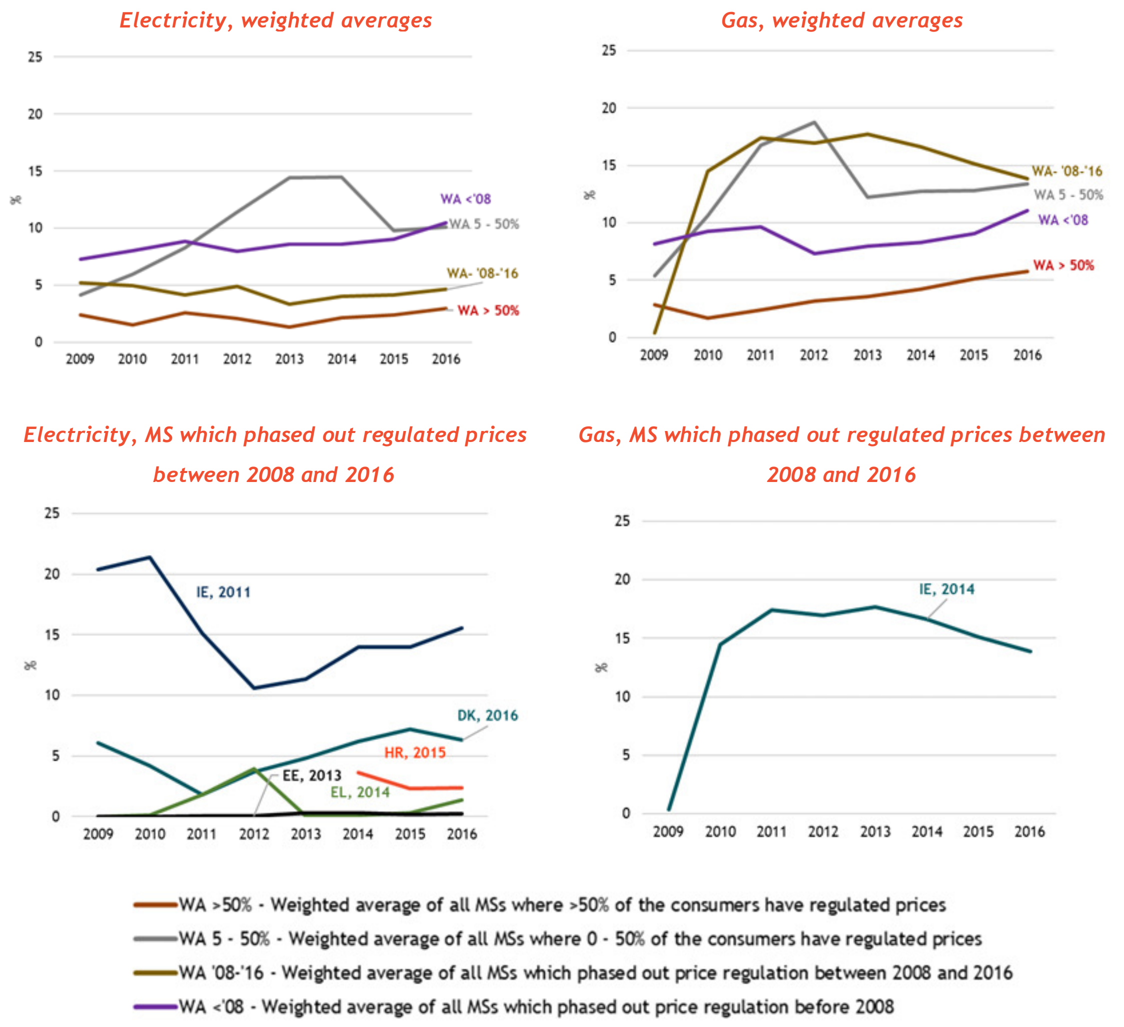
Evolution of switching rates in the EU over time

For **electricity,** countries with between 5 and 50% of households under regulated prices exhibit a peak in switching rates between 2013 and 2014, of around 15%, influenced by Spain and Portugal. By 2016 this had fallen to 10%, just lower than that for the countries which phased out prices before 2008 (with 11% average switching rates). The rate for countries which phased out regulation between 2008 and 2016 stayed around 5% during the assessed period.

Gas markets had a peak of over 18%, occurring in 2012 for countries with a minority share of households under regulated prices. While the switching rates for the 2008 to 2016 phase-out group has also decreased from a peak in 2013, the one from the countries which phased out regulation before 2008 is steadily increasing since 2012, reaching around 12%. For gas, groups of countries which phased out price regulation have switching rates higher than the group of countries which still have a majority of households under price regulation.

These trends indicate how switching rates trends can inflect for certain country groups, rising in certain periods only to fall in later year, and are thus more unstable than other trends such as for the share of consumers under regulated prices which does not present such inflections. Electricity and gas markets had similar peaks of switching rates for the group of countries with 5-50% of households with price regulation, but the peak occurred earlier for gas markets. In their turn, countries with price regulation for a majority of households have systematically the lowest switching rates. Also, the group of countries which phased out price regulation between 2008 and 2016 have much higher switching rates for electricity than gas throughout the period of analysis.

Figure 5-13: Evolution of switching rates



Source: Own calculations based on CEER data and VaasaETT.
Note: Switching rates for households in relation to the total number of metering points. Data is weighted by the total household consumers per country and per energy market. The country label indicates the phase out year for regulated prices.

Savings on energy expenditures

Monetary savings on energy expenditures are the main reason for households to switch suppliers. The analysis across country groups can indicate the impacts of the phase out of regulated prices on these monetary savings.

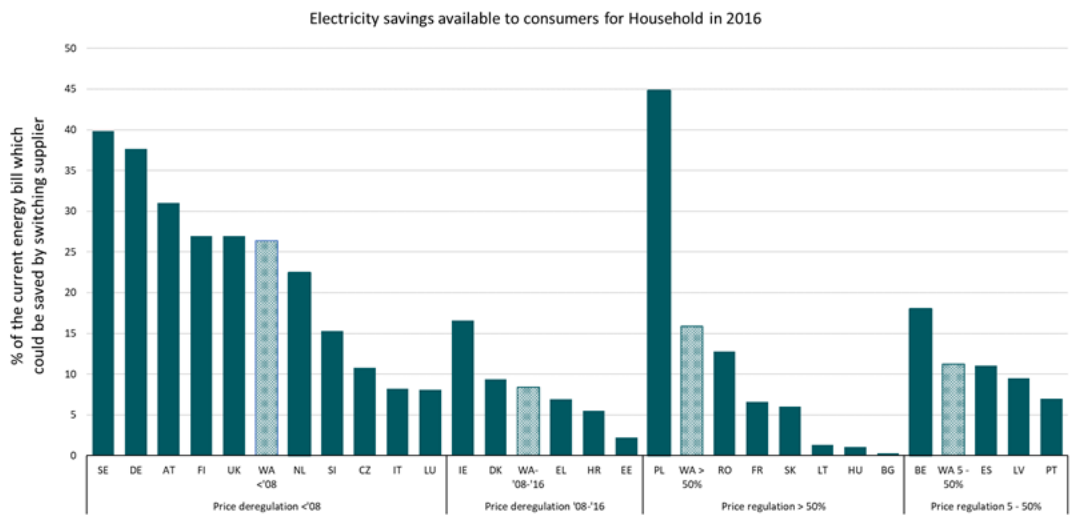
Figure 5-14 indicates that the highest savings to be made by switching **electricity** supplier (in relation to the current energy bill, including one-off benefits such as sign-in premiums) are 45% for Polish households in electricity. The highest weight-averaged savings to be made were in the group of countries which phased out regulated prices before 2008, at 26%. The potential savings in countries which phased out price regulation after 2008 or which still keep such regulation amount to between 8 and 16%.

Poland is an exceptional case, having the highest potential savings for electricity (45%) as indicated. However, as indicated by Figure 5-12 and the Polish NRA representative, switching rates for electricity suppliers are still low, at around 3.5%.[97] There are also countries where high switching rates accompany high saving potentials, such as in Belgium and the UK for electricity and gas. On the other hand, there can be countries with low savings potential which exhibit a much higher switching rate, such as Portugal for electricity and gas.

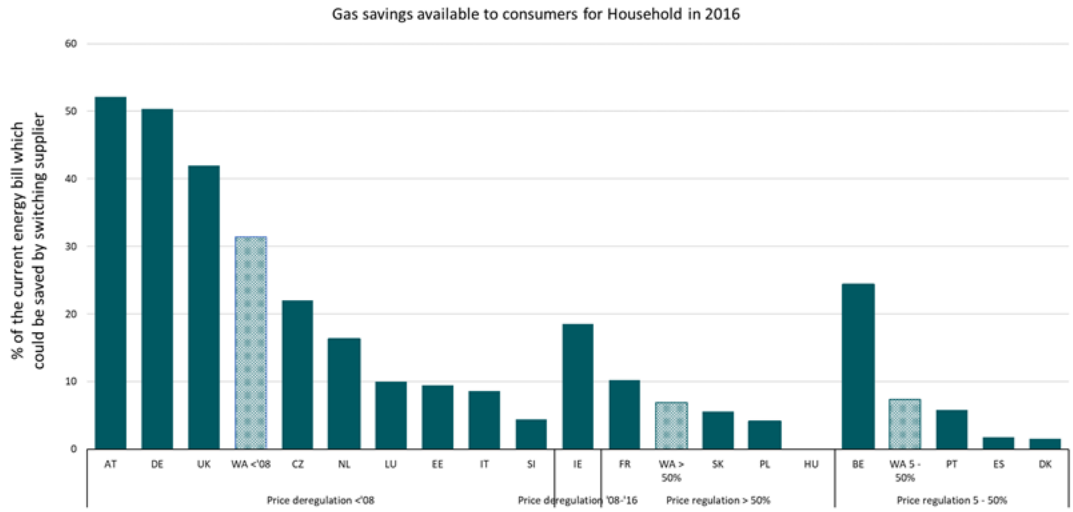
For **gas** the country with the highest potential savings from switching suppliers is Austria, at 50% of the current energy bill. Austria exhibits a modest switching rate of 5% for gas, lower than the weighted average for its country group. The highest potential savings appear in the group having phased out regulated prices before 2008, with a weighted average of 31%, while the other groups exhibit lower averages, at around 7%.

The analysis indicates the interplay of several factors. Countries with developed retail markets which phased out regulated prices a decade ago exhibit the highest savings potential. However, in countries without competitive retail markets (due to its inexistence or low number of suppliers for example) the savings potential will be naturally low or inexistent. On the other hand, the countries with the highest savings potential for electricity and gas exhibit lower switching rates than the weighted average of its country group.

Figure 5-14: Savings available to household consumers in 2016



[97] ERO (2017). National Report - The President of the Energy Regulatory Office in Poland, 2017



Source: Own calculations based on data from VaasaETT (2015).

Note: Data is weighted by the total household consumers per country and per energy market.

5.2.3 Impact of regulated prices on retail prices

Energy prices for households and their evolution

The final retail price for consumers is composed of the network costs, taxes & levies, and energy & supply components. As transmission and distribution activities are regulated[98], so are their costs, which thus cannot be competitively determined (except through regulatory incentives). Similarly, taxes and levies are determined by governmental authorities in order to finance energy sector-related and general public expenses. Hence, the energy and supply component is the only component of retail prices where phasing out price regulation can deliver increased competition and consequently benefits to European consumers. Thus, by focusing on the energy and supply component of the retail electricity and gas price for households, we can assess the impact of regulated prices on the retail electricity and gas markets and the expenditure of household consumers.

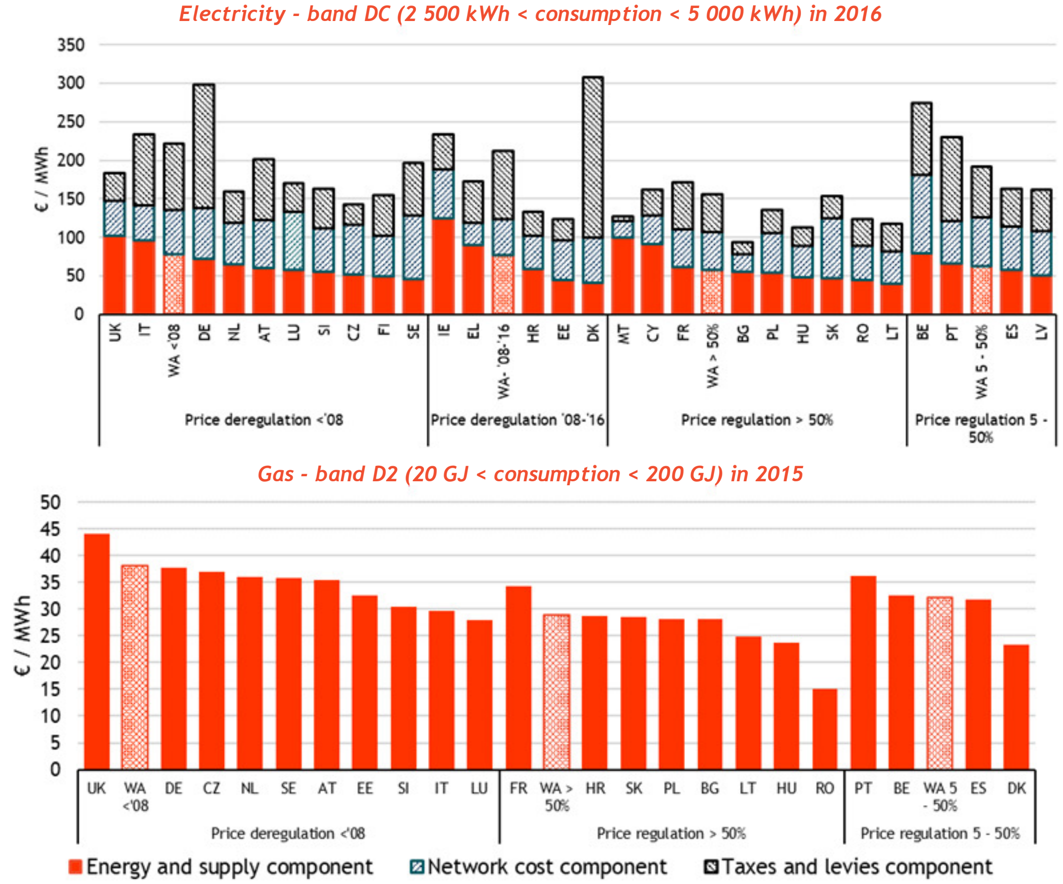
Figure 5-15 shows the retail electricity price components for household consumers for all EU28 Member States. The energy and supply component is also provided for the gas market. The report only discloses the figures for the average consumption bands per market to isolate the differences between regulated and non-regulated markets rather than differences within different consumer groups. Also, wholesale price data refers to the second semester of each year as only that period was available for the full horizon of analysis.

On the **electricity** market, the energy and supply price component varied significantly in 2016 across all countries between 38 EUR/MWh (in Denmark) and 133 EUR/MWh (in Ireland). Countries which phased out regulated prices before 2008 exhibited higher energy and supply component prices (average of 92 EUR/MWh), versus 60 EUR/MWh for countries which had a majority of households under price regulation by 2016.

[98] The 1st energy package started the unbundling process, separating the generation, transmission, distribution and supply activities of the European electricity and gas markets. However, it maintained transmission and distribution as regulated activities due to their natural monopoly characteristics.

For **gas** markets, the energy price component ranged from 15 EUR/MWh (in Romania) to 44 EUR/MWh (in the UK) in 2015. The weighted averages amounted to 38 EUR/MWh (for countries which phased out regulated prices by 2008) and 29 EUR/MWh (for those which had a majority of households under price regulation in 2016).

Figure 5-15: Prices for electricity (2016) and gas (2015) on the household consumer market



Source: Eurostat (and EC ad-hoc data for Spain for the electricity energy and supply component) for electricity data and EC ad-hoc data for gas

Note: that for gas, no data is available for Finland, Ireland, Greece and Latvia. Data is weighted by the total household consumption per country and per energy market.

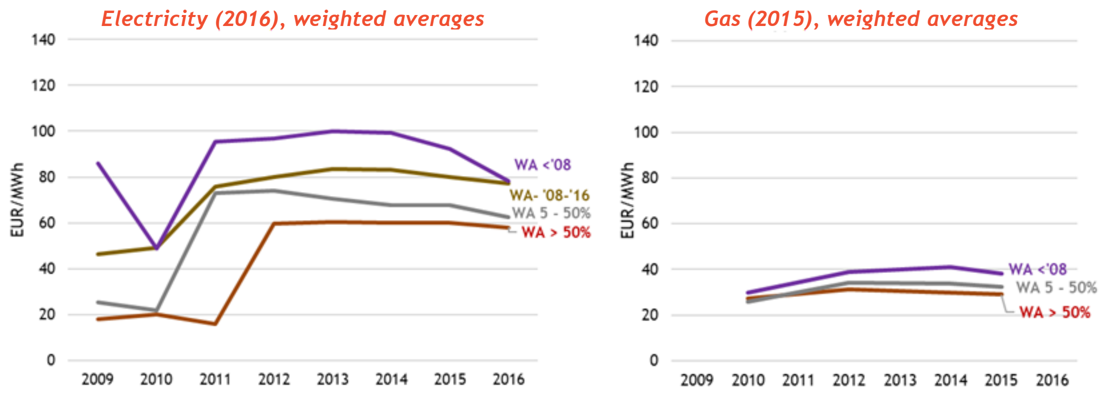
Evolution of energy prices in the EU over time

Figure 5-16 presents the developments of the energy and supply price component for households over time. For **electricity**, the energy and supply component price for electricity increased until 2012 and then fell in most countries which phased out prices between 2008 and 2016, in line with the other weighted average groups. Between 2008 and 2016, the price decreased from 92 EUR/MWh in 2008 to 78 EUR/MWh in 2016 (-14%) in Member States which phased out price regulation prior to 2008. All other weighted averages show increased electricity prices between 2008 and 2016. The energy and supply component rose from 27 EUR/MWh in 2008 to 77 EUR/MWh in 2016 in Member States which phased out price regulation between 2008-2016 (+188%), from 27 EUR/MWh to 63 EUR/MWh in Member States with a minority of consumers under regulated prices (+130%) and from 17 EUR/MWh to 58 EUR/MWh in Member States with a majority of consumers under regulated prices (+235%). Concerning the specific Member States which phased out price regulation between 2008 and 2016 (Croatia, Denmark, Estonia, Ireland and Greece), no sharp increases in the energy and supply component of the retail electricity prices are observed after deregulation. Ireland liberalized electricity prices for households in 2011. However, the energy and supply component rose until 2014, falling afterwards. Looking at the evolution of total retail electricity prices (thus not only the energy and supply component), all countries in the group observed a slight increase from 2012 to 2015 – the range moved from 147-216 EUR/MWh to 156-236 EUR/MWh. Strong total electricity retail price reductions in Greece are not observed, although Ireland does exhibit a reduction of 8 EUR/MWh from 2013 to 2015, to 129 EUR/MWh.

For **gas**, data availability hampers the analysis. The averages for the energy and supply component prices are around 29-32 EUR/MWh for countries with regulated prices compared 38 EUR/MWh for countries which phased out price regulation before 2008. The weighted averages for all country groups have slightly increased, from the 27-37 EUR/MWh in 2008 to 29-38 EUR/MWh in 2015. The weighted average for the Member States which phased out price regulation prior to 2008 remained rather stable over the years; it increased from 37 EUR/MWH in 2008 to 38 EUR/MWH in 2015 (+2%). Also in Member States with price regulation, the energy and supply component of the retail price did not change (significantly): 32 EUR/MWh in 2008 and in 2015 in Member States with a majority of the households under regulated prices and 27 EUR/MWh in 2008 and 29 EUR/MWh in 2015 (+6%) in Member States with a minority of the households under regulated prices. Prices have risen highest in the UK, from 34 EUR/MWh in 2008 to 44 EUR/MWH in 2015 (+29%). As an illustration for total gas retail prices for households (to which consistent data is unavailable for the period and countries under analysis), they have decreased both in Greece (up to 40% reductions from 2012 to 2016)[99] and Ireland (in the 2013-early 2016 period)[100].

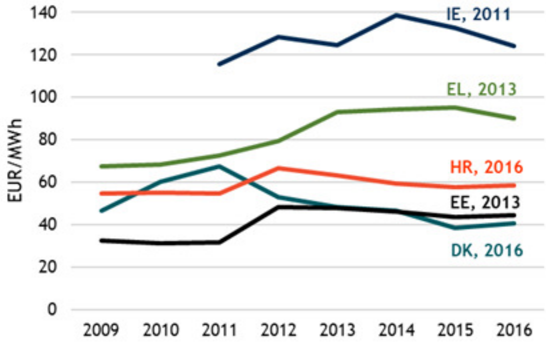
Overall, since 2009 the energy and supply prices are lower for countries which still had regulated prices by 2016, both for electricity and gas. Moreover, prices in both markets rose until 2013-2014 before decreasing (in different degrees). However, several other factors affect energy and supply component prices, such as the energy supply structure (i.e. its mix) or international fossil fuel prices.

Figure 5-16: Energy and Supply component of household energy retail prices for middle consumption bands (DC and D2)



[99] RAE (2017). National Report 2017 - Regulation and performance of the electricity market and the natural gas market in Greece, in 2016
[100] CER (2016). Regulator's 2015 National Report to the European Commission

Electricity (2016), MS which phased out regulated prices between 2008 and 2016



Gas (2015), MS which phased out regulated prices between 2008 and 2016

No data for Ireland which is the only MS in this category

Source: Own calculations based on data from Eurostat (and EC ad-hoc data for Spain for the electricity energy and supply component) for electricity data and EC ad-hoc data for gas.
Note: no data for Ireland (which is the only country in the WA '08-'16 group for gas). Data is weighted by the total household consumption per country and per energy market. The country label indicates the phase out year for regulated prices.

Energy expenditures as a share of disposable income

In addition to the comparison of the energy and supply component of the retail price between MS and the correlation with price end user price regulation, the energy expenditures as share of the disposable income for households in the middle consumption bands was calculated.[101] This indicator essentially shows the significance of the total energy bill compared to the disposable income and is therefore a proxy to understand the level and evolution of the affordability of energy. The affordability of the energy bill is becoming increasingly important especially for vulnerable end-users and they are exposed to large energy cost differences between Member States.

Care must be taken when comparing with other sources for energy expenditures of households due to factors such as differences in the methodology, for example between calculations using the total number of households instead of the number of households connected to the electricity or gas distribution systems.[102]

Figure 5-17 indicates that the average **electricity** expenditure for households ranges from a maximum of 7% (in Bulgaria and Greece) to 2% (in Luxembourg and the Netherlands). The countries with a minority share of consumers under regulated prices or those which phased out price regulation recently exhibit a larger weighted average for electricity expenditures than the other groups (5% versus less than 4%). The weighted average of countries which phased out regulated prices after 2008 is almost double than for those that did so before that year. This is driven by Greece for the former group, while Italy, Luxembourg, the Netherlands and the UK lower the latter weighted average.

Gas expenditures ranges from over 3% (in Hungary, Italy and the Netherlands) to barely any expenditure (in Bulgaria). Countries which phased out regulated prices before 2008 have a higher average, at over 2%

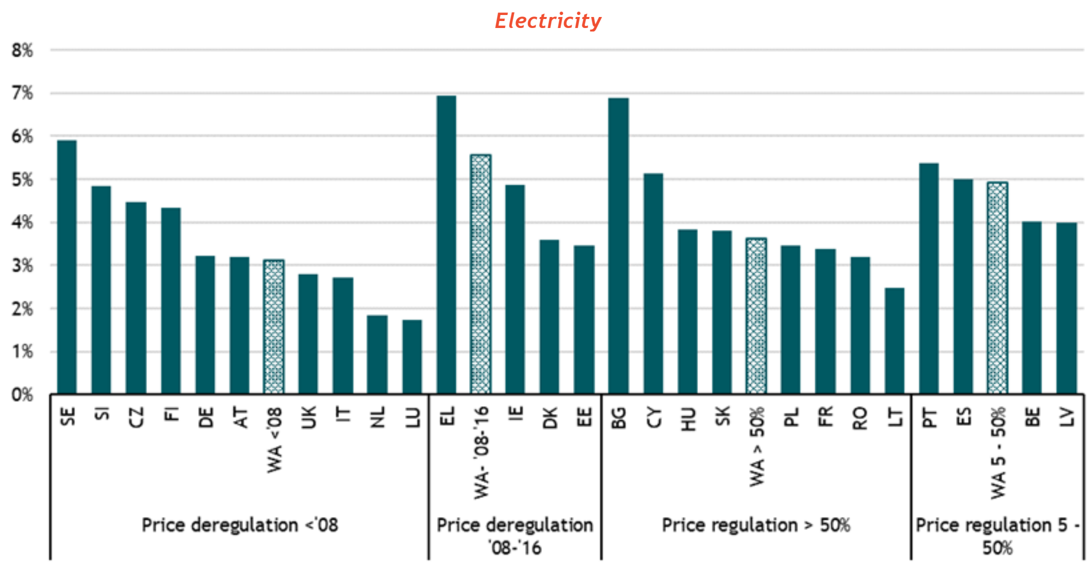
[101] The data available on gas and electricity prices is provided per consumption band. This report shows the middle consumption bands for easier visualisation: DC for the electricity market for household consumers (2.5 MWh – 5 MWh per year), D2 for the gas market for households consumers (20 GJ – 200 DJ per year), and ID for the electricity market for non-household consumers (2 GWh – 20 GWh per year)
[102] The data presented below represents the total energy costs (calculated as the energy consumption for the household sector multiplied by the retail price) divided by the total number of households in the country. Using the number of connection points, or a proxy based on the percentage of the population connected to the (gas) grid, a more accurate indicator could be obtained.

driven by Italy, while countries with a more recent phase out (between 2008 and 2016) exhibit the lowest weighted average for gas, at a little over 1%.

The comparison between the expenditures suggests that electricity represents a higher average expenditure than gas in most countries where data is available, except in Italy and the Netherlands. However, this is due to the fact that in several countries not all households have connections to the gas grid (i.e. the actual number of connection points to the gas grid are lower than the number of households). Moreover, the ratio between expenditures in electricity and gas can vary significantly, ranging from equal expenditure to an order of magnitude of difference.

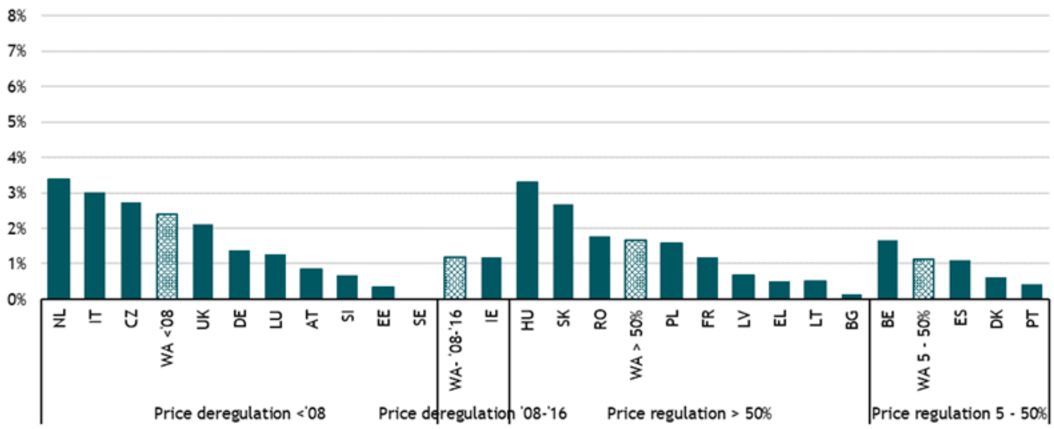
There is a higher variation of gas and electricity expenditures within groups than between them, so that no pattern is visible regarding the price regulation groups and energy expenditures. This is especially the case when comparing electricity and gas markets, since then trends can be opposite, with the country groups which phased out regulated prices before or after 2008 exhibiting the highest expenditures for one energy market but the lowest expenditures for the other market. Thus, the data does not support any assumption that markets with regulated prices will lead to lower energy expenditures, but energy expenditure differences between electricity and gas are also driven by important factors such as the geography and resultant climate, so that more investigation is warranted in this topic. Also, not only the energy expenditures will affect the indicator, but also the total disposable income which forms the denominator of the indicator.

Figure 5-17: Expenditures on electricity and gas as share of disposable income for households (for middle consumption bands DC and D2) using PPS prices[103]



[103] Purchasing Power Parity (PPS) is an artificial currency used to compare prices across countries, taking into account the differences in purchasing power between countries (Eurostat statistics explained, 2014).

Gas



Source: Own calculations based on Eurostat

Note: The most recent data available data was used in the calculations. For Hungary, Romania and the UK this was 2015, for all others 2016. No data is available for Croatia and Malta. Average yearly household expenditures may deviate with other sources due to factors such as differences between numbers of households and actual connection points.

Data is weighted by the total household consumers per country and per energy market.

Competition performance & mark-ups

In this section we assess the gross margins applied by suppliers when calculating end-user prices (mark-ups). Mark-ups for the retail markets are calculated as the differences between the wholesale price and retail energy and supply price component.[104] According to ACER/CEER, the estimated mark-ups are not meant to assess retail margins of suppliers, but serve rather as an "indication of the level of retail competition and the 'responsiveness' of retail to wholesale prices over time".[Error! Bookmark not defined.] Besides, they indicate that while in the short-term negative retail mark-ups (i.e. energy and supply components below wholesale market prices) may be attractive, they will have negative long-term effects on electricity and gas investments, the financial health of companies, the entrance of new suppliers and on providing adequate price signals to consumers.[Error! Bookmark not defined.] Care must be taken in comparing the present calculated mark-ups with those from other sources due to methodological differences, such as the consideration of supplier procurement strategies, the use of other consumption bands, differences from spot and forward prices, and the price data used.

Figure 5-18 indicates the mark-ups for middle bands for electricity (band DC) and gas (band D2). For **electricity**, Ireland exhibited the highest mark-up in 2016, at 80 EUR/MWh, followed by the UK and Malta (at 51 EUR/MWh). Only Lithuania is in the 0 – 5 EUR/MWh range for electricity mark-ups. No country presented a negative mark-up for electricity in 2016, in contrast to 2013 when Latvia, Lithuania and Romania exhibited such negative mark-ups (-23, -4 and -2 EUR/MWh respectively). Latvia and Romania both introduced reforms since 2012 to phase out regulated prices which may have had an effect on those negative mark-ups.

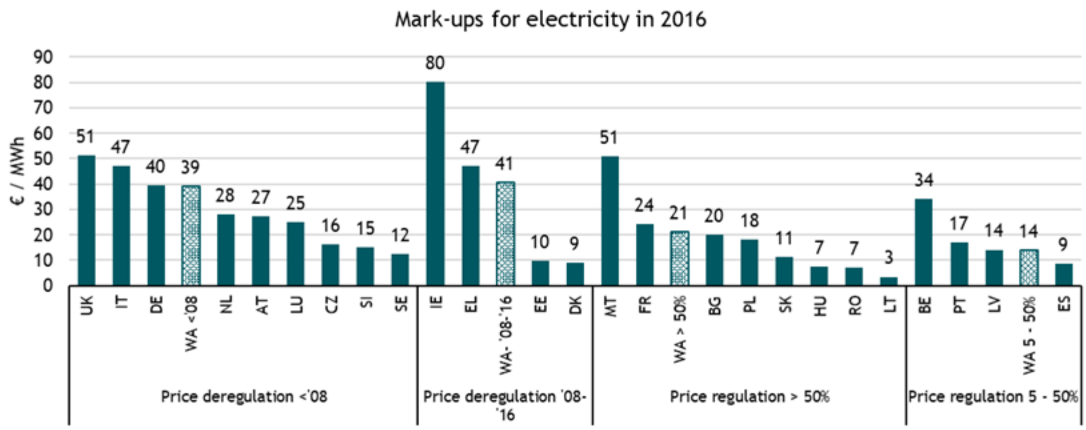
[104] ACER/CEER (2015), Annual Report on the Results of Monitoring the Internal Electricity and Natural Gas Markets in 2014

For **gas** data is available for a lower number of countries, among which the UK had the highest observed mark-up in 2017 at 24 EUR/MWh. Bulgaria, Croatia, Denmark and Hungary are in the 0-5 EUR/MWh range for gas mark-ups. In 2015, only Romania exhibited a negative mark-up of -10 EUR/MWh for gas, while in 2012 Bulgaria, Croatia, Romania, Slovenia, Slovakia, and Portugal did so (with the Romanian gas mark-up then at -18 EUR/MWh). These countries (except for Slovakia) have implemented reforms to phase out regulated prices for households. Countries such as Bulgaria, Croatia and Lithuania which exhibited negative mark-ups in the past may still exhibit very low mark-ups in the 0 – 5 EUR/MWh range. In Bulgaria and Croatia the energy & supply price component fell faster than gas wholesale prices since the peak of wholesale prices in 2012, leading to the slightly positive mark-ups (as shown in the country factsheets). However, a more detailed analysis of the components of these mark-ups (such as supplier margins and procurement strategies) would be required to assess the profitability of European suppliers in these markets.

The two groups of countries with a significant share of household consumers under regulated prices exhibit generally lower mark-ups than those which phased out regulated prices before or after 2008, especially for electricity. Thus, for electricity the mark-up weighed averages of countries with a pre- and post-2008 phase out amount to 39 and 41 EUR/MWh, against 21 and 14 EUR/MWh for countries with a minority or majority share of households under price regulation. For gas, these weighed averages are 18, 7, and 12 EUR/MWh respectively (no data exists for Ireland, the only country which phased out price regulation for gas between 2008 and 2016).[105] Therefore, while Member States have generally eliminated negative mark-ups for electricity and gas, there are still differences in the positive mark-up levels between country categories, especially in electricity where mark-ups are generally higher.

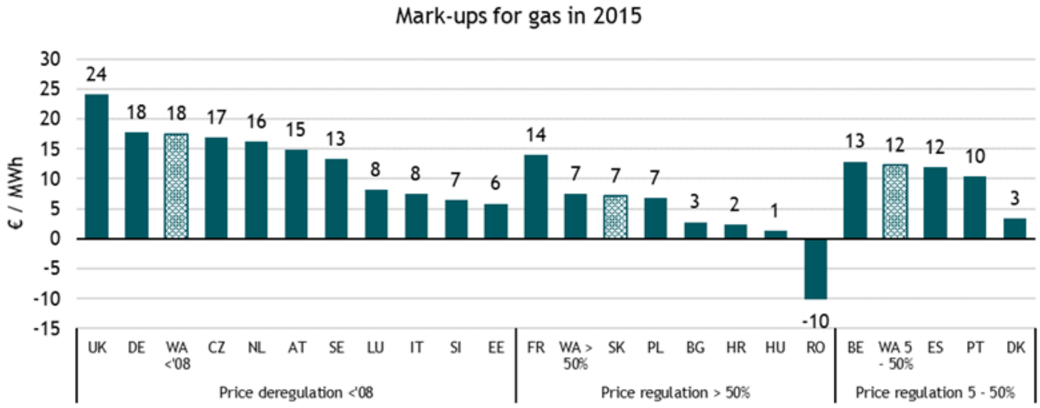
Figure 5-18: Mark-ups for the middle consumption bands (DC and D2) for electricity (2016) and gas (2015)

Electricity - band DC (2 500 kWh < consumption < 5 000 kWh) in 2016



[105] The weighted average for the '2008 – 2016 phase out' group is determined by Italy. Here the household gas 'protected market' model was significant until at least 2016 and could pressure mark-ups downward.

Gas - band D2 (20 GJ < consumption < 200 GJ) in 2015



Source: Own calculations based on Eurostat and Task 1 of this report for wholesale prices.
Note: No data available for Finland, Croatia, Cyprus for electricity and no data for Finland, Ireland, Greece, Lithuania and Latvia for gas. Mark-ups are calculated by subtracting the wholesale price from the energy and supply component of the retail price. Data is weighted by the total household consumption per country and per energy market.

Evolution of the household mark-ups in the EU over time

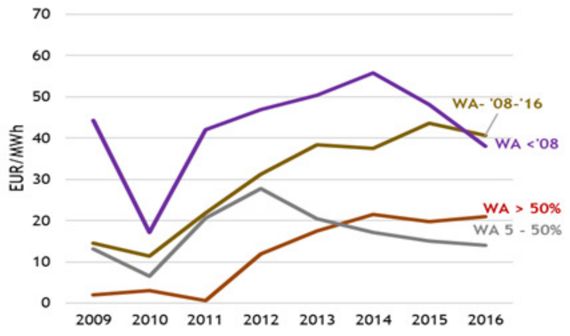
Although other factors influence mark-ups, Member States (throughout all groups of price regulation) have significantly reduced the occurrence of negative mark-ups both for electricity and gas household supply.

The average-weighed mark-ups for **electricity** increased for countries which phased out regulated prices before 2008, from 13 EUR/MWh in 2008 to 39 EUR/MWh in 2016 (195%). Mark-ups also increased for countries with minority shares of households under regulated prices over the same years (3 to 14 EUR/MWh, 310%). Member States which phased out regulated prices between 2008 and 2016 saw an increase in mark-ups, from an average of 4 EUR/MWh to 41 EUR/MWh (+841%). This was especially driven by increases in the mark-ups in Greece and Ireland. It is also noted that the weighted average of the mark-ups for Member States with a majority of consumers under regulated electricity prices rose significantly (+910%) between 2009 and 2016. However, the mark-up remains below the mark-up of the Member States which phased out price regulation (prior to 2008 and between 2008 and 2016).

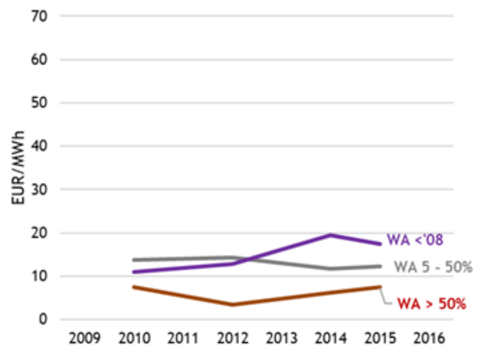
For **gas**, mark-ups increased for countries with a pre-2008 phase out of regulated prices (11 to 18 EUR/MWh between 2010 and 2015, +61%). Countries with a majority of households under regulated prices (which moved away from negative mark-ups as mentioned) correspondingly saw an increase in mark-ups between 2008 and 2015, from -11 EUR/ MWh to 7 EUR/MWh. This increase was especially driven by increasing mark-ups in France. However, other countries with a majority of households under regulated prices experienced increasing mark-ups as well, except Hungary. Member States with a minority of households under regulated prices saw a decrease in mark-ups between 2010 and 2015, from 14 EUR/MWh to 12 EUR/MWh (-11%).

Figure 5-19: Evolution of mark-ups

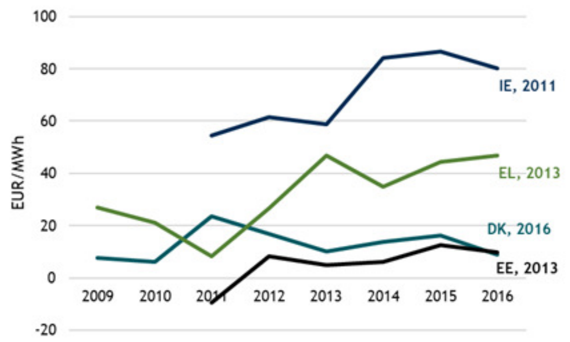
Electricity, weighted averages



Gas, weighted averages

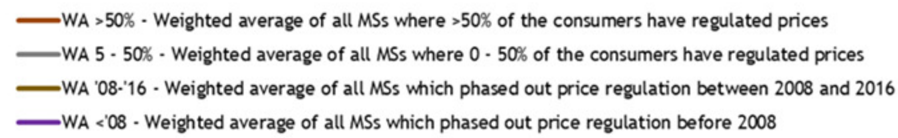


Electricity, MS which phased out regulated prices between 2008 and 2016



Gas, MS which phased out regulated prices between 2008 and 2016

No data for Ireland which is the only MS in this category



Source: Own calculations based on Eurostat and Task 1 of this report for wholesale prices.
Note: no data for Ireland (which is the only country in the WA '08-'16 group for gas). Data is weighted by the total household consumption per country and per energy market. The country label indicates the phase out year for regulated prices

5.2.4 *Energy poverty*

Two proxies are used in this section to assess energy poverty and, in particular, to assess the difference in energy poverty between Member States with and without price regulation: the inability to keep homes adequately warm and the arrears on the utility bills. These indicators are monitored by EU statistics on income and living conditions (EU-SILC). The indicator on the "inability to keep homes adequately warm" is often used as a proxy to measure energy poverty, and it can be correlated with a low household income, high energy costs and energy inefficient homes. Figure 5-20 compares indicators which proxy energy poverty and the retail electricity price between Member States in 2016 for households who consume 2500 to 5000 kWh per year.

Correlation between economic developments and energy (poverty) indicators

Throughout this report, indicators like the energy expenditures as a share of the disposable income and the energy poverty indicators are used to assess the evaluation on energy expenditures and *energy poverty and, ultimately, to determine the potential impacts of price regulation on energy expenditures and energy poverty. However, these indicators are constructed using an energy market component and a general economic component. For instance, the energy expenditures as a share the disposable income are dependent on energy prices (energy market component) and on disposable incomes (general economic component). The energy poverty indicators are also affected by economic conditions (i.e. disposable income). Thus, differences between Member States can be driven by differences on the energy market, but also by economic differences.*

There are two specific economic phenomena which should be taken into account in the energy poverty section:

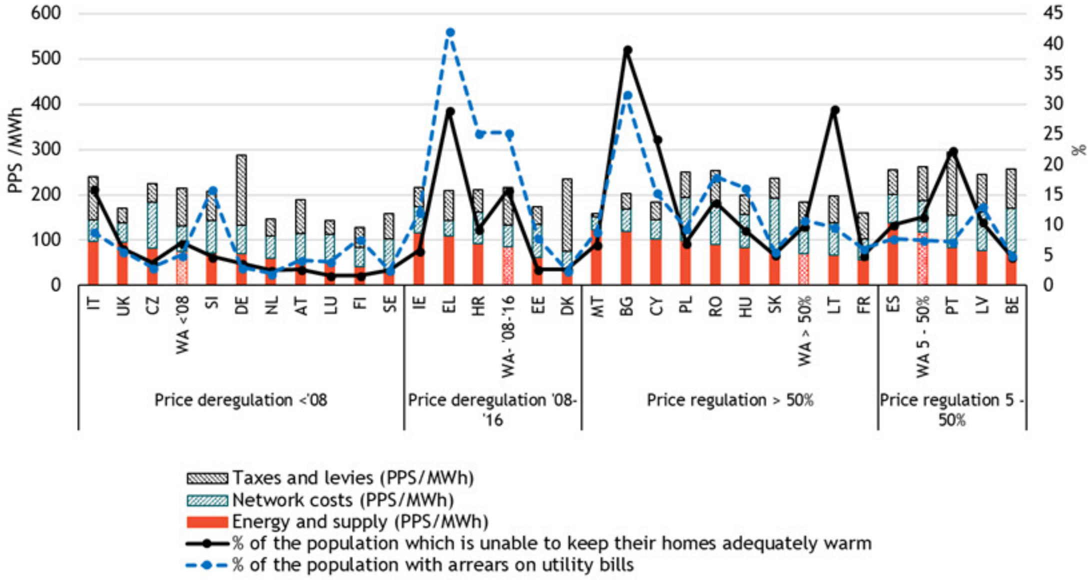
1. ***Differences in disposable incomes*** *- The levels of disposable income and purchasing power varies significantly between Member States. As such, the difference in energy poverty indicators between, for instance, Belgium and Bulgaria is driven more intensively by differences in the GDPs per capita (GDP per capita in PPS in Belgium is more than twice as high as in Bulgaria) than by differences on the energy markets.*
2. ***The importance of the economic crisis*** *- The economic crisis from 2008 (and its aftermath) harmed all EU-28 Member States, but Greece in particular. The deteriorating energy indicators in Greece are (partly) due to lower disposable incomes as a result of the crisis.*

Even though this might be evident in the cross-country graphs, it is not evident when comparing weighted averages. It is therefore emphasized that the weighted averages of several indicators of the Member States which phased out electricity price regulation between 2008-2016 are more intensively affected by the economic crisis than the weighted averages for other groups (driven by Greece).

The countries with the highest rates of arrears and heating problems correspond relatively closely to the poorest Member States (Bulgaria, Romania) or those that have experienced serious economic problems in recent years (Greece, Lithuania, Portugal), as discussed in the textbox above. Even though these countries have regulated prices (except for Greece), the energy and supply component of the retail prices in these countries do not seem to be lower in comparison to other countries or to have a positive effect in the energy poverty indicators. Overall, those countries which phased out price regulation before 2008 have lower rates of arrears and inability to keep homes warm. No distinct correlation is disclosed between the energy and supply component of the retail electricity price and the energy poverty indicators. Even though the energy poverty indicators were high in Bulgaria, Greece, Lithuania, Poland and Romania, the energy and supply component of the retail price was relatively high in Greece and Bulgaria, but not in Lithuania, Poland and Romania. This supports the requirement of the revised directive on the Internal Electricity Market[106] that countries should strive to protect vulnerable consumers with mechanisms which distort energy markets as little as possible rather than apply blanket price regulation or even social tariffs.

[106] Article 5 (3) of European Commission (2016) COM(2016) 864 final/2 - Directive Of The European Parliament And Of The Council On Common Rules For The Internal Market In Electricity.

Figure 5-20: Electricity price components for Band DC (in PPS), the inability to keep home adequately warm and arrears on utility bills in Austria



Source: Own calculations based on Eurostat

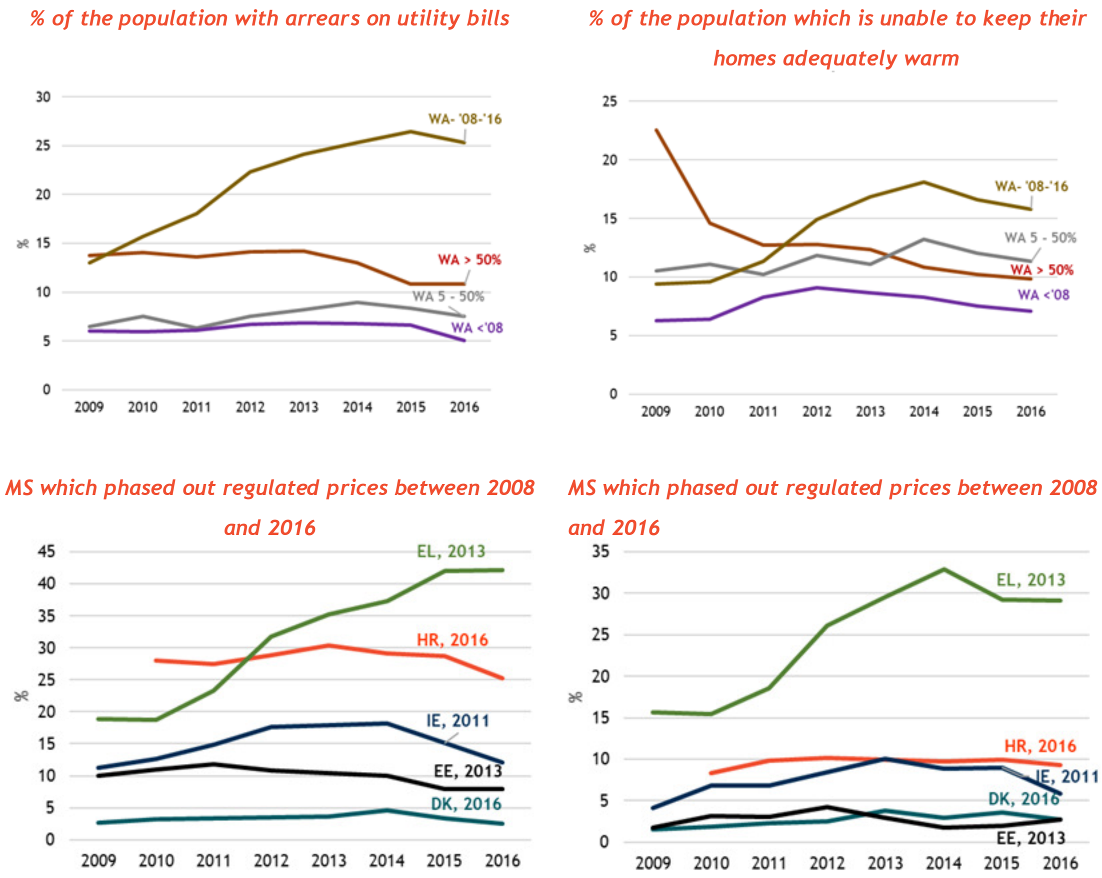
Note: that the % of the population which is unable to keep their homes adequately warm and the % of the population with arrears on the utility bills are not separated for the gas and electricity market.

Data is weighted by the total household consumers per country and per energy market.

Evolution of energy poverty in the EU over time

Figure 5-21 shows the development of the energy poverty indicators over time for the weighted averages and for the countries which phased out price regulation between 2008 and 2016. It discloses that most of the country groups experienced a declining trend in terms of energy poverty which suggests that less households experienced energy poverty. However, for the group of countries which phased out energy price regulation between 2008 and 2016, both weighted averages increased meaning that relatively more households faced arrears on their utility bills and were not able to warm their houses adequately. Zooming in on this group of countries shows that his is driven by the intensifying energy poverty in Greece from 2010 onwards, clearly linked with the economic crisis that has hit Greece hardest of all Member States, as discussed in the textbox above. In other Member States, the energy poverty indicators remained relatively constant or decreased over time.

Figure 5-21: Energy poverty evolution over time



Source: Own calculations based on Eurostat.

Note: Data is weighted by the total household consumers per country and per energy market. The country label indicates the phase out year for regulated prices.

5.2.5 Evolution of quality of service

Consumer satisfaction and consumer choice are the main areas identified for the assessment of the evolution of the quality of service. Consumer satisfaction is assessed using the market performance index while consumer choice analyses the types of offers available.

Consumer satisfaction

This section allows to analyse several consumer satisfaction indicators in the EU28 Member States. This is important to analyse whether there is a relationship between consumer satisfaction and the existence of phase out of price regulation in the EU. The Market Performance Index (MPI) is a composite indicator that covers five key aspects of consumer experience:

- **Comparability** – how easy or difficult is it to compare goods or services?
- **Trust** – do consumers trust suppliers to comply with consumer protection rules?
- **Expectations** – does the market live up to consumer expectations?
- **Choice** – are consumers happy with the number of suppliers?
- **Overall detriment**[107] – proportion of consumers who have experienced a problem in the market and related amount of detriment; (more specifically, if no problem has been experienced a score of 10 is assigned to the component but if the respondent did encounter a problem, the

[107] Introduced in 2015

component reflects the amount of detriment: the higher the detriment rating, the lower the component score).

In this section we analyse the MPI together with the share of consumers who have experienced at least one problem, the trust of consumers in suppliers, their ability to compare products and services, and the perceived ease of switching suppliers.

Figure 5-22 shows consumer experience indicators across Member States in 2015. For **electricity,** MPI results are positive overall (above 50/100 in all cases, and close to or above 70/100 for all countries except Bulgaria and Spain). The lowest MPI for electricity is found in Bulgaria. However, the weighted average MPI for the countries in which more than 50% of the household consumers face electricity price regulation (the group to which Bulgaria belongs) is amongst the highest MPI scores. It is interesting to see that for all countries which phased out price regulation before 2008 (except Italy) the scores are above 75 points; while for those which still have regulated prices or which phased them out between 2008 and 2016 the score is in some cases lower. This is confirmed by the weighted averages: the MPI for Member States which phased out price regulation prior to 2008 is (slightly) higher than the MPI for Member States with (either a majority or minority) of the consumers under regulated prices.

For **gas**, the MPI results are positive as well (ranging between 69/100 and 87/100). The variation between Member States is significantly lower for gas which is especially driven by the difference in Bulgaria's scores on the electricity market (52/100) and on the gas market (73/100). Comparing the weighted averages between the different groups of price regulation shows that the highest MPI is in those Member States in which more than 50% of the household consumers face regulated gas prices.

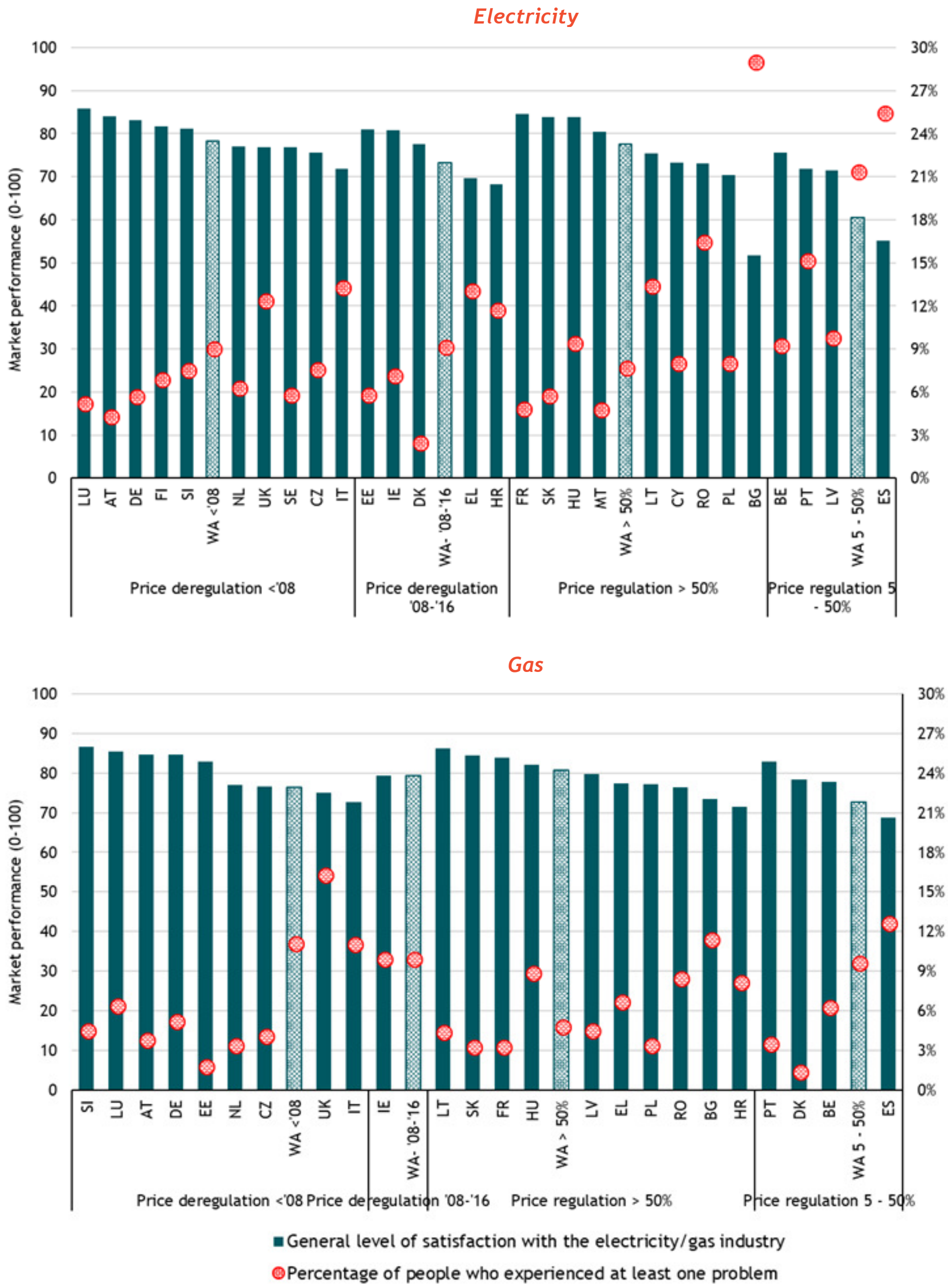
Thus, the analysis indicates a low correlation of consumer perception of market performance with the existence (or not) of price regulation. Furthermore, specific countries made significant advances in improving consumer satisfaction. This indicates that the (in)actions of stakeholders of the energy sector including the national regulatory authorities are more impactful to consumer satisfaction than whether countries are in specific stages of phasing out regulated prices.

Regarding the number of consumers who have experienced at least one problem, for **electricity** only in Denmark 5% or less of all households have experienced at least one problem. Moreover, only countries which did not yet phase out regulated prices exhibit 13% or higher rates in the indicators.

For **gas**, in half of the Member States, 5% or less of the households have experienced at least one problem. Also, there is no relation between the existence of regulated prices and higher values of the indicator. For gas the UK shows the highest percentage of consumers experiencing a problem, of over 16%.

Therefore, the number of consumers experiencing at least one problem is higher for electricity than gas, in line with the comparative performance of the MPI for both markets. There are also indications of an inverse correlation within price regulation groups, between low MPIs and higher incidence of experiencing problems. On the other hand, there seems to be little difference between regulated and unregulated markets when it comes to the percentage of people who have encountered at least one problem with their electricity supplier, especially for gas.

Figure 5-22: Market performance of the electricity and gas industries from a consumer perspective in 2015



Source: Own calculation based on Consumer Market Scoreboard data.

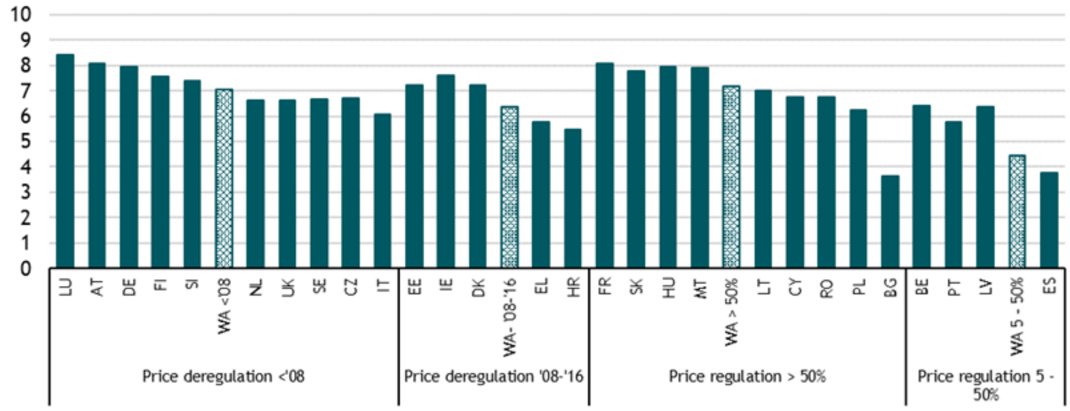
Note: Data is weighted by the total household consumers per country and per energy market.

Figure 5-23 and Figure 5-24 show different consumer satisfaction indicators across Member States for **electricity** and **gas** respectively. Concerning the trust of consumers with suppliers, there is no correlation with the existence of regulated prices neither for electricity nor for gas. For both energy carriers, the groups where consumers trust more in suppliers (with scores between 7 and 8) are those which phased out regulated prices before 2008, or those which still have a majority of households under regulated prices. These groups also exhibit a higher score on the ability of consumers to compare products or services. Except for the case of gas, where Ireland is the only country of the 5 – 50% group.

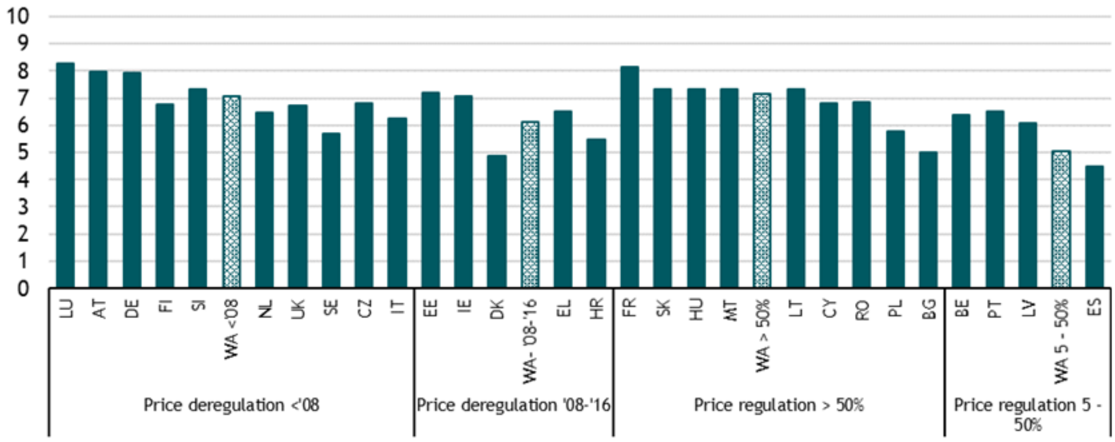
The perceived ease of switching provides even less differences among countries with and without price regulation, as the average scores for all groups are between 7 and 8 both for electricity and gas. Given that regulators are implementing measures to incentivize retail competition such as price comparison tools and maximum switching duration in many countries phasing out regulated prices, the lack of differences across price regulation groups in the ability of consumers to compare products or switch suppliers deserves further investigation.

Figure 5-23: Consumer satisfaction indicators for electricity in 2015: Ability of consumers to compare products or services[108], trust of consumers in suppliers[109] and perceived ease of switching[110]

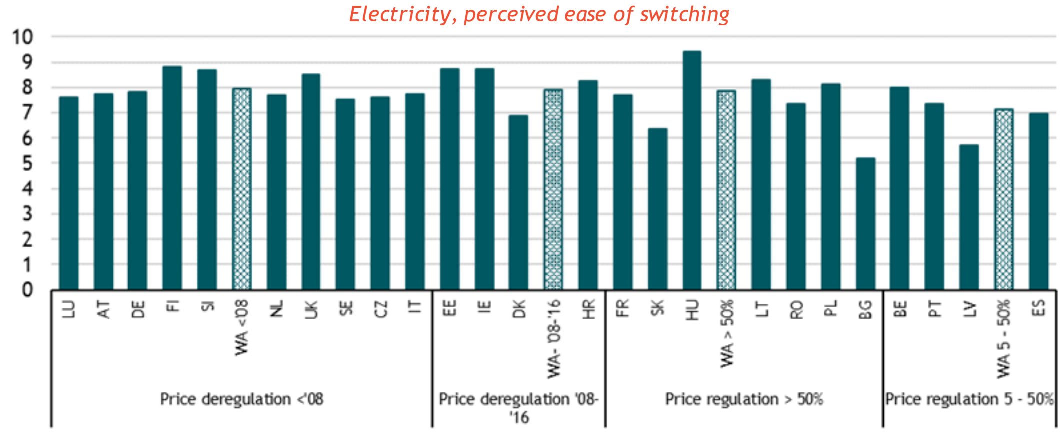
Electricity, trust of consumers in suppliers / providers to respect the rules and regulations protecting consumers



Electricity, ability of consumers to compare products or services



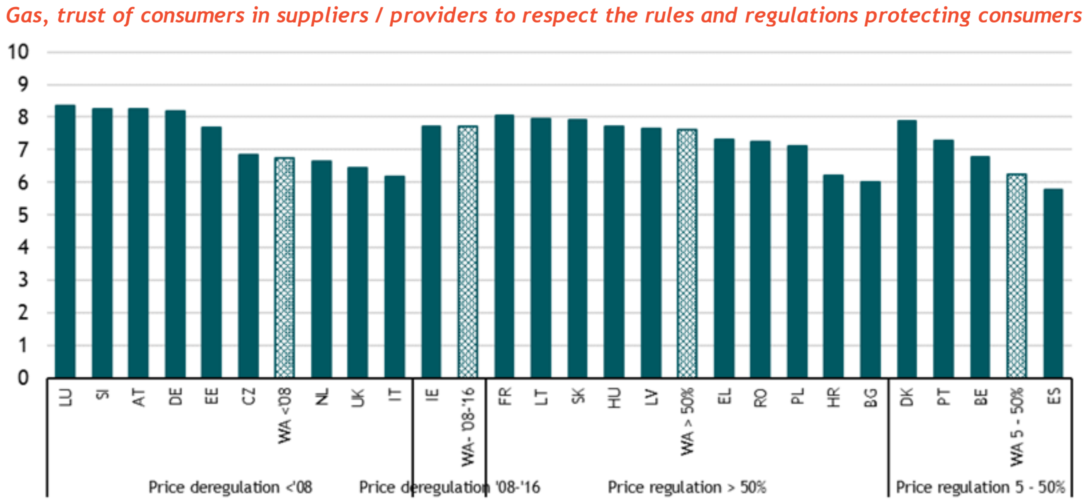
[108] DG Justice survey: The functioning of retail electricity markets for consumers in the EU. Question: "I can choose from a sufficient number of electricity providers?"
[109] DG Justice survey: The functioning of retail electricity markets for consumers in the EU. Question: "In your opinion, do consumers trust electricity suppliers with respect to the rules and regulations protecting consumers?"
[110] DG Justice survey: The functioning of retail electricity markets for consumers in the EU. Question: "Which of the following best reflects your experience of switching?" Average of three answers (easy, average, difficult)



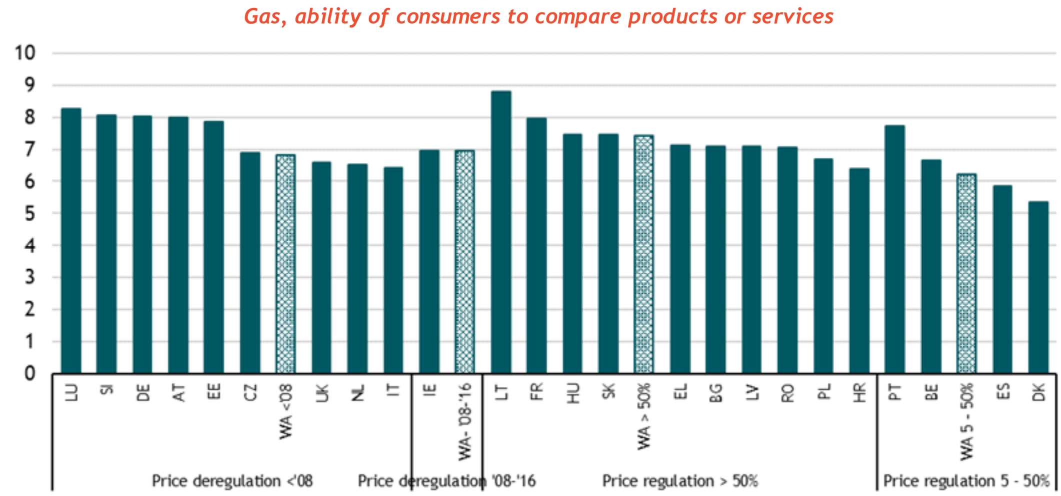
Source: Own calculation based on Consumer Market Scoreboard data (DG JUST).

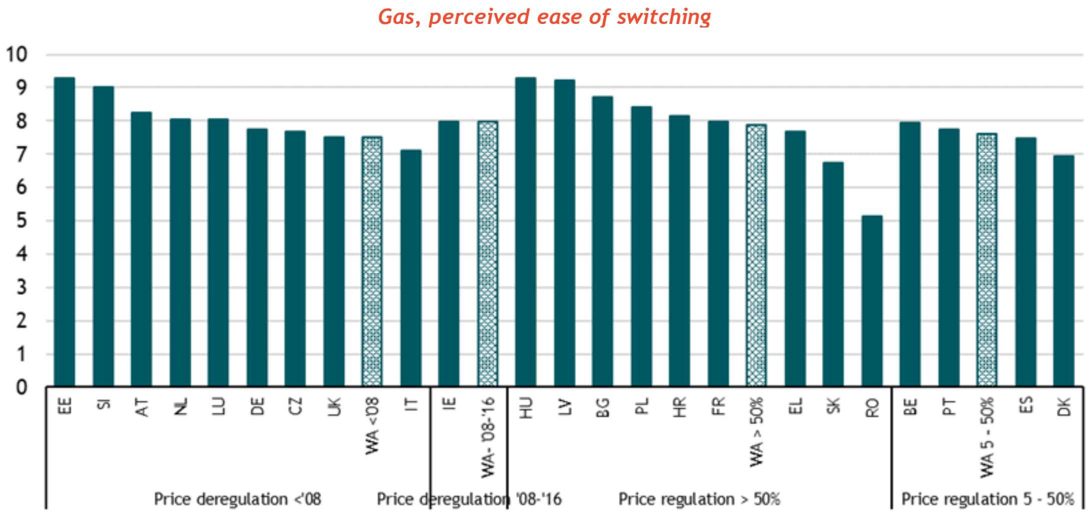
Note: If data was unavailable, the Member State is not included in the graphs. Data is weighted by the total household consumers per country and per energy market.

Figure 5-24: Consumer satisfaction indicators for electricity in 2015: Ability of consumers to compare products or services[111], trust of consumers in suppliers[112] and perceived ease of switching[113]



[111] DG Justice survey: The functioning of retail electricity markets for consumers in the EU. Question: "I can choose from a sufficient number of electricity providers?"
[112] DG Justice survey: The functioning of retail electricity markets for consumers in the EU. Question: "In your opinion, do consumers trust electricity suppliers with respect to the rules and regulations protecting consumers?"
[113] DG Justice survey: The functioning of retail electricity markets for consumers in the EU. Question: "Which of the following best reflects your experience of switching?" Average of three answers (easy, average, difficult)





Source: Own calculations based on Consumer Market Scoreboard data (DG JUST).

Note: If data was unavailable, the Member State is not included in the graphs. Data is weighted by the total household consumers per country and per energy market.

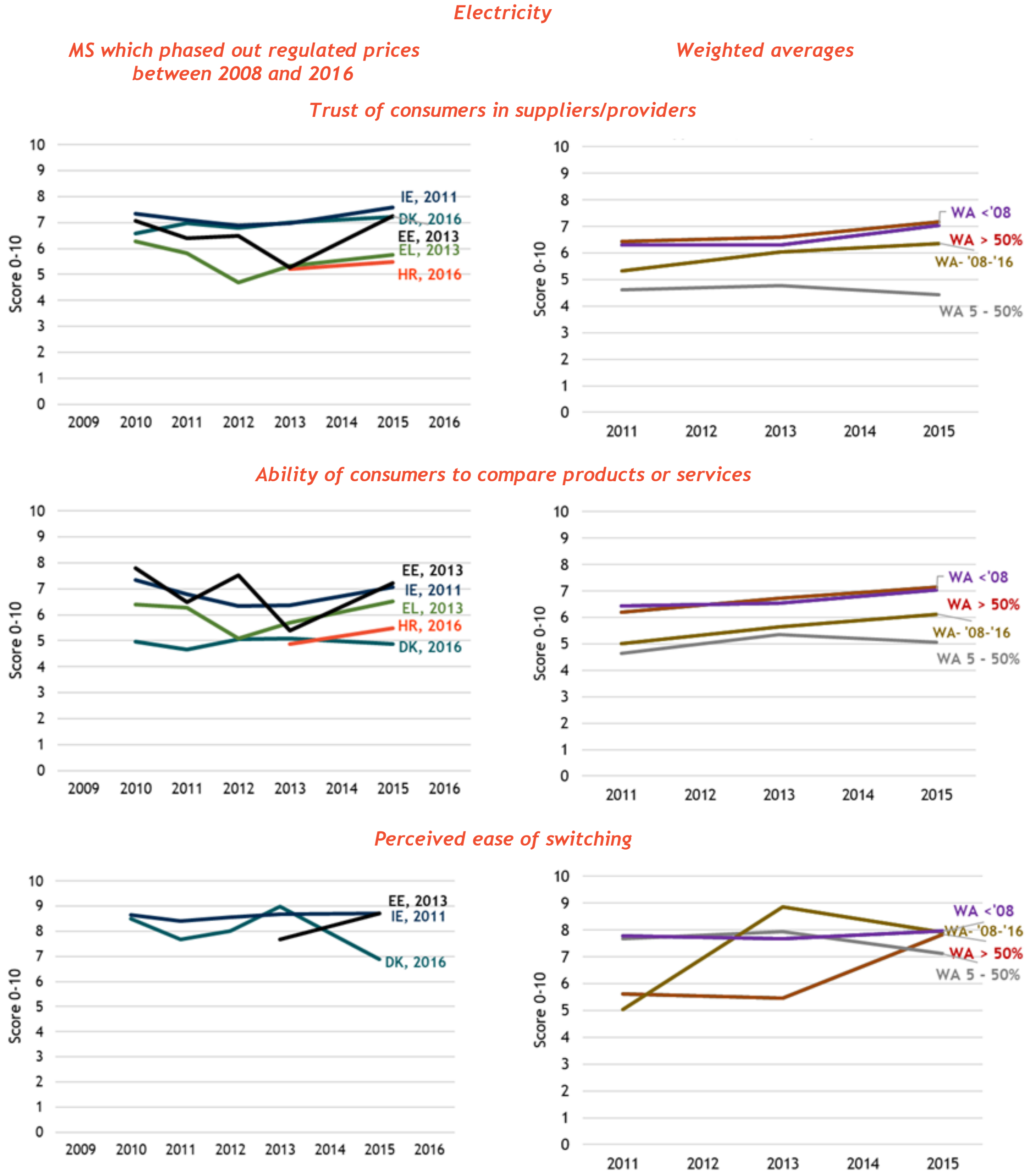
Evolution of consumer satisfaction in the EU over time

Figure 5-25 shows the evolution over time for the consumer satisfaction indicators for those MSs that phased out price regulation between 2008 and 2016 on the **electricity** market for household consumers. It is interesting to see that the trust of consumers in suppliers/providers increased for all country groups between 2013 and 2015, except for the group in which a minority share (5-50%) of the household consumers have regulated electricity prices. In the years before, however, this positive trend is not observed. The same holds for the ability of consumers to compare products or services, with Denmark being the exception. Less data is available for the perceived ease of switching. Based on the available data, it is concluded that the perceived ease of switching remained rather stable during the data period for Ireland. For Estonia an increase is observed and for Denmark no clear trend is disclosed.

The time series for consumer satisfaction indicators in **gas** markets for the weighted-average country groups is presented in Figure 5-26. The trust of consumers in suppliers/providers increased for all country groups between 2011 and 2015, especially for Ireland, which is the only country which phased out price regulation between 2008 and 2016. This is valid especially from 2013 to 2015, while before that the trend in not homogeneous. The ability of consumers to compare products or services follows the same pattern, improving for all country groups since 2013, most of all for Ireland. On the other hand, the perceived ease of switching for households decreased for all country groups, except Ireland and most of all for the countries which phased out price regulation before 2008.

In conclusion, in Europe both for electricity and gas the trust of consumers in suppliers/providers and the ability of consumers to compare products and services has improved in the 2013-2015 period, while the perceived ease of switching trends is not homogeneous. Moreover, the analysis of the weighted averages indicates no patent relationship between the existence or absence of price regulation and the consumer satisfaction indicators. The patterns suggest that sensibly specific actions of countries have a greater impact on consumer satisfaction than whether these countries have gone or are undergoing a phase out of price regulation. Hence, in all groups specific countries made significant improvements. This is illustrated by the case of Estonia for electricity since 2013, where all indicators improved significantly regardless of the trends for the other country groups.

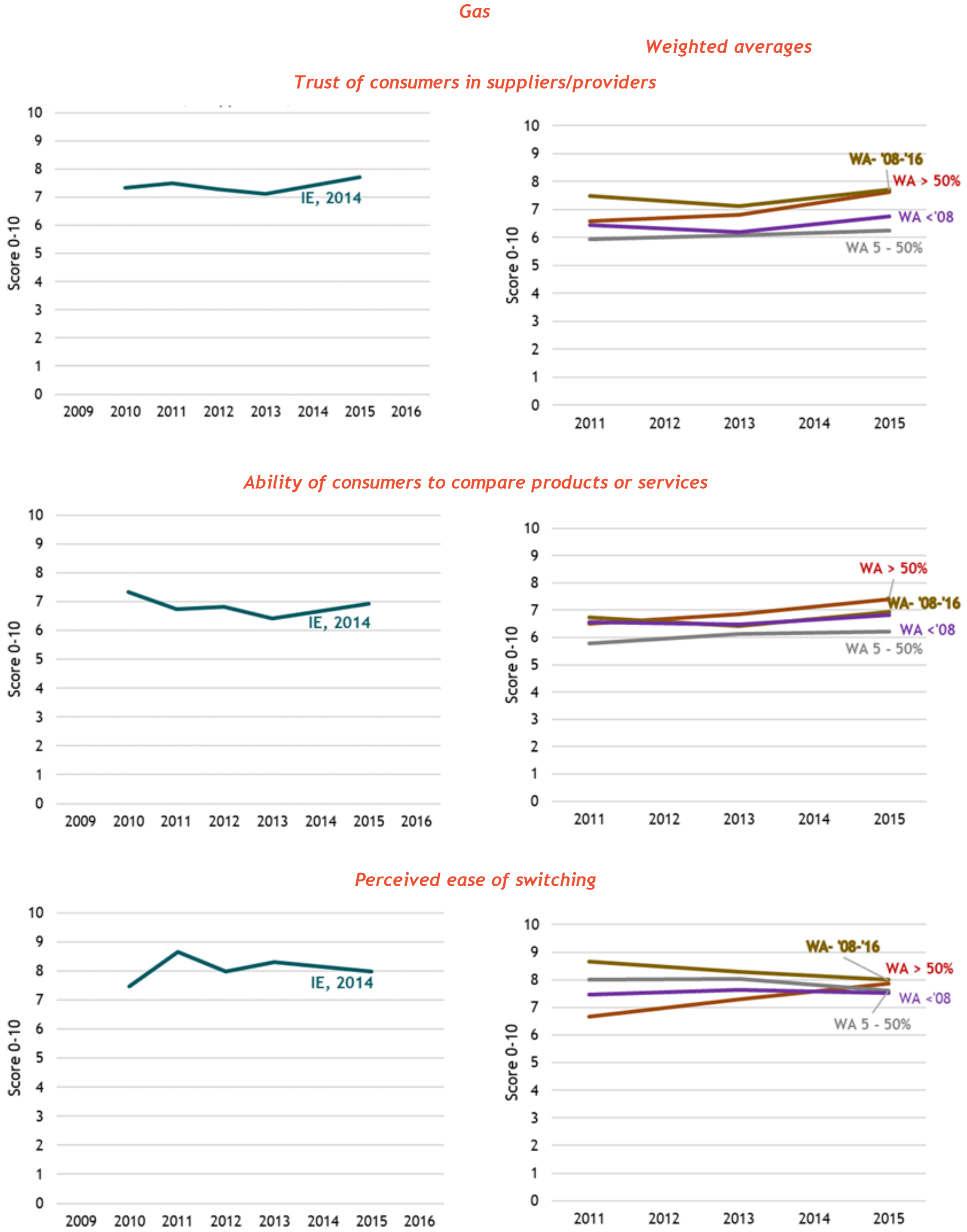
Figure 5-25: Consumer satisfaction indicators (2011-2015) - electricity markets



Source: Own calculation based on Consumer Market Scoreboard data (DG JUST)

Note: No electricity data available on the perceived ease of switching for Croatia and Greece. The country label indicates the phase out year for regulated prices

Figure 5-26: Consumer satisfaction indicators (2011-2015) - gas markets



Source: Own calculation based on Consumer Market Scoreboard data (DG JUST)

Note: The country label indicates the phase out year for regulated prices

Consumer choice

The 2016 Consumer Market Survey[114] found that in many Member States, consumers were not satisfied with the choice of **electricity** suppliers, prices and products available. According to the report, a broader range of products should be available to consumers, including green alternatives. Further, the report recommends differentiated peak/off-peak prices to encourage consumers to assess whether their behaviour is energy-efficient and to reduce their energy consumption and/or energy bill. Consumers also need advice on which type of price is the most suitable for them.[115]

Data on consumer choice is limited, often available for only one year and incomplete. The database includes information at Member State level on:

- Number of offers available;
- Dual-offers (electricity and gas combined) available;
- Certified green offers available;
- Availability of non-price-financial benefit (sign-in discounts, bonus for renewing contract, loyalty programs, etc.);
- Availability of non-financial benefits (home insurance, free maintenance of water boilers, etc.);
- Availability of ICT-based offerings (in-house display, energy consumption feedback mobile app, etc.);
- Type of offers available for electricity and gas.

However, the number of offers is expected to vary only to a limited extent, and therefore the indicator is relevant for cross-country comparison. This section looks at consumer choice, also relating it to the state of price regulation in each Member State. Figure 5-27 presents the available types of offers for households and number of offers per supplier in capital cities in 2015. It must be noted that the indicator represents the shares of available offers (as opposed to the actual contracted types). Dynamic price offers are considered a particular type of variable offer and are presented separately.

The type of **electricity and gas** offers for households are discussed together as the variation between these two markets appear to be minor within Member States. The countries with the highest share of variable offers (including dynamic price offers) are Luxembourg, Slovenia and Spain for electricity; and the same countries plus Ireland for gas. Malta households have variable offers in the data because the single supplier offers incentives for lower household consumption of electricity.[116]

Both for **electricity and gas**, the data indicates that countries where it is not possible to classify available offers (or for which there is no information) are almost exclusively those with a majority share of households still under price regulation. Dynamic price offers are slightly more common for electricity than for gas, with a significant share in Denmark, Estonia, Finland and Sweden, versus Denmark and Sweden for gas. Electricity dynamic price offers appear almost exclusively in countries which phased out price regulation (before or after 2008), with the exception of Denmark for gas (which had only a small share of consumers under regulated prices by 2016). This is therefore more advanced offer types for more liberalized markets.

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[114] European commission (2016), Second consumer market study on the functioning of the retail electricity markets for consumers in the EU. Executive summary.
[115] European commission (2016), Second consumer market study on the functioning of the retail electricity markets for consumers in the EU. Executive summary.
[116] REWS (2018). Malta's Report to the European Commission on the Implementation of Directive 2009/72/EC, Directive 2009/73/EC and Directive 2005/89/EC

The number of offers per supplier in capital cities are lowest in countries with high shares of households under price regulation, with often only one offer per supplier. Thus in 2015, the number of offers per supplier in capital cities in countries which phased out price regulation for households before 2008 or in the 2008-2016 period averaged at 3.1 and 2.9, respectively, compared to 2.1 for countries with a majority share of households with regulated prices. For gas, the number of offers is 2.4 for countries which phased out price regulation before 2008, 3 for Ireland (the only country which phased out regulated prices between 2008 and 2016), 3.4 for the countries with 5 - 50% households under regulated prices and 1.1 for countries with a majority of households under regulated prices. The high number of offers in the 5 - 50% group occurs especially due to Denmark and Spain, which despite being going through a phase out already have multiple offers from suppliers.

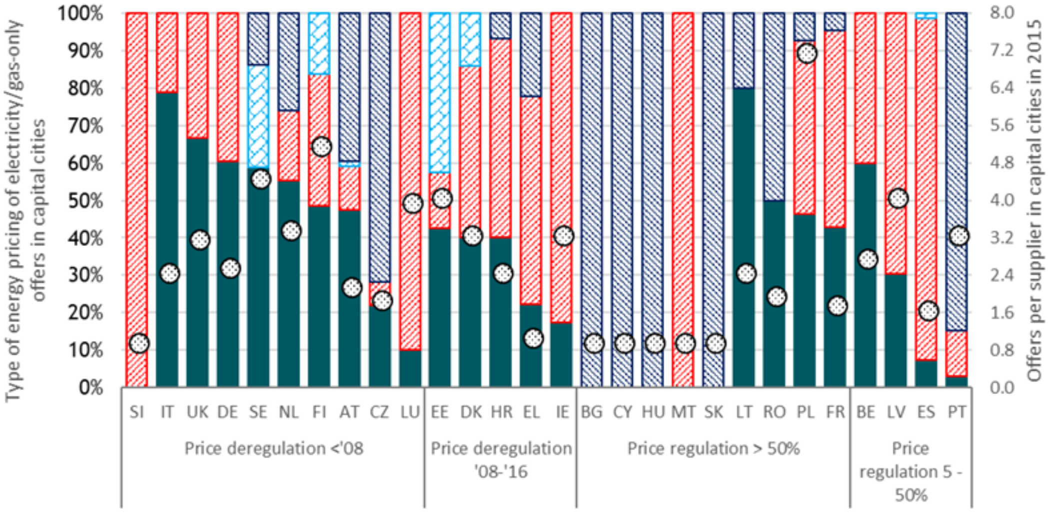
Thus countries in the 5 – 50% group are typically phasing out price regulation or have already done so, maintaining only targeted regulation towards vulnerable consumers (social tariffs, for example in Portugal and Latvia, as indicated in section 5.2.1). As for countries which phased out price regulation before 2016, they have at least two offers per supplier, except for Slovenia[117] and Greece in electricity, and Slovenia and Estonia for gas. The low offer of Estonian gas offers in the capital can be partially explained by the dominance of the incumbent supplier.

The analysis of the available offer types and number per supplier in capital cities indicates a differentiation between countries which have a majority of households under price regulation and the other country groups. The differentiation between the other groups is less evident, with cases of high or low offer type and number availability being explained by national circumstances such as market structure, a nearly completed phase out of regulated prices, or how the offers types are actually implemented. Nonetheless, dynamic price offers do occur exclusively in developed household retail markets. Compared with the previous section on consumer satisfaction, there is more evidence of greater consumer choice than satisfaction in countries which phased out (untargeted) household price regulation when compared with those which have a majority of households under such regulation.

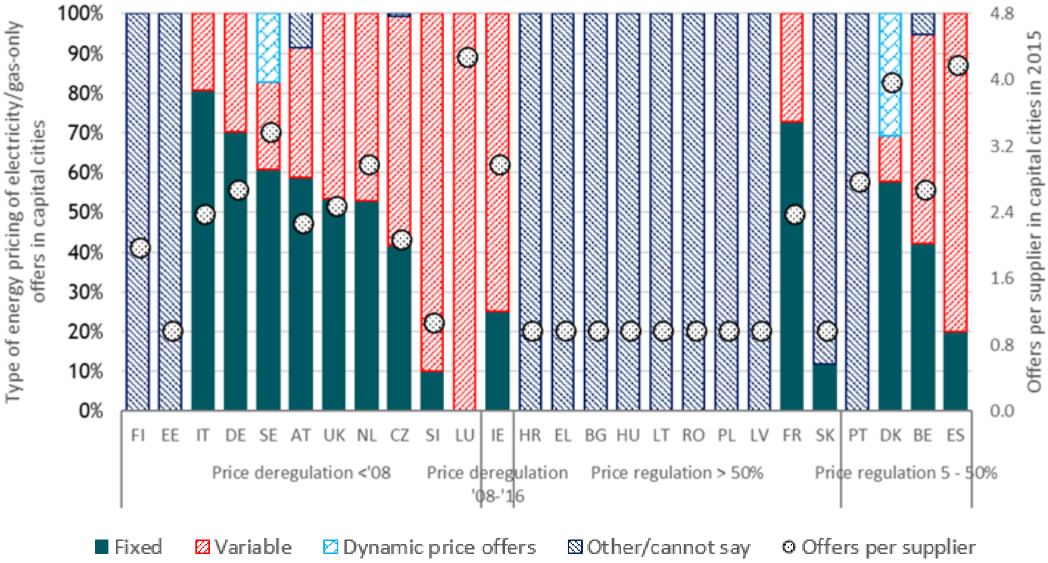
[117] Considering the Slovenian electricity is not price-regulated with multiple suppliers active, the low number of offers need further research (although there are also dual-offers available).

Figure 5-27: Types of electricity and gas contracts available and offers per supplier in capital cities in 2015

Electricity offers for households



Gas offers for households



Source: Own calculation based on ACER/CEER (2015) Annual Report on the Results of Monitoring the Internal Electricity and Gas Markets in 2015.

5.3 Price regulation in EU non-household markets for electricity and gas

5.3.1 Price regulation

In addition to the analysis on the effect of price regulation on the electricity and gas market for household consumers, this section provides the analysis on the effect of price regulation on the electricity and gas market for non-household consumers. Member States are categorised using almost identical groups as in the household section. However, as explained in section 5.1.3, in the household section countries are grouped based on the share of *consumers* under regulated prices. In the non-household section countries are grouped based on the share of *consumption* under regulated prices.

Status of price regulation

The analysis of ACER and CEER indicates that regulated prices in non-household markets are generally phased out sooner than in household markets in Member States. Table 5-2 shows existence price regulation on the electricity and gas market for non-household consumers and confirms the analysis of ACER and CEER.

For the **electricity** market, whereas in nine Member States a large share (50-100%) of the household consumers faced electricity price regulation in 2016, only three Member States (Bulgaria, Cyprus and Malta) had a large share (50-100%) of the non-household consumers under price regulation. In two Member States (France and Croatia), price regulation on the electricity market for non-household consumers is still existent, but to a smaller extent (5-50%). Ten Member States (Denmark, Estonia, Greece, Spain, Hungary, Ireland, Lithuania, Latvia, Portugal, Romania and Slovakia) phased out price regulation on the electricity market for non-household consumers between 2008 and 2016. The twelve remaining Member States (Austria, Belgium, the Czech Republic, Denmark, Finland, Italy, Luxembourg, the Netherlands, Poland, Sweden, Slovenia and the UK) phased out price regulation on the electricity market for non-household consumers prior to 2008.

Regarding price regulation on the **gas market** for non-household consumers, similar differences are disclosed. Whereas ten Member States had a large share (50-100%) of household consumers under price regulation, only four Member States (Bulgaria, Greece, Latvia and Poland) had large share (50-100%) of non-household consumption under price regulation in 2016. Only in one Member State (Hungary) 5-50% of the consumers face price regulation. Cyprus and Malta are not included in the analysis as gas markets for non-household consumers are non-existent. In all other twenty Member States price regulation for gas has been phased out either prior to 2008 (Austria, Belgium, the Czech Republic, Denmark, Estonia, Spain, Finland, Italy, Luxembourg, the Netherlands, Sweden, Slovenia and the UK) or between 2008 and 2016 (Denmark, France, Hungary, Ireland, Lithuania, Portugal, Romania and Slovakia).

Figure 5-28 shows that end-user electricity and gas price regulation remains in place only for a few non-household electricity markets throughout the EU. It also reveals that in several central and eastern European countries, price regulation has been either phased out between 2008 and 2016 or is still in place.

Table 5-2: Existence of price regulation for non-household consumers[118] in the EU28 in 2016

MS	Electricity	Gas
AT	Phased out (pre-2008)	Phased out (pre-2008)
BE*	Phased out (pre-2008)	Phased out (pre-2008)
BG	> 50%	> 50%
CY	> 50%	NA – No gas market
CZ	Phased out (pre-2008)	Phased out (pre-2008)
DE	Phased out (pre-2008)	Phased out (pre-2008)
DK	Phased out (2016)	Phased out (2016)
EE	Phased out (2014)	Phased out (pre-2008)
EL	Phased out (2011)	> 50%
ES	Phased out (2008)	Phased out (pre-2008)
FI	Phased out (pre-2008)	Phased out (pre-2008)
FR	5 - 50%	Phased out (2014)**
HR	5 - 50%	Phased out (2009)
HU	Phased out (2008)	5 - 50%
IE	Phased out (2010)	Phased out (2011)
IT	Phased out (pre-2008)	Phased out (pre-2008)
LT	Phased out (2010)**	Phased out (2011)
LU	Phased out (pre-2008)	Phased out (pre-2008)
LV	Phased out (2008)	> 50%
MT	> 50%	NA – No gas market
NL	Phased out (pre-2008)	Phased out (pre-2008)
PL	Phased out (pre-2008)	> 50%
PT**	Phased out (2013)	Phased out (2012)
RO	Phased out (2014)	Phased out (2015)
SE	Phased out (pre-2008)	Phased out (pre-2008)
SI	Phased out (pre-2008)	Phased out (pre-2008)
SK***	Phased out (2012)	Phased out (2012)
UK	Phased out (pre-2008)	Phased out (pre-2008)

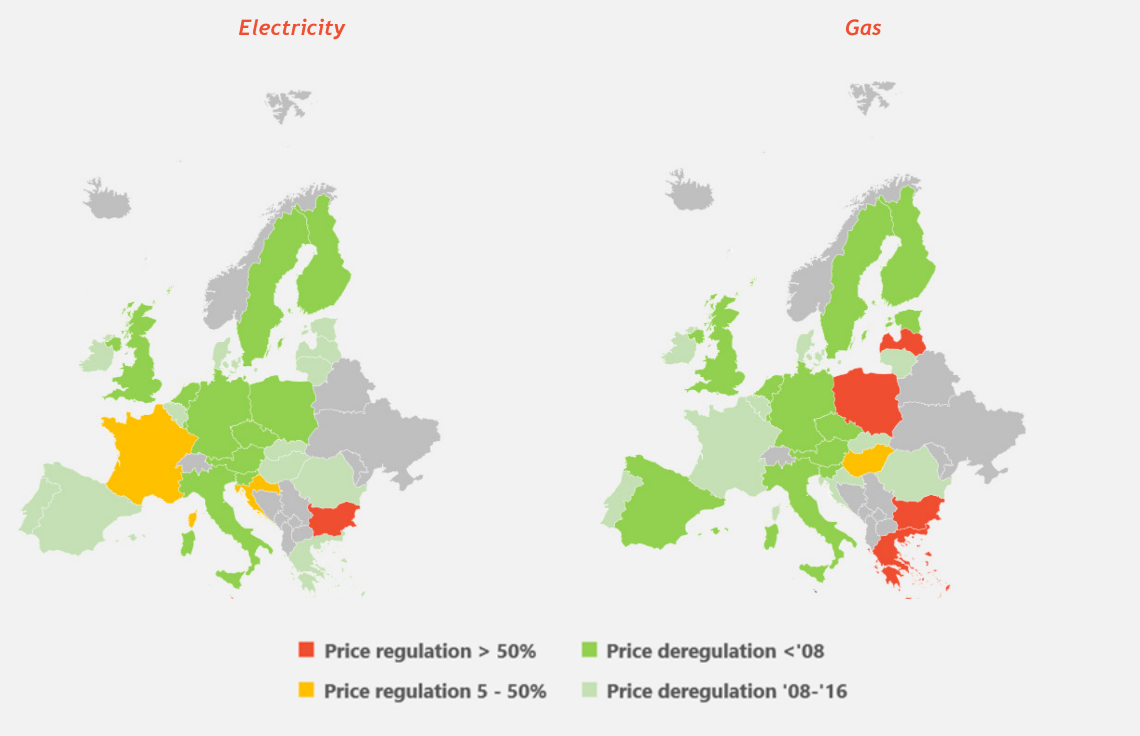
Source: CEER data and NRA representatives

** Belgium applied price monitoring to SMEs since 2012 (phased out in 2017), but it is less than 5% of consumers.*
*** Some countries still had a small share of non-household consumption under price regulation up to 2016 (less than 5%): France for gas; Lithuania for electricity; and Portugal for both gas and electricity.*
**** The last price regulation change in Slovakia occurred in 2012 (price regulation for SMEs was phased out and reintroduced in the same year due to large increases in the electricity prices). Slovakia still applies gas and electricity price regulation for SMEs, which represent less than 5% of non-household consumption (the number of price-regulated non-households is not available by CEER).*

The year of deregulation indicates the date of entry into force of legislation for countries which phased out price regulation by 2016 (share below 5% of non-household consumption with regulated prices).

118 Based on share of household consumers under regulated prices.

Figure 5-28: Non-household price regulation from a geographical perspective



Source: CEER data and NRA representatives

Assessment of the share of consumption under regulated prices

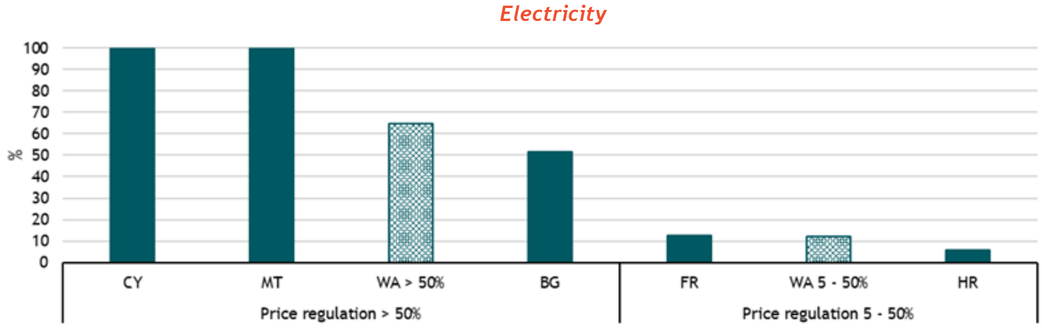
The share of consumers and consumption volumes of electricity and gas under regulated prices is calculated by combining data included in CEER (total number of regulated consumers, total number of consumers, consumption under regulated prices and total consumption). As explained above, few countries still applied price regulation for non-households in 2016, both in electricity and gas. Moreover, most of these countries were transitioning towards markets without price regulation.

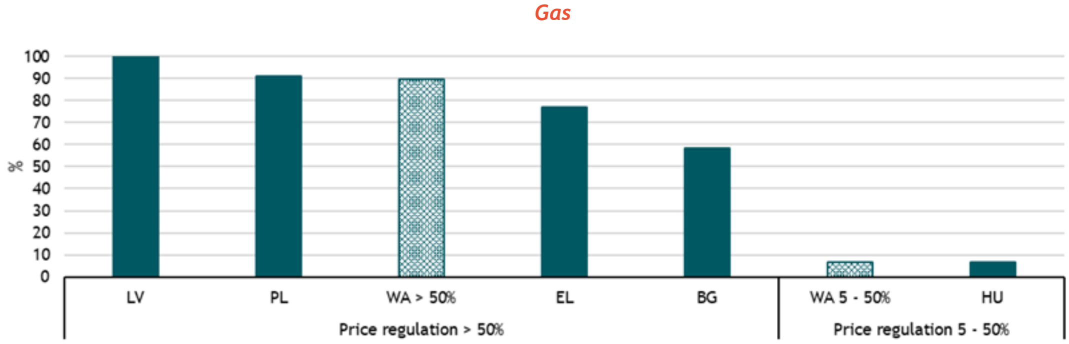
For **electricity**, France and Croatia already exhibit low shares of regulated energy consumption for non-households (12% and 6%, respectively), slightly above the 5% threshold applied in this analysis. Bulgaria is phasing out regulated prices, with only the low voltage level remaining as regulated since 2013.[119] The 100% share of electricity non-household regulated prices for Cyprus and Malta is explained by the fact that even though these countries have opened their retail markets the incumbents remain the only supplier in these Member States.

For **gas**, Hungary already exhibits low shares of regulated energy consumption for non-households (6%), slightly above the 5% threshold applied in this analysis. Bulgaria, Greece and Poland still have a majority of non-household consumption under regulated prices (all non-households in the case of Latvia). Bulgaria still sets a price cap for gas (with suppliers having the freedom to offer lower prices)[120]; while Greece had geographical supply monopolies for natural gas in 2016, but moved on to a liberalized gas supply with a transition period in 2017-2018.[121] For Poland, price regulation for natural gas supply to non-households ended in 2017,[122] thus after the period covered by the data analysis.

[119] https://ec.europa.eu/energy/sites/ener/files/documents/2014_energy_market_en_0.pdf
[120] EWRC (2017), Annual Report to the European Commission.
[121] RAE (2017). National Report 2017 Regulation and performance of the electricity market and the natural gas market in Greece, in 2016.
[122] "Energy Union Factsheet Poland", Commission Staff Working Document, EC, SWD (2017) 407 final

Figure 5-29: Share of non-household consumption volume with regulated prices for country groups and Member States in which price regulation was still in place in 2016





Source: Own calculation based on CEER data and NRA representatives

Note: Data is weighted by the total non-household consumers per country and per energy market.

Evolution of non-household consumption with regulated prices in the EU over time

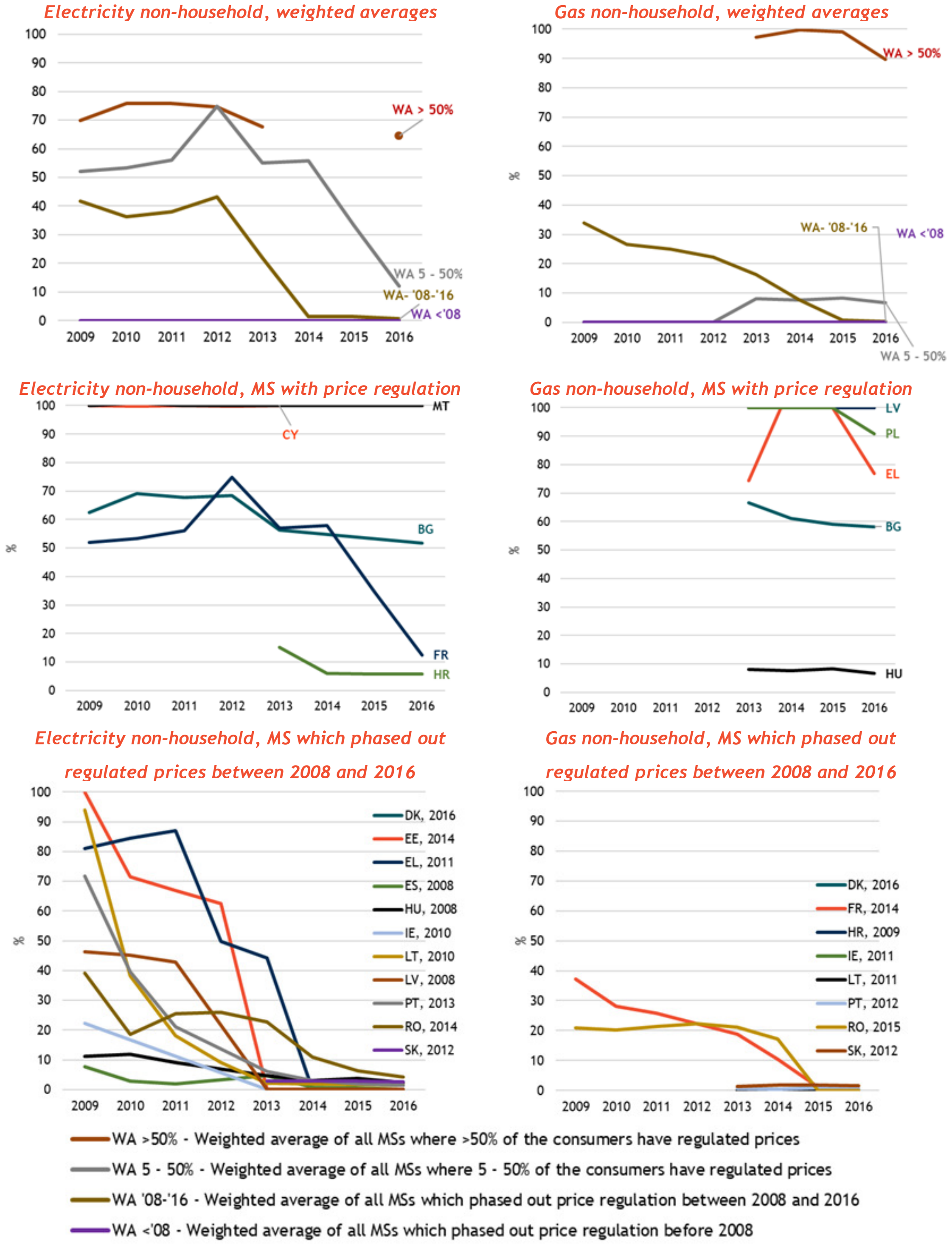
Figure 5-30 presents the evolution of the share of non-household consumption with regulated prices for Member States which still have price regulation and for those which phased out price regulation between 2008 and 2016, as well as the weighted averages for the different country groups. Overall, the share of non-household consumption under regulated prices is declining both for electricity and gas. To be precise, the share of non-household consumers under regulated prices decreased from 26% to 14 % on the electricity market and from 16% to 9% on the gas market.[123] Detailed information at country level for electricity and gas can be found in the Task 3 country factsheets, for households & non-households.

When analysing the Member States' share of consumption with **regulated electricity prices** over time in the non-household sector, we see that there is a continuous decrease. For example, France went from over 70% to under 20% (from 2012 to 2016). Decreases were more modest in Bulgaria and Croatia.

Concerning the **gas market**, the share of consumption under regulated prices decreased in Poland and Greece from 100% to around 90 and 80% respectively. Latvia remained stable with 100% of consumption regulated, and so did Hungary with less than 10% of consumption regulated.

[123] Note that only Member States for which data was available on the number of households under regulated prices in 2016 and in 2008 are considered in this calculation. Thus, one should not interpret the second percentage as the overall percentage of non-household consumers under regulated prices as Member States for which data was not available in 2008 are excluded. These Member States were excluded in order to allow for a comparison between 2008 and 2016 - not to identify the overall share of consumers under regulated prices in the EU.

Figure 5-30: Share of the non-household consumption with regulated prices for country groups and Member States



Source: Own calculation based on CEER data and NRA representatives

Note: Data is weighted by the total non-household consumption per country and per energy market. A description of the weighted averages' groups is provided in section 5.1.3. The country label indicates the phase out year for regulated prices. Lack of data for Bulgaria and Malta impede calculating electricity weighted averages for 2014 and 2015 for the WA > 50% group.

5.3.2 Impact of regulated prices on non-household retail prices

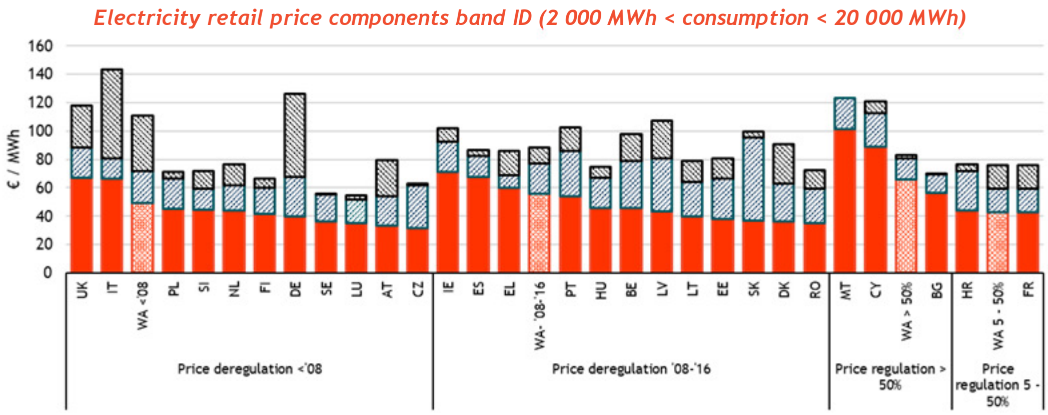
Energy prices for non-households

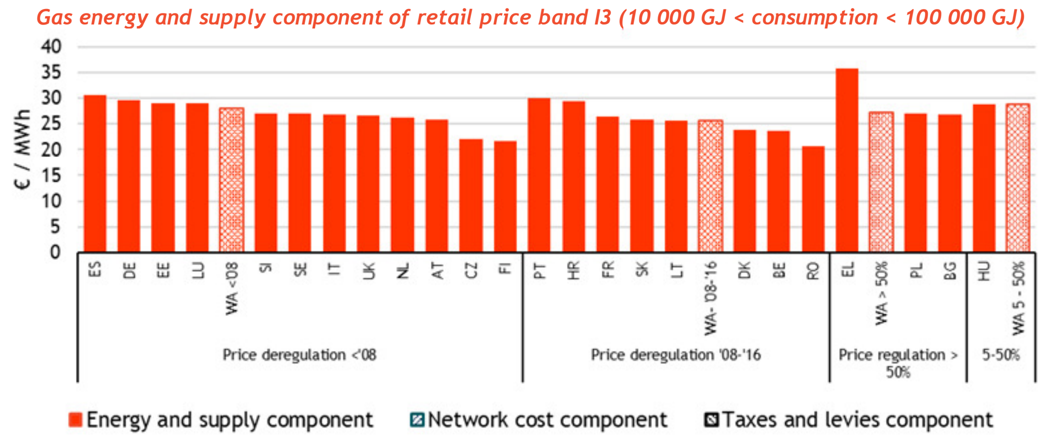
As for the household sector, retail prices were assessed by comparing the evolution of the energy and supply component of the retail prices across countries and their development over time. Section 5.2.3 indicates that due to the network costs and taxes & levies, which are components of retail prices not subject to competition, the energy and supply component is the one where the phase out of price regulation can enable competition and deliver benefits to European consumers, including non-households.

Figure 5-31 shows the retail **electricity** price components for non-household consumers for all EU28 Member States. For electricity, the countries with the highest energy and supply price components were Malta and Cyprus at above 80 EUR/MWh, and then Ireland, Italy, Spain and the UK in the 60-80 EUR/MWh range. In contrast, the countries with the lowest energy and supply price components were Austria, the Czech Republic, Denmark, Estonia, Lithuania, Luxembourg, Slovakia, Romania and Sweden, all below 40 EUR/MWh. A relationship can be observed between the level of price regulation and the energy and supply component of electricity prices. Countries which phased out regulated prices before 2008 exhibit one of the lowest weighted averages, at 50 EUR/MWh. France and Croatia exhibit comparatively low prices, at 49 and 47 EUR/MWh, but have only a small share of non-households under electricity price regulation. On the other hand, countries which still have a majority share of non-households under price regulation have the highest, at 66 EUR/MWh. Thus, Malta, Cyprus and Bulgaria all have energy and supply components of at least 61 EUR/MWh.

For **gas**, Greece had the costliest energy and supply component at over 35 EUR/MWh, while Belgium, Czech Republic, Denmark, Finland and Romania exhibited the lowest, under 25 EUR/MWh. In the gas market, weighted averages are very similar across country groups, ranging from 26 to 29 EUR/MWh, although they are the highest for the country groups which still have price regulation. The restricted range for gas is a reflection of the variation of energy and supply component prices between countries itself, which is much more limited for gas than for electricity. Several factors could cause this, including the reliance on natural gas imports in EU supply and the indexation to oil prices.

Figure 5-31: Prices for electricity (2016) and gas (2015) on the non-household consumer market





Source: Own calculation based on Eurostat (and EC ad-hoc data for Spain for the electricity energy and supply component) for electricity data and EC ad-hoc data for gas.

Note: that the scale of the y-axis is different in each panel. No data is available on the gas market for IE and LV Data is weighted by the total household consumption per country and per energy market.

Competition performance & mark-ups

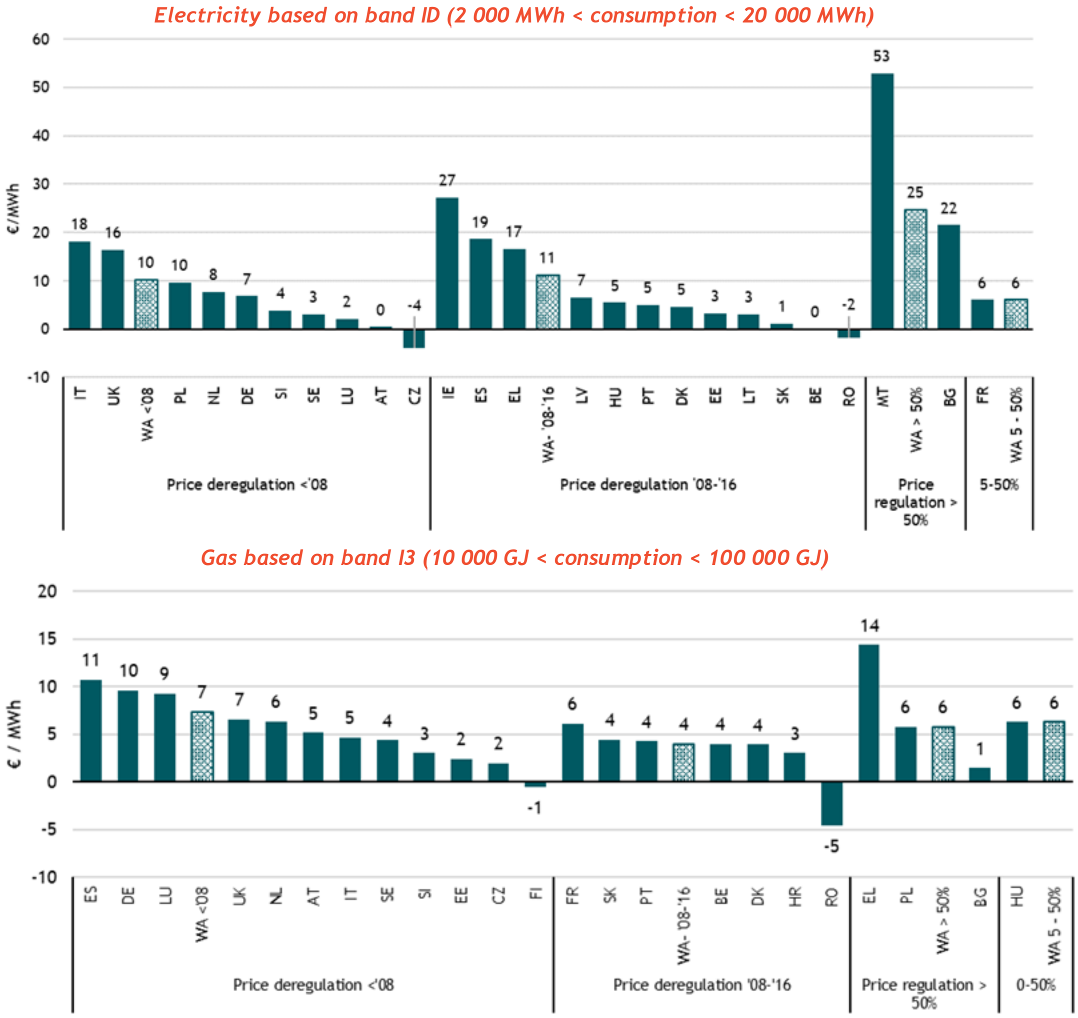
This section assesses the gross margins applied by suppliers when calculating end-user prices (mark-ups). Mark-ups for the retail markets are calculated as the differences between the wholesale price and retail energy price component.[124] According to ACER/CEER, the estimated mark-ups are not meant to assess retail margins of suppliers, but serve rather as an "indication of the level of retail competition and the 'responsiveness' of retail to wholesale prices over time".[125] As indicated in section 5.2.3, care must be taken in comparing the present calculated mark-ups with those from other sources due to methodological differences, such as the consideration of supplier procurement strategies, use of other consumption bands, differences from spot and forward prices, and the energy price data used. Figure 5-32 shows the mark-ups for selected consumption bands for the electricity and gas market for non-household consumers. In the non-household segment, both countries with and without regulated prices show a large spread in mark-ups for electricity and for gas.

The country with the highest calculated mark-ups for **electricity** is Malta (over 50 EUR/MWh), followed by Ireland at 27 EUR/MWh. In the Czech Republic and Romania, negative mark-ups for electricity are observed (-4 and -2 EUR/MWh, respectively). This is the case if the energy and supply component of the retail electricity (or gas) price for a certain band is higher than the wholesale price. For electricity, countries which phased out regulated prices before 2008 exhibit a lower weighted average price than the other groups, at 10-11 EUR/MWh (notice that France is the only country in the 0-50% group).

For **gas** the highest mark-ups are observed in Greece (14 EUR/MWh) and Spain (11 EUR/MWh). Romania exhibits a negative mark-up (-5 EUR/MWh), and also Finland has a minor negative mark-up (–1 EUR/MWh). For gas there are no clear distinctions across the different groups of regulated and non-regulated countries, as all weighted averages are in the 6-7 EUR/MWh range.

[124] ACER/CEER (2015), Annual Report on the Results of Monitoring the Internal Electricity and Natural Gas Markets in 2014
[125] CER/CEER (2015), Annual Report on the Results of Monitoring the Internal Electricity and Natural Gas Markets in 2014

Figure 5-32: Electricity (2016) and gas (2015) mark-ups for the middle bands and the wholesale price



Source: Own calculations based on Eurostat and Task 1 of this report for wholesale prices.

Note: Mark-ups are calculated by subtracting the wholesale price from the energy and supply component of the retail price. Data is weighted by the total household consumption per country and per energy market.

Evolution of the non-household mark-ups in the EU over time

The average-weighed mark-ups for non-household **electricity** in countries which phased out regulated prices before 2008 decreased from 19 EUR/MWh in 2013 to 10 EUR/MWh in 2016. Mark-ups also decreased for countries which phased out price regulation between 2008 and 2016 (from 25 to just above 10 EUR/MWh) and for countries with minority consumption share under regulated prices (11 to 6 EUR/MWh).

On the other hand, mark-ups for non-household **gas** consumers increased in countries with more than 50% regulated consumption and those which phased out regulated prices before 2008.

Figure 5-33: Evolution of mark-ups for non-household consumers by country group

Source: Own calculations based on Eurostat and Task 1 of this report for wholesale prices.

Note: no data for Ireland (which is the only country in the WA '08-'16 group for gas). Data is weighted by the total household consumption per country and per energy market. The country label indicates the phase out year for regulated prices

5.4 Propensity to invest and tariff deficits

5.4.1 Propensity to invest

Regulated tariffs are often considered a barrier to investment. The proposal for the IEM regulation recast states that price regulation can discourage investments.[126] However, data on investments is limited and data that is available often has gaps in time series or per technology. The database comprises investment data only for renewable energy technologies from Eurobserv'ER[127] and, as a proxy, data on additional installed capacity at Member State level from Platts.[128] The impact of price regulation on these investments has been assessed, but no conclusive results can be reached given the complexities of and influencing factors on investment decisions.

[126] COM(2016) 861, Proposal for a regulation on the internal market for electricity. Available from: https://ec.europa.eu/energy/sites/ener/files/documents/1_en_act_part1_v9.pdf
[127] EurObserv'ER Annual Overview Barometer can be assessed here: https://www.eurobserv-er.org/16th-annual-overview-barometer/
[128] More on Platts products & services can be found here: https://www.platts.com/products-services

Other studies[129] assess the investments in the energy sector in-depth focusing on investment trends, along with the main barriers and drivers for investment.

5.4.2 Tariff deficits

Tariff deficits are an issue that emerged in Europe several years ago and which were first observed in Spain and more recently in Portugal and Greece. A tariff deficit is defined as a shortfall of revenues in the electricity system[130], which arise when the tariffs for the regulated components of the retail electricity price are set below the corresponding costs borne by the energy companies.[131] Tariff deficits, and the measures taken to address them, have an impact on the financial performance of energy companies and often on the energy prices. Furthermore, they are considered as liabilities for public finances as they often result from public decisions which set tariffs at insufficient levels to cover the corresponding cost.[132] Also, if regulated end-user prices are set too low, suppliers might not be able to recover their costs and face potential losses which may lead to a tariff deficit. Thus, tariff deficit is considered one of the detrimental outcomes that can result from a system of regulated prices.

The European Commission has developed a methodology that estimates the likelihood of having an electricity tariff deficit.[133] Most of the relevant data which supports this methodology has been included in the database and comprises: GDP growth, government debt or deficit (as share of GDP), consumption under regulated prices, penetration of renewable energy, government effectiveness and regulatory quality. However, individually, these indicators do not support the assessment of tariff deficits and their link to regulated prices.

This section aims to assess whether there is a higher risk for countries with regulated prices to have a tariff deficit. Negative electricity mark-ups (as introduced earlier, i.e. where the retail energy price component is lower than the wholesale prices)[134] were also assessed as indicators which may signal a risk of a tariff deficit. However, this analysis focuses on the retail component, whereas tariff deficits also commonly occur in the network component. Our analysis showed no direct correlation between negative mark-ups on the retail component and tariff deficits and hence these results are not presented here.

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129 See for example:
CEER (2017), CEER Report on Investment Conditions in European Countries. Available at: https://www.ceer.eu/documents/104400/-/-/44a08bad-efe7-01da-8b37-a3dd7edccfd5
Trinomics (2017), European energy industry investments. Available at: https://www.eesc.europa.eu/sites/default/files/files/energy_investment.pdf
High Level Group on Energy Infrastructure in Europe (2016), Fostering Investment in Cross-Border Energy Infrastructure in Europe. Available at: https://www.ceps.eu/system/files/Fostering%20Investment%20in%20Cross-border%20Energy%20Infrastructure%20in%20Europe%20-%20A%20report%20by%20the%20High-Level%20Group%20on%20Energy%20Infrastructure%20in%20Europe.pdf
Bloomberg NEF (2018), Clean energy investment. Available at: https://about.bnef.com/clean-energy-investment/#toc-download
IEA (2017), World Energy Investment 2017. Available at: https://www.iea.org/publications/wei2017/
UN & Bloomberg (2018), Global trends in renewable energy investment 2018. Available at: http://fs-unep-centre.org/sites/default/files/publications/gtr2018v2.pdf

130 Literature that has been assessed does not refer to similar issues for natural gas

131 European Commission (2014), Electricity Tariff Deficit: Temporary or Permanent Problem in the EU? Available from: http://ec.europa.eu/economy_finance/publications/economic_paper/2014/pdf/ecp534_en.pdf

132 European Commission (2014), Electricity Tariff Deficit: Temporary or Permanent Problem in the EU? Available from: http://ec.europa.eu/economy_finance/publications/economic_paper/2014/pdf/ecp534_en.pdf

133 European Commission (2014), Electricity Tariff Deficit: Temporary or Permanent Problem in the EU? Available from: http://ec.europa.eu/economy_finance/publications/economic_paper/2014/pdf/ecp534_en.pdf

134 Where wholesale prices serve as a proxy for the procurement costs borne by the energy suppliers

Table 5-3: Overview of tariff deficits in the EU

MS	Existence of price regulation		Tariff deficit between 2008-2016
	Electricity, households	Electricity, non-households	
AT	Phased out (pre-2008)	Phased out (pre-2008)	No tariff deficit
CZ	Phased out (pre-2008)	Phased out (pre-2008)	No tariff deficit
DE	Phased out (pre-2008)	Phased out (pre-2008)	Temporary tariff deficit[135]
FI	Phased out (pre-2008)	Phased out (pre-2008)	No tariff deficit
IT	Phased out (pre-2008)	Phased out (pre-2008)	No tariff deficit
LU	Phased out (pre-2008)	Phased out (pre-2008)	No tariff deficit
NL	Phased out (pre-2008)	Phased out (pre-2008)	No tariff deficit
SE	Phased out (pre-2008)	Phased out (pre-2008)	No tariff deficit
SI	Phased out (pre-2008)	Phased out (pre-2008)	No tariff deficit
UK	Phased out (pre-2008)	Phased out (pre-2008)	No tariff deficit
DK	Phased out (2016)	Phased out (2016)	No tariff deficit
EE	Phased out (2013)	Phased out (2014)	No tariff deficit
EL	Phased out (2013)	Phased out (2011)	Electricity tariff deficit (2014)[136]
HR	Phased out (2016)	5 - 50%	No tariff deficit
IE	Phased out (2011)	Phased out (2010)	No tariff deficit
BE	5 - 50%	Phased out (pre-2008)	No tariff deficit
ES	5 - 50%	Phased out (2008)	Electricity tariff deficit (2000s-2015)
LV	5 - 50%	Phased out (2008)	Potential electricity tariff deficit (until 2010-2011)
PT	5 - 50%	Phased out (2013)	Electricity tariff deficit (since 2006)
BG	> 50%	> 50%	Electricity tariff deficit
CY	> 50%	> 50%	No tariff deficit
FR	> 50%	5 - 50%	Electricity tariff deficit[137]
HU	> 50%	Phased out (2008)	Gas and electricity tariff deficit (2011-2012)[138]
LT	> 50%	Phased out (2010)	No tariff deficit
MT	> 50%	> 50%	Electricity tariff deficit (up to 2014)
PL	> 50%	Phased out (pre-2008)	No tariff deficit
RO	> 50%	Phased out (2014)	Potential electricity tariff deficit
SK	> 50%	Phased out (2012)	No tariff deficit

Source: Country factsheets.

Germany and Greece were the only Member States which had tariff deficits but do not have price regulation. However, Greece only phased out regulated prices in 2013. Germany, on the other hand, is a special case as it only had a temporary tariff deficit due to the way that its support of renewable energy is structured. The EEG surcharge, paid for by end-consumers and defined each year based on forecasted renewable energy production, hereby runs the risk of not matching with actual costs of renewable energy electricity production. This deficit is, however, not cumulated annually but rather paid off immediately in the subsequent year (via an increase in the surcharge). Accounts were hence balanced in 2017, leading to a small reduction of the EEG surcharge in 2018.[139]

Table 5-3 shows the status of price regulation and whether a tariff deficit has been identified. The assessment is focused on electricity and households. It can be noted that 11 out of the 28 countries have shown signs of tariff deficit, and that 8 of the 11 countries showing signs of tariff deficits still have

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135 Paid of the subsequent year

136 Greece faced a deficit in their special account for renewable energy in early 2014, caused by the large investment in RES. Electricity bills include a RES levy, but due to the economic crisis, it was not possible to increase the RES levy to cover the deficit. A suppliers' charge was introduced in 2016 (charge that suppliers pay to offset the cheaper electricity they buy due to RES integration), resulting in an expected surplus of €256 million by end 2018 in the special account for RES.

137 Not a tariff deficit per se, as the applied regulated tariffs do cover the costs. However, the CSPE (Contribution to the Public Service of Electricity) is sometimes considered tariff deficit. The CSPE is a contribution which covers the costs of support to renewables, support to co-generation, subsidies to electricity costs in Corse and other French overseas territories, as well as the social tariff for vulnerable consumers.

138 There is also mention of potential losses in 2013, but they are not quantified.

139 Bundesnetzagentur (2017). Monitoringbericht 2017.

regulated prices for households (Spain, Latvia, Portugal, Bulgaria, France, Hungary, Malta, Romania). This confirms that tariff deficits are more common in countries with regulated (household) prices. The correlation is, however, not as apparent with the regulation of non-household energy prices. Detailed information on each of the countries with tariff deficits can be found in the Task 3 country factsheets.

6 Task 4 - Analysis of Energy subsidies and their impact on prices

6.1 Our approach and objectives

The aim of this task was to update, expand and improve the inventory created for the report 'Subsidies and costs of EU energy'[140] (later named "Subsidies study by Ecofys et al.") and to assess their impact on wholesale and retail prices. More specifically the objective set by the European Commission (EC) was to provide a comprehensive set of information on all forms of financial support to any energy-related purpose in several economic sectors in all EU28 Member States (MS), to obtain a better understanding of the magnitude of energy subsidies within the European Union (EU). In the context of recurrent commitments by the G20 to phase out fossil fuel subsidies, reinforced at the EU level by the "Clean Energy for all Europeans" package presented in November 2016, the EC required that a particular focus of the inventory is put on fossil fuel subsidies.

Scope

The inventory (later named 'first inventory') carried out in 2014 had mainly focused on the energy industry, manufacturing and the tertiary-residential sectors. The current version of the inventory has seen its scope widened to energy products used in the transport and agriculture sectors. The period covered was also extended to 2016, covering the 9 years since 2008. As for the previous study, the current inventory covers all technologies and energy sources.

Current state of play of international commitments to phase out fossil fuel subsidies
G20 countries first committed *"to phase out and rationalize over the medium term inefficient fossil fuel subsidies while providing targeted support for the poorest"* in 2009 during the G20 summit in Pittsburgh. The G20 communiqué later specified that *"Inefficient fossil fuel subsidies encourage wasteful consumption, reduce our energy security, impede investment in clean energy sources and undermine efforts to deal with the threat of climate change"*.[141] The Paris Agreement adopted at the 21st Conference of Parties (COP21) under the United Nations Framework Convention on Climate Change (UNFCCC) of November 2015 sets an objective of *"holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C"*[142], sending a *"clear signal (…) to shift away from polluting fossil fuels"*.[143] In November 2016, the European Commission presented its "Clean Energy for all Europeans Package"[144] that reasserts the European Union's commitment to phase out fossil fuel subsidies. The

[140] Ecofys et al. (2014), 'Subsidies and costs of EU energy'. Available at: https://ec.europa.eu/energy/en/content/final-report-ecofys
[141] "To phase out and rationalize over the medium term inefficient fossil fuel subsidies while providing targeted support for the poorest", G20 Pittsburgh Leaders Declaration, September 2009. Available at: https://www.oecd.org/g20/summits/pittsburgh/G20-Pittsburgh-Leaders-Declaration.pdf
[142] UNFCCC, Conference of the Parties, Twenty-first session, Paris, December 2015. Available at/ https://unfccc.int/resource/docs/2015/cop21/eng/l09.pdf
[143] European Commission, "Historic climate deal in Paris: EU leads global efforts", Paris, 12 December 2015. Available at: http://europa.eu/rapid/press-release_IP-15-6308_en.htm
[144] European Commission, "Clean Energy for all Europeans" package, (COM(2016) 860), November 2016. Available at: https://ec.europa.eu/transparency/regdoc/rep/1/2016/EN/COM-2016-860-F1-EN-MAIN.PDF

text mentions that "*this package is also stepping up EU's action in removing inefficient fossil fuel subsidies in line with international commitments under G7 and G20 and in the Paris Agreement. The remaining but still significant public support for oil, coal and other carbon-intensive fuels continues to distort the energy market, creates economic inefficiency and inhibits investment in the clean energy transition and innovation. The market design reform is removing priority dispatch for coal, gas and peat and will limit the need for capacity mechanisms which often relied on coal. The Commission will also establish regular monitoring of fossil fuel subsidies in the EU and expects Member States to use their energy and climate plans to monitor the phase-out of fossil fuel subsidies. The Commission will carry out a REFIT evaluation of the EU framework for energy taxation in order to define possible next steps also in the context of the efforts to remove fossil fuel subsidies*".

6.2 Methodology

Estimating the financial support for an energy-related purpose or 'energy subsidies' has been subject of study for a wide range of literature, especially dealing with fossil-fuel subsidies. Various methodologies to estimate subsidy amounts have been established. Amongst these, three main methodologies have been developed by the most relevant international institutions, namely the International Energy Agency (IEA), the International Monetary Fund (IMF) and the Organisation for Economic Co-operation and Development (OECD)[145,146]. Whilst, the methodologies used by the IEA and the IMF used a standardized top-down method called the price-gap approach (see box text below), that of OECD is based on a bottom-up method that consists of inventorying all government support mechanisms (interventions support both energy production and consumption) individually and adding up all their respective amounts as part of a global database.

Price gap-approach

The price-gap approach consists of estimating the difference between a reference price (import, export or production price) and the price paid by end users for a particular energy/technology. If this difference is positive, then a subsidy is considered to exist. Multiplying the price difference by the corresponding quantities of energy consumed, enables total subsidies to be estimated.

This shared, simple methodology can be applied to all countries, easing the comparisons between them. This is the main advantage of the price-gap approach. However, setting the reference price is crucial to calculate the amounts of subsidies since its level highly influences the volume of the estimated financial aids. Therefore, the level of the reference price is crucial and can be controversial.

The OECD approach has been preferred for the present study for several reasons explained below.

[145] Ambrus Bárány and Dalia Grigonytė, Measuring Fossil Fuel Subsidies, ECFIN Economic Briefs 40. March 2015.
[146] OECD-IEA fossil fuels support and other analysis http://www.oecd.org/site/tadffss/methodology/

6.2.1 Inventory methodology strengths

First, as noted by Bárány and Grigonytė, *"one clear advantage of the OECD methodology is that it can cover more sophisticated methods of public support"*[6]. Indeed, there are various forms of public interventions and a price-gap approach does not cover all of them, as not all interventions have an impact on the consumer prices. Therefore, the bottom-up approach addresses a broader range of measures.

Second, the cost of financial supports funded directly out of government / public institutions budgets can be measured precisely thanks to various official publications (governments' annual budget / finance law, government tax expenditures estimations, public institution reports, etc.). A price-gap approach is not necessary for these.

Third, measures inventoried in official publications[147] are mostly explicit, i.e. they represent specific budgetary expenditures and therefore directly impact the government budgets.

Fourth, inventorying subsidies through a bottom-up approach can be extended beyond fossil-fuels, i.e. to the electricity, nuclear, renewable energy sources (RES) and energy efficiency sectors, and to also include indirect financial transfer measures.

6.2.2 Inventory methodology limitations

Although the bottom-up approach offers numerous advantages, it also includes drawbacks. We identify these below and how they have been dealt with in our work.

The first limitation comes from the fact that no common methodology is shared throughout the EU28 for calculating the various types of interventions. Indeed, each MS is free to implement its own methodology for calculating the amounts later released in official publications. Because of the lack of standardised methodologies and a lack of sharing of those that are used by countries, the comparison across countries is a complex exercise.

Second, only one change of methodology in national interventions has been noticed in the current inventory (in the transport sector in France, responsible for a €0.7bn increase between 2011 and 2012). However, there is a lack of transparency, as methodologies used by MS are not publicly released; a change of methodology during a period of time by a given country may either not be reported or not be retroactively addressed in the official documents. Therefore, straightening data is not possible and comparisons across years can be affected.

Third, the level of disclosure and accuracy of sub-national tax expenditures varies widely across MS.

Fourth, when the quality of the data allowed for it, amounts collected were attributed to the concerned specific energy/ies, technology/ies and specific economic sector/s. When that direct attribution was not possible, amounts have been allocated to economic sectors based on the energy consumption of the concerned sector. Similarly, when the direct attribution of amounts to energy technologies was not possible those amounts were attributed to the various technologies based on either the national energy

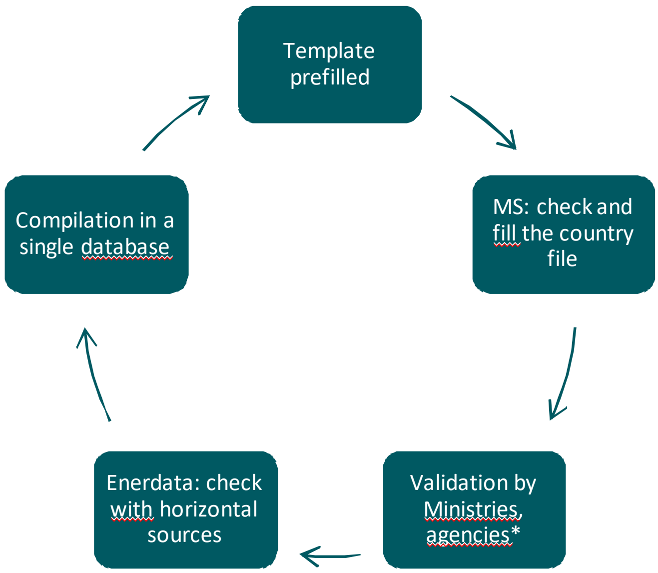
[147] Some measures where not estimated by governments / official institutions, often VAT-related interventions which are not always included in tax expenditures reports published by governments. Therefore, these interventions have been estimated by the consortium to provide a magnitude of amounts transferred.

balances or on national power generation mixes for electricity-related interventions, thus using the methodology adopted by the OECD. It is to be noted that (not directly attributable) interventions linked to fossil-fuels-based electricity generation have been allocated to fossil-fuels, while (not directly attributable) interventions linked to RES-based electricity generation have been allocated to RES technologies.

6.2.3 *Data gathering*

When using the bottom-up approach, one of the key factors to get a thorough understanding of energy subsidies was to develop a robust methodology. Our approach was based on five steps (see Figure 6-1). Our first step was to adjust the typology of subsidies used in the previous study and prefill the spreadsheet templates with results from the 2014 study, but using the classification for the current study (which built upon the 2014 study). The database has then been split by country and sent to a network of 28 energy market experts located in each MS. The second step has consisted for the experts to check, complete and expand the information included in their national inventory. The third step, when possible, was to have the inventory validated by third parties, for instance ministries, national agencies, energy regulator…, etc. Once received, Enerdata has checked all the experts' files and has started a quality check process (step 4) that has consisted of asking experts for clarifications or adjustments, as well as comparison with transversal sources (detailed later). The fifth and final step was to harmonise the global database making sure all interventions were reported in a similar way by the 28 experts.

Figure 6-1: Data collection process



**When possible*

Data sources

A large panel of financial support measures are covered in the current inventory coming from various of sources. Direct data collection from official documents has always been preferred over in-house estimates.

Most of the information collected has been taken from official public documents such as governments' annual budget / finance law, government's tax expenditure reports, MS statistics offices reports, MS

Court of Auditor's reports, ministries' reports[148] and reports from other public institutions such as energy regulators, energy agencies, building agencies, etc. In addition, a minor portion of the official information was collected through direct written exchanges between experts and national institutions. Finally, research, development and demonstration (RD&D) budgets have been taken from the IEA Energy Technology RD&D Budget Database[149]. In total, 75% of the information inventoried has come from this kind of official documents, i.e. financial support officially stated by national institutions.

When information was not available or missing for some years over the full period, experts and Enerdata have provided estimates to approximate the amounts of subsidy. Estimations have been performed based on either evolution of the energy consumption and fiscal framework over the period, or using one of the two items when the other was missing. By default, amounts reported in the previous or next year of a given year have been replicated in order to obtain a consistent coverage over the period (e.g. for a missing value in 2014, we have taken either 2013 value or that of 2015). For interventions without any official provided amounts, experts and Enerdata have estimated the monetary financial supports using both energy consumption and fiscal information related to each specific measure. Such estimates are well documented with a clear description of methodologies used. In total, 18% of the interventions reported have been estimated. The remaining 7% being measures with no subsidy values, as it was not possible to estimate them.

Two transversal interventions subject to in-house estimates

Two cross-country tax expenditure interventions have been subject to in-house estimates for consistency and comparison purposes.

Free allocation of Emission Allowance Units (EAUs) under the ETS.

During the EU-ETS Phases I and II (2005-2012), stationary installations (manufacturing industries and the power sector) were allocated free emission allowances (note that one allowance is the right to emit one tonne of CO_2 equivalent). During Phase I, almost all allowances were given to businesses for free. Over Phase II, the proportion of free allocation fell slightly to around 90%. Since the beginning of Phase III (2013-2020),the power sector no longer receives free allowances (with the exception of free allowances under condition of investments for the modernisation of the power sector in eight MS[150]) and only part of the manufacturing industries benefits from this intervention[151].

Since Phase III, the intra-European Economic Area (EEA) air flights are also included in the system although 85% of the allowances are granted for free to aircraft operators[152]. In both cases, stationary installations and aviation, MS experts have not reported this intervention[153]. Consequently, we have monetised the subsidy in-house for each country using the following calculation:

148 Including reports published by Ministries of Energy, Ministries of Environment, Ministries of Economy and Finance, Ministries of Housing.
149 IEA Energy Technology RD&D Budget Database. Available at: http://www.iea.org/statistics/rdd/
150 Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Lithuania, Poland and Romania, see https://ec.europa.eu/clima/policies/ets/allowances/electricity_en
151 European Commission, Climate action. Available at/ https://ec.europa.eu/clima/policies/ets/allowances_en
152 The legislation, was designed to apply to emissions from flights from, to and within the European Economic Area (EEA). The EU, however, decided to limit the scope of the EU ETS to flights within the EEA until 2016 to support the development of a global measure by the International Civil Aviation Organization (ICAO). In light of the adoption of a Resolution by the 2016 ICAO Assembly on the so-called CORSIA global measure, the EU has decided to maintain the geographic scope of the EU ETS limited to intra-EEA flights from 2017 onwards. The EU ETS for aviation will be subject to a new review, that should consider how to implement the global measure in Union law through a revision of the EU ETS legislation. In the absence of a new amendment, the EU ETS would revert back to its original full scope from 2024. See https://ec.europa.eu/clima/policies/transport/aviation_en
153 Some MS have implemented schemes to compensate the indirect cost of the EU ETS to support their manufacturing industries to prevent from a risk of carbon leakage in the context of global competition. However, these interventions inventoried in the database come in addition to the monetisation of the free allowances carried out by Enerdata.

- EUA ETS subsidy in € = ΣtCO_2 of free allowances/year x EUA average annual prices in €/tCO_2.

Tax expenditure on fuel consumption in maritime and air transport

The Energy Tax Directive (ETD)[154] states that "*Existing international obligations and the maintaining of the competitive position of Community companies make it advisable to continue the exemptions of energy products supplied for air navigation and sea navigation, other than for private pleasure purposes, while it should be possible for Member States to limit these exemptions*".

As part of the current inventory, only eight countries had reported such tax expenditures[155]. The data comparisons across countries revealed that the eight MSs' own methodologies used to calculate these tax expenditures were significantly heterogeneous. Therefore, it was decided to carry out an estimation of each MS tax expenditure using a common standardized approach. This consisted of combining the fuel sold for consumption for domestic traffic (available in the energy balances of Eurostat for domestic aviation and inland navigation) with the excise duty rates for kerosene/fuel oil/diesel by MS for the respective year (available in the EC TAXUD database[156]).

- Air transport tax expenditure = kerosene consumption for domestic aviation in €/1,000 litres x standard excise tax rate for kerosene in €/1,000 litres
- Water transport tax expenditure in € = gasoline, diesel and fuel oil consumption for domestic navigation in toe x standard excise tax rates for gasoline, diesel and fuel oil in €/toe

Data checking

The collection of information as well as the cross-checking have been made easier thanks to several public information sources made available by international institutions providing multi-country coverage, and by using national sources. The most relevant sources we have used are:

- OECD fossil-fuel subsidies: http://www.oecd.org/site/tadffss/;
- OECD tax exemptions: https://pinedatabase.oecd.org/;
- IEA Energy Technology RD&D Budget Database: http://www.iea.org/statistics/rdd/ ;
- MURE database on energy efficiency policies and measures: http://www.measures-odyssee-mure.eu/ ;
- CAN report and factsheets: http://www.caneurope.org/publications/reports-and-briefings/1490-report-phase-out-2020-monitoring-europe-s-fossil-fuel-subsidies;
- State Aid Scoreboard: http://ec.europa.eu/competition/state_aid/scoreboard/index_en.html;
- CEER Status Review on RES Support Schemes reports: https://www.ceer.eu/

Such horizontal sources give a full picture of existing subsidies and were particularly useful for cross-checking the subsidies that have been collected by experts. We ensured the current database includes at a minimum those subsidies inventoried in the above databases, except for particular cases. Some notes on the specific uses of each database are provided below:

154 Directive 2003/96/EC of 27 October 2003 restructuring the Community framework for the taxation of energy products and electricity, OJ L 283, 31.10.2003. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32003L0096

155 Austria, France, Germany, Italy, The Netherlands, Portugal, Spain, Sweden and the United Kingdom.

156 Taxation and Customs Union, "Taxes in Europe" database (TEDB). Available at: https://ec.europa.eu/taxation_customs/taxes-europe-database-tedb_en

- Information included in the OECD fossil-fuel subsidies and tax exemptions online tools, as well as the inventories carried out by CAN, were a solid reference to explore subsidies for fossil fuels for the countries they cover;[157]
- The IEA Energy Technology RD&D Budget Database was used to cover the RD&D budgets dedicated by MS by energy/ technology;
- The MURE database on energy efficiency policies and measures that cover a full range of interventions in the energy efficiency sector was useful to cover this sector;
- The CEER Status Review on RES Support Schemes reports was used to cross-check energy subsidies for renewables, in particular for the feed-in-tariffs and premiums until 2015 (the amounts for 2016 were missing);
- The DG Competition State Aid Scoreboard was used to cross-check the collected information and to ensure an extensive coverage of the intervention reported.

6.2.4 Restrictions

Although the scope of the current inventory has been extended compared to the previous study, the coverage has been restricted to the following areas:

- Sub-national interventions are not covered;
- Investments by development banks are not covered;
- Transport: was restricted to tax reductions/exemptions (i.e. no support for investment interventions, including for electric vehicles) and domestic transport (i.e. international transport is not covered, except for the EU ETS allowances granted for free to intra-EU aircraft operators);
- Nuclear: restricted to only subsidies for decommissioning and waste management. Potential financial support for nuclear liability may exist but has not been estimated in this study (see the box below). The EC has the intention to investigate this specific topic in separate studies;
- Agriculture: restricted to tax exemptions. Support for specific (energy) crops is not covered;
- Financial support related to cost of integration of intermittent RES are not covered (see box below);
- Government ownership (of all or a significant part) of an energy company;
- Diesel versus Petrol (gasoline) excise tax differences (see box below).

Nuclear liability - discussion on the extent of these “hidden” subsidies
Due to the potential scale of damages that may arise from a severe nuclear accident, a specific regime of nuclear third party liability has been established through international conventions, in particular the 1960 Paris Convention[158] and the 1963 Vienna Convention[159]. Through these conventions and the national legislations of the EU MS Parties to them, nuclear third-party liability in the EU is channelled to nuclear power plants’ operators. Operator’s liability is legally limited in time and, in most of the MS with operating nuclear power plants, it is also limited in amount. The scope of this specific liability regime is limited to risks of an exceptional character for which general tort law rules are not suitable. It does not apply to the on-site assets and revenues of the operator (the first party liability), which are covered under the normal insurance market.

157 OECD covers 21 countries, namely Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, United Kingdom.
CAN covers 11 countries, namely Czech Republic, France, Germany, Greece, Hungary, Italy, Netherlands, Poland, Spain, Sweden and the United Kingdom.

158 The Convention on Third Party Liability in the Field of Nuclear Energy of 29 July 1960, concluded under the auspices of the OECD

159 The Convention on Civil Liability for Nuclear Damage of 21 May 1963, concluded under the auspices of the IAEA

13 EU MS are currently Parties to the Paris Convention, 10 are Parties to the Vienna Convention and 5 are Parties to neither of the two. There is consequently a wide disparity between EU MS on the level of third party liability imposed on nuclear operators and the financial security that they are obliged to provide for coverage of the risk; these financial security amounts range, for the time being, from €43.9 million to €2.5 billion (MS with nuclear power plants). Although there are no precise estimates for the total costs of a severe nuclear accident, whose scope is especially large and difficult to quantify, the amounts of financial security set out in EU MS appear to be rather limited when compared to the cost of previous major nuclear accidents. For example, by the end of 2016, the Japanese government revised its estimations for the costs of the Fukushima's nuclear disaster to about €175 bn (JPY21.5 trillion)[160] from an initial estimate of about €42 bn (JPY11 trillion) in 2011[161]. In addition, TEPCO indicated having paid above € 60 bn (JPY 8 trillion) for the compensation of nuclear damage, as of June 2018[162]. In Ukraine, the State published several National reports with revised assessments of Chornobyl total economic costs, estimated up to €170 bn (USD200 bn)[163] as of 2010.

Currently, there is no harmonised and internationally accepted methodology to appraise the total economic costs of a hypothetical severe nuclear accident[164]. In addition, there is a need to clearly assess how, and to which extend, the private coverage for nuclear third-party liability could be further increased.

For these reasons, a precise evaluation of the "hidden" subsidies to nuclear, i.e. amounts that a State would eventually have to pay, in addition to its contribution within the signed international nuclear conventions, to complement the operators' payments in case of a severe nuclear accident, cannot be undertaken. Following the Chornobyl and Fukushima disasters which have turned out to be much costlier than expected, existing frameworks and methodologies are further questioned, and revision and improvement seem necessary at the international level.

Therefore, financial support for nuclear third-party liability may exist (as liability of nuclear operators is limited in most EU MS and as the financial securities to be provided by operators for the coverage of the risk do not match the potential costs resulting from a severe nuclear accident) but, cannot be estimated at this stage. The reasons for this include the fact that there is not a sufficiently developed nor harmonised approach by EU MS on how the insurance, private and financial markets could provide for increased coverage in this field nor on the specific calculation methodology to include it in the current inventory. The EC is investigating this specific topic further in separate studies.

[160] Available at: https://www.reuters.com/article/us-tepco-fukushima-costs/japan-nearly-doubles-fukushima-disaster-related-cost-to-188-billion-idUSKBN13Y047
[161] Available at: https://www.wiseinternational.org/nuclear-monitor/836/economic-impacts-fukushima-disaster
[162] Available at: http://www.tepco.co.jp/en/comp/images/jisseki-e.pdf
[163] Available at: http://www.inaco.co.jp/isaac/shiryo/genpatsu/chornobyl25eng.pdf
[164] A dedicated expert group by the Nuclear Energy Agency is working on the development of methodologies for assessing economic impacts of nuclear accidents, more information available at: https://www.oecd-nea.org/ndd/costna/

System integration costs of intermittent RES

In line with EU energy and climate objectives, energy production from RES has been significantly increasing over the past decade. Whilst power generation of some renewable technologies may be predictable, such as hydro-, and biomass- and biogas-fired power plants, it is also the case that solar and wind, which represent most of the power generating capacity addition, are by their nature variable, limitedly predictable and location specific. The intermittent character of solar and wind causes costs linked to the integration of this electricity generation into the power system.

Integration costs of intermittent RES are mainly composed of three types of costs: the back-up costs (costs to back-up periods of low power generation from RES by, mainly, conventional thermal power plants), the balancing costs (use of operational flexibility systems to maintain supply-demand balance on short time scales), and the grid integration costs (grid investments required to connect RES power plants, and to strengthen the network).

Given that this issue is relatively recent at national and European level, it has been observed "*there is no uniform definition on which exact costs should be included or not, nor is there a common standardized methodology to derive these costs or how to assign these costs to (intermittent) IRES-based generation*"[165]. Furthermore, integration costs are typically very case/country specific (specific generation mix, interconnections, means of flexibility, etc.). As a result, the literature provides very broad ranges for the different types of integration costs.

Since very few MS have put in place regulations for this topic, that could potentially be characterised as a form of subsidy, this type of intervention has not been covered within this study.

Diesel vs gasoline excise tax difference

The excise tax difference favouring diesel over gasoline has not been covered in this study. In some ways, this tax difference can be seen as a form of tax expenditure, as the level of taxation differs between two fuels that are mainly consumed for the same purpose, i.e. road transport. However, in the context of this study we have defined tax expenditure as the exemption, exclusion, or deduction from the base of a tax for a given product. Therefore, the excise tax difference between diesel and gasoline has not been considered as tax expenditure, and therefore was not included in the current inventory.

Moreover, currently, most of the MS do not consider the excise tax difference between diesel and gasoline as tax expenditure. This finding has also been relevant for excluding this measure in our study.

That being said, some countries do consider this tax difference as a tax expenditure and include it in their annual budget / finance law reports. This is the case of Denmark (€0.2bn in 2016), Italy (€5bn in 2016) and Sweden (€0.9bn in 2016).

[165] KU Leuven, Determining the impact of renewable energy on balancing costs, back up costs, grid costs and subsidies, 2015. Available at: http://www.creg.info/pdf/ARCC/161019-KULeuven.pdf

Some other countries have also released official estimations of their potential tax losses. This is at least the case of France (€6.1bn in 2015[166]) and Germany (€7.35bn in 2014[167]). In addition, there are also countries which had, or are, envisaging policy measures pursuing the end, or reduction, of the tax gap between diesel and petrol[168].

A study from 2015 by Transport & Environment has estimated the total revenue forgone by MS governments tied to this diesel vs gasoline tax difference to €27bn for the year 2014[169]. This would represent around 55% of the total fossil fuel subsidies we have identified for 2014 in the present study (€48bn, in current prices).

6.2.5 *Interventions definitions*

Inventorying financial supports first requires clarity on what is considered an energy-related intervention and which of them are covered. For consistency purposes, we have retained the definition of subsidy from the OECD, which is defined as *"any measure that keeps prices for consumers below market levels, or for producers above market levels, or that reduces costs for consumers or producers"*.[170]

Since the study is not only covering what is commonly called *subsidy* but all energy-related financial supports, the scope of interventions covered was widened to also include indirect transfers (see below).

6.2.6 *Typology of the interventions*

Furthermore, through a large literature review, we have classified the interventions under four main categories, namely tax expenditures, direct transfers, indirect transfers and RD&D budgets. The full list of interventions is available in Annex J.

6.2.7 *Finance-based categories*

Tax expenditures

Tax expenditures are the amount of tax benefits, or preferences, received by taxpayers and forgone by governments. Tax expenditures are relative preferences within a country's tax system that are measured with reference to a benchmark tax treatment set by that country. Amounts of tax expenditures are estimated by government with reference to a benchmark tax level.
Tax expenditures include the following eight interventions[171]:

- Accelerated depreciation;
- Free allocation of EUA under the EU ETS;
- Exemption & reduction of Energy tax;
- Exemption & reduction of Fuel excise tax;

166 Cour des comptes, L'efficience des dépenses fiscales relatives au développement durable, 2016. Available at : https://www.ccomptes.fr/sites/default/files/EzPublish/20161108-efficience-depenses-fiscales-developpement-durable.pdf
167 German Environment Agency (Umweltbundesamt – UBA), Umweltschädliche Subventionen in Deutschland 2016. Available at: https://www.umweltbundesamt.de/publikationen/umweltschaedliche-subventionen-in-deutschland-2016
168 According to ODI/CAN report (2017) (https://www.odi.org/sites/odi.org.uk/files/resource-documents/11762.pdf) the Netherlands ended differentiated tax rates between diesel and petrol in 2013 and France is envisaging to reduce that taxation gap by 2021.
169 Transport & Environment, Europe's tax deals for diesel, October 2015. Available at https://www.transportenvironment.org/sites/te/files/publications/2015_11_02_Note_27bn_diesel_indirect_subsidy.pdf
170 OECD, Environmentally Harmful Subsidies: Challenges for Reform, 2005. http://www.oecd.org/tad/fisheries/environmentallyharmfulsubsidieschallengesforreform.htm?_sm_au_=iqVF4vT022Z302T6
171 The full intervention definitions are reported in Annex G.

- Exemption & reduction of Taxes and levies;
- Exemption & reduction of VAT (related to energy use);
- Tax allowance;
- Tax credits.

Information on tax expenditure amounts are commonly found in government's annual budget / finance law and government's tax expenditure reports. In reality, tax expenditures in MS are mainly directed to final consumers. For example, often a favourable excise tax / energy tax rate is granted to some groups of persons, for instance low tax rates for diesel for agriculture, or for specific purposes such as equipment used for building retrofitting that enjoy reduced VAT rates.

Direct transfers

Direct transfers are direct expenditures by governments to recipients, which could be either consumers or producers. Direct transfers include the following two interventions:

- Grants;
- Soft loans.

Most of the inventoried information on direct transfer amounts have been collected from government's annual budget / finance law, ministries' reports and reports from other public institutions' reports such as energy regulators, energy agencies, building agencies.

Indirect transfers

Indirect transfers encompass various types of economic mechanisms that consist of transferring amounts of money from groups of people / technology / territory to a specific group (people, technology, territory). Most often, such measures are financed through final consumers' tariffs/prices and use cross-subsidy mechanisms.
Indirect transfers include the following 11 interventions:

- Biofuels blending mandates;
- Capacity mechanisms;
- Differentiated grid connection charges;
- Energy efficiency obligations;
- Feed-in tariffs;
- Feed-in premiums;
- Interruptible load schemes ;
- Power purchase agreement (PPA);
- Price guarantees (cost support);
- Price guarantees (price regulation);
- RES quotas with tradable certificates.

Information gathered on indirect transfer amounts have been collected through various documents such as MS statistical office reports, MS Court of Auditor's reports, ministries' reports and reports from other public institutions' such as energy regulators, energy agencies, building agencies, etc.

RD&D budgets

Energy research, development and demonstration (RD&D) budgets cover various types of interventions such as fiscal instruments (e.g. taxes), financial instruments (e.g. loans, grants), market-based mechanisms, direct investment (e.g. public procurement), education and information campaigns, or technology replacement programmes. The amounts for these RD&D interventions have been taken from the IEA Energy Technology RD&D Budget Database[172].

6.2.8 *Non-finance-based classification*

In addition to the above finance-based classification, further classifications of the interventions have been carried out to better define them and facilitate the analysis.

The main characteristics of the typology of subsidies are as follows:

- 5 main types of intervention:
  - support to investment refers to subsidies supporting investment to any energy-related purpose (e.g. "Investment grants hydropower" in Austria;
  - support to energy demand refers to subsidies that influence the energy demand either upward or downward (e.g. "Reduced rate of domestic consumption tax applicable to heating oil used as diesel fuel in agriculture and construction" in France);
  - support to energy savings refers to measures focusing on reducing the energy demand only (e.g. amounts provided within the "Energy Efficiency Fund" in Portugal);
  - support to production refers to subsidies that favour higher production of any energy source (e.g. feed-in tariffs and feed-in premiums);
  - support to RD&D refers to budget provided by public institutions to support energy research, development and demonstration (RD&D).
- 9 sectors (Agriculture, Energy industry, Manufacturing, Services, Transports, Households, Public, Non-households, Cross sector). The complete NACE classification is available in Annex A.
- 5 main groups of energy/technology (oil/gas/coal, electricity, nuclear, heating & cooling, RES).

More characteristics of subsidies (like the type of instruments used to provide support) were collected and are analysed in this report. The full list of categories and their definitions appear in annex J.

6.3 Analysis of financial support to energy-related purpose

6.3.1 *Overview of the distribution of the interventions*

The global database that gathers all the interventions collected by the networks of experts as well as interventions calculated or included directly by Enerdata (i.e. free allowances under EU ETS, tax expenditure on fuel consumption in the air and water transports) contains almost 1,500 interventions, against 700 in the previous study, corresponding to a growth of 110%. (roughly 250 of the additional interventions identified were in the new sectors studied, i.e. Agriculture and Transport; among the other 550 additional interventions identified, most are in the energy industry [265 new interventions] and the household sector [100]).

76% of interventions have actual cost estimates for at least one year over the 2008-2016 period, coming from official sources, while measures with values estimated using other approaches represent 18% of the overall inventoried measures. Only 7% of the interventions are not monetised.

172 IEA Energy Technology RD&D Budget Database. Available at: http://www.iea.org/statistics/rdd/ .

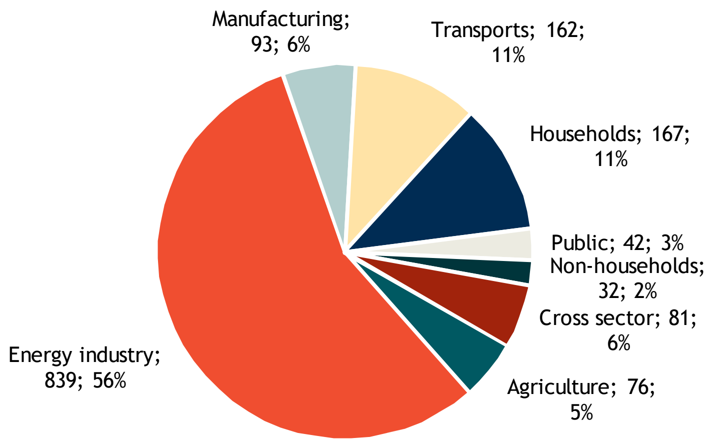
Table 6-1: Intervention key information

	Number of interventions	Distribution
Total number of interventions	1,492	100%
- of which interventions with actual costs	1,127	76%
- of which interventions with estimates	260	17%
- of which interventions without amounts	105	7%

Source: Own data, interventions database

In terms of sectors, most of the interventions are linked to the energy industry (Figure 6-2), with 56% of the measures, followed by households (12%) and transports (11%). The remaining smaller numbers of interventions are split rather equally between the different sectors.

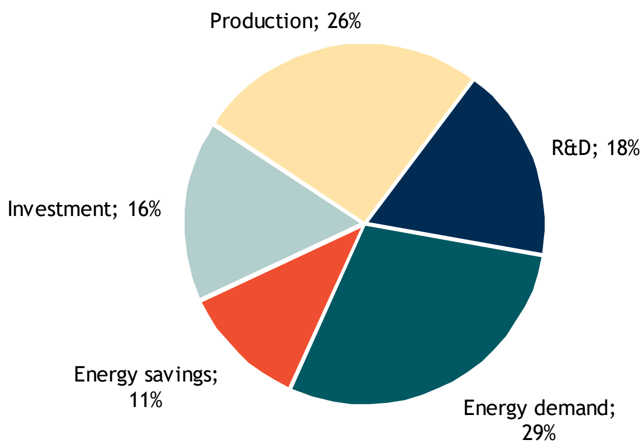
Figure 6-2: Distribution of the number of interventions by sector (in 2016)



Source: Own calculations based on interventions database

Measures to support energy demand (29%) and to support production (26%) are the most frequent, followed by RD&D (18%), support to investment (16%) and support to energy savings (11%), as shown in Figure 6-3.

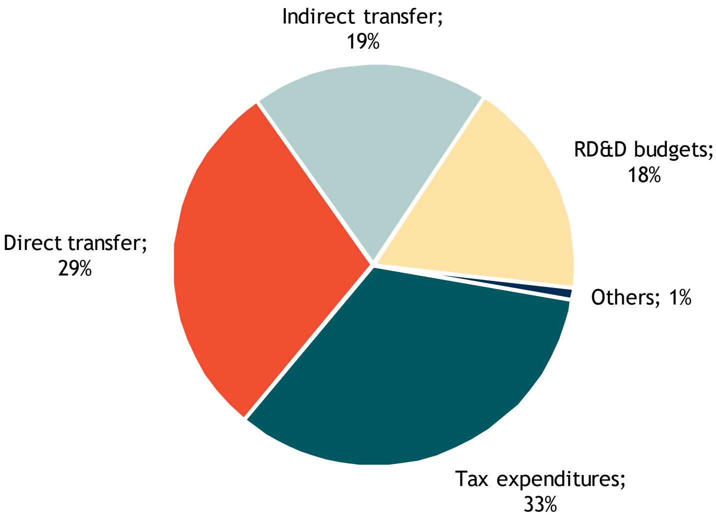
Figure 6-3: Distribution of the number of interventions by type (in 2016)



Source: Own calculations based on interventions database

When it comes to the categories of instruments used to provide the support (Figure 6-4), tax expenditures (34%) and direct transfers (29%) are the most frequent measures, while indirect transfers account for 19% and RD&D budgets for 18%.

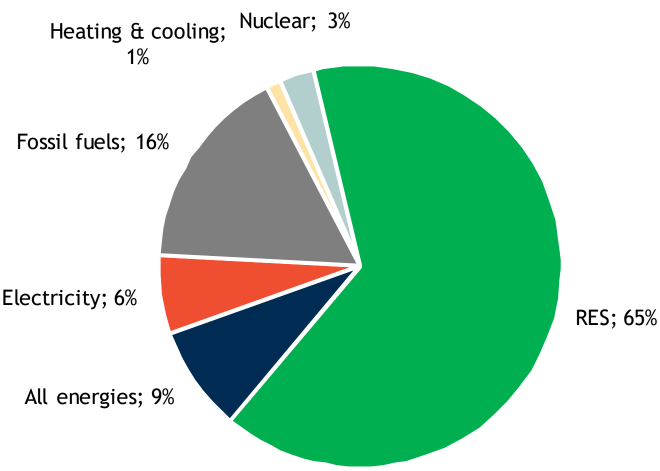
Figure 6-4: Distribution of the number of interventions by type of instruments used (in 2016)



Source: Own calculations based on interventions database

As presented in Figure 6-5, interventions for RES (65%) are the most abundant. Fossil-fuels account for 17%, nuclear 3% and Heating and cooling 1%, while those covering several/all energies/technologies represent 8% of all measures inventoried. Measures targeting electricity represent 6%.

Figure 6-5: Distribution of the number of interventions by energy, technology (in 2016)



Source: Own calculations based on interventions database

6.3.2 Consistency checks with other studies

Before starting the analysis of the information collected, an important step of the project was to ensure the consistency of the data we had collected. This was to ensure that the total amounts of subsidies gathered were in line with the information available in other, similar databases. To benchmark our data, we used the following two inventories: the OECD "Inventory of Support Measures for Fossil Fuels" and the first EC inventory of 2014. In both cases, the comparison was performed at comparable scope.

Comparison with OECD data

Since 2011, the OECD has released several well-documented studies[173] on the amounts of subsidies for fossil fuels across OECD' members. In addition to these analyses, OECD also publishes its "Inventory of Support Measures for Fossil Fuels"[174] that gathers a large number of measures considered as subsidies. The database covers 21 EU MSs, with those not included: Bulgaria, Croatia, Cyprus, Latvia, Lithuania, Malta and Romania. This database has been used as a reference to benchmark the current inventory.

Table 6-2: Comparison of subsidy amounts between OECD data and the current study (€bn, current prices)

Subsidies in €b, in current prices	2008	2012	2016
OECD (a)	32	45	45
This study (b)	49	56	54
Difference (b-a)	17	11	10
Difference (%)	+ 53%	+ 25%	+ 22%

Source: Own data and OECD

**Note: the same 21 EU MSs, without subsidies related to free emission allowances under the ETS.*

Overall, the amount of interventions inventoried in the current database shows robust information compared with OECD data. Over the scope of 21 EU MSs, the OECD database identifies €45bn (current prices) of public financial support for fossil fuels in 2016. On the same geographical scope, the current study reaches a total amount of €56bn (current prices). That is, the current inventory shows amounts exceeding those of OECD by 25% in 2016.

Although both inventories mainly use the same methodology, their results slightly differ. Discrepancies are mainly explained by differences in their respective detailed scope and coverage. The OECD only reports declared interventions in official publications and their related amounts, including the diesel to gasoline excise tax difference in relevant countries[175]. However, the OECD does not provide estimates and does not fill gaps in time series. In contrast, the current inventory completes the amounts disclosed in official publications, providing estimates and fills gaps if information is missing. For instance, zero taxation on energy consumption in domestic air and maritime transport are not included in the OECD database, except for countries that have explicitly reported these interventions. In contrast, the current inventory includes estimates of these interventions for all 28 MSs.

Comparison with previous study (2014)

As a second step the current inventory totals for the 2008-2012 period were benchmarked against results of the previous study. Table 6-3 below provides an overall comparison of both studies using a comparable scope, i.e. excluding the agriculture and transport sectors that were not covered in the previous study.

173 OECD. Available at: http://www.oecd.org/site/tadffss/publication/
174 OECD. Available at; http://www.oecd.org/site/tadffss/data/
175 The diesel to gasoline excise tax difference is included in the OECD database for Denmark, Italy, the Netherlands (until 2012 included) and Sweden over the whole period. The current inventory does not include this measure.

Table 6-3: Comparison of financial support amounts between 2014 study data and the current study (€bn, 2012 prices)

Subsidies in €b, in 2012 prices	2008	2012	Total 2008-2012
First inventory 2014 (a)	65	99	414
This study 2018 (b)	120	141	646
Difference (b) - (a)	55	42	232
Difference (%)	+ 84%	+ 43%	+ 56%

A comparison of the two studies shows a significant improvement in the exhaustiveness of the information collected since the amounts exceed by over 56% those collected in the 2014 study for the same 5-year period. The coverage improvements are explained by a better availability of information as a consequence of MS efforts on data transparency and data revision, and by energy experts focusing on providing accurate estimations when data were missing.

6.3.3 *Results and analysis of trends*

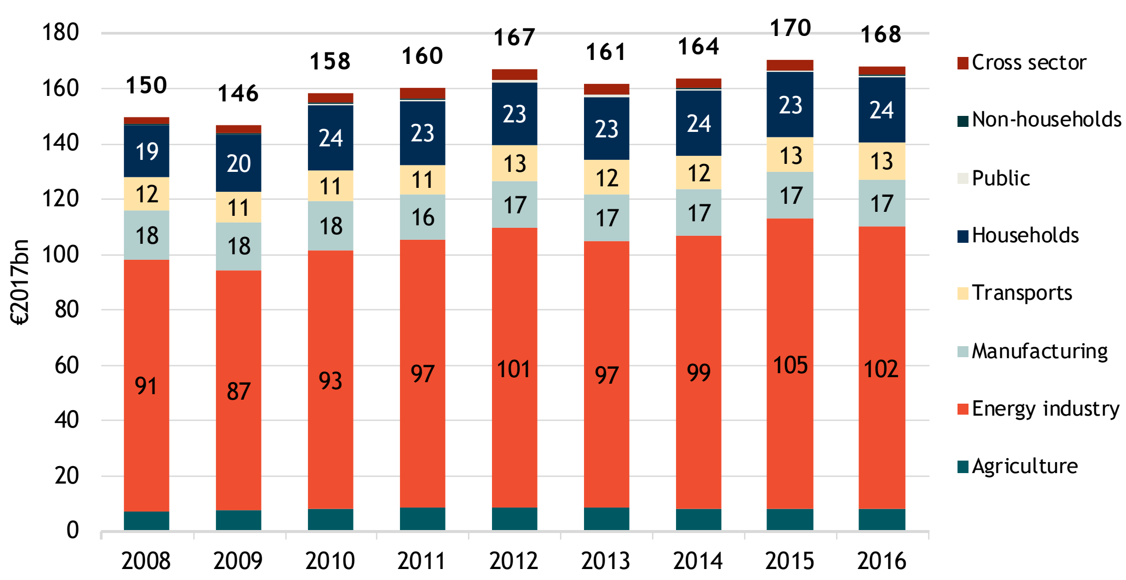
In this chapter, we present the results of all the consolidated information in the database to derive the main trends of the financial support for energy-related purposes. In order to remove the distorting effect of inflation, the following figures are expressed in constant 2017 Euro prices.

Over the 2008-2016 period, the cumulative financial support to energy-related purposes represented around €1,450bn, in constant prices 2017. Annual amounts have increased over the nine years covered from €150bn in 2008 to €168bn in 2016 (+€18bn), representing a 12% increase.

Trends overview

The €18bn increase (in annual terms) over the nine years is mainly due to the *energy industry sector* that accounts for over half of the increase (€11bn, 61% share in 2016) (Figure 6-6), while the *residential sector (Households)* ranks second with a €5bn increase and the *transport sector* third with €2bn.

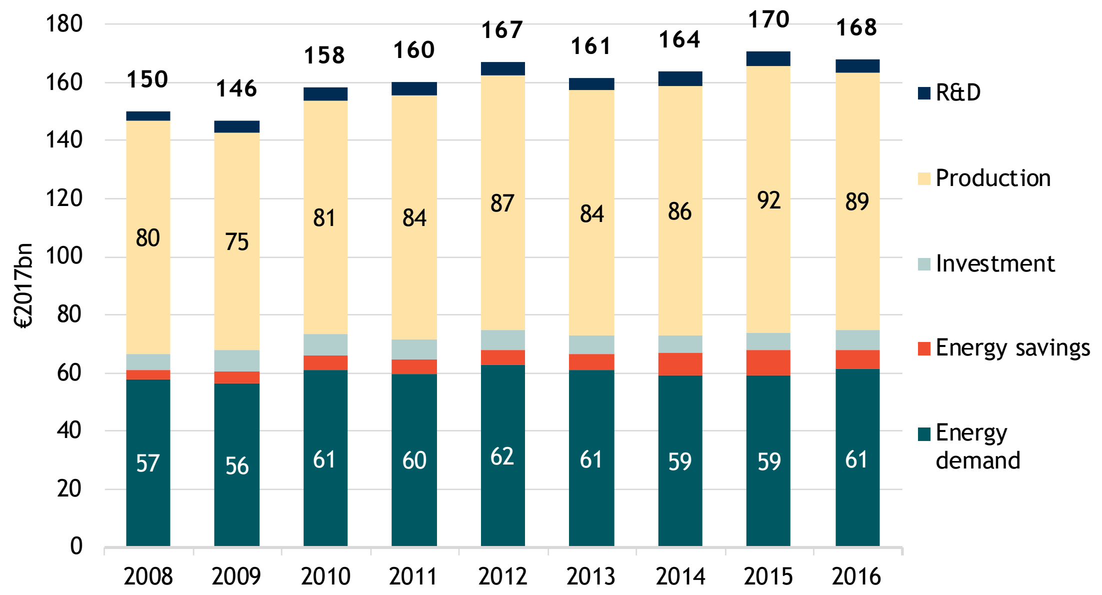
Figure 6-6: Financial support by sector (2008-2016, €2017bn)



Source: Own calculations based on interventions database

A second conclusion to be drawn from the analysis of the current inventory (see Figure 6-7) is that the lion's share of the financial support is dedicated to interventions that *support the production* and the *demand* of energy. Subsidies for *R&D*, *investments* and *energy savings* together represent only 11% of the overall amounts in 2016.

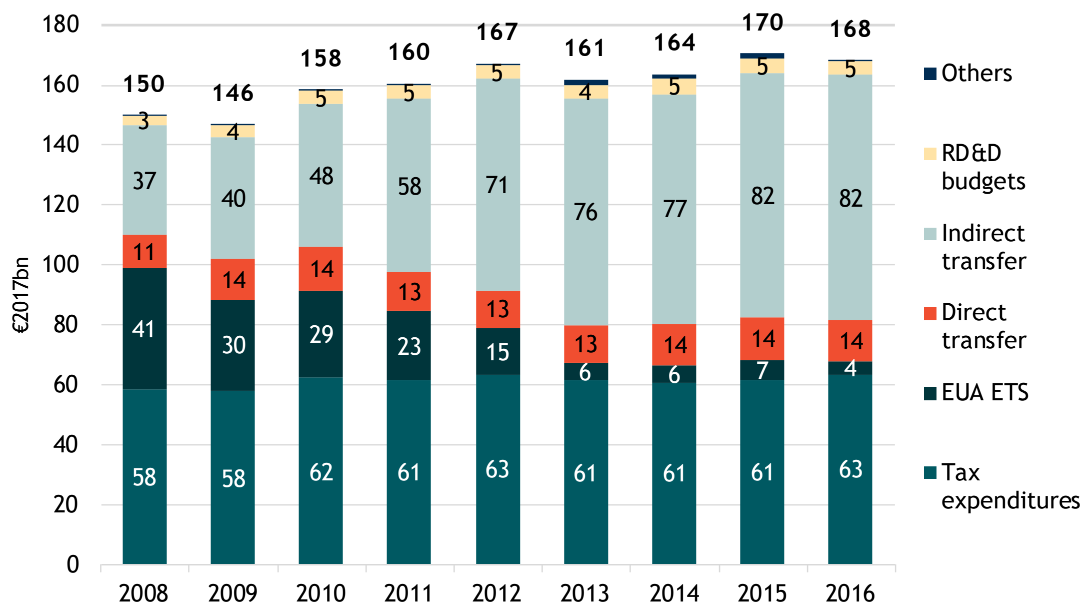
Figure 6-7: Financial support by category (2008-2016, €2017bn)



Source: Own calculations based on interventions database

In terms of financial tools used by EU Member States, growth is driven by *tax expenditures* and *direct and indirect transfer* measures. Conversely, *free ETS allowances* have gone down significantly over the study period, in line with the EU's strengthened efforts to mitigate climate change.

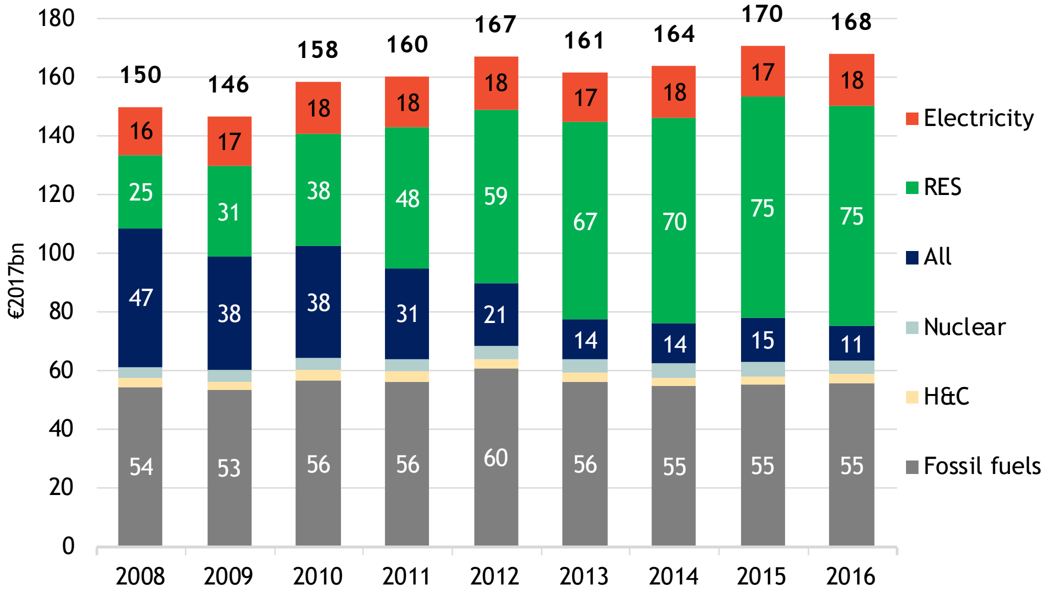
Figure 6-8: Financial support by intervention type (2008-2016, €2017bn)



Source: Own calculations based on interventions database

As regards the different sources of energy / technology, the support to fossil fuels has remained the same over the period of study (see Figure 6-9), despite the fact that the EU intends to phase out these subsidies. In contrast, the reduction of subsidies in the "*All*" section[176], due to the reduction of costs related to the free ETS allowances, combined with the increasing support for RES, reflects the efforts undertaken by the EU to move towards a low carbon energy system.

Figure 6-9: Financial support by energy (2008-2016, €2017bn)



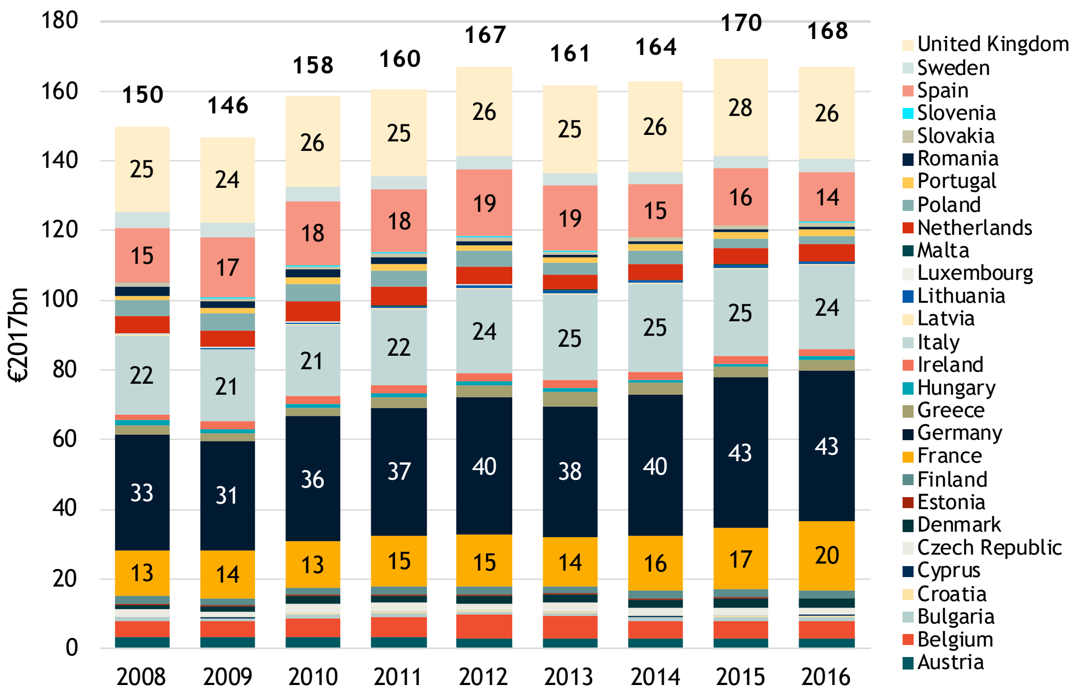
Source: Own calculations based on interventions database

In 2016, (see Figure 6-10) Germany provided the largest amount of financial support to its energy system with a total of €43bn (30% of the EU28), followed by the United Kingdom with €26bn (16%), Italy €24bn (14%), France €20bn (12%), and Spain €14bn (9%).

From 2008 to 2016, the amount of financial support increased the most in Germany (with +€10bn in 2016 with respect to 2008; +30% compared to 2008), France (+€7bn; +54%), The United Kingdom (+€1.8bn; +7%) and Italy (+€1.5bn; +7%). On the other end, the countries with the largest absolute reductions were Poland (-€2.1bn; -46%), Romania (-€1.8bn; -71%), Spain (€1.1bn; -7%) and Sweden (-€1bn; -22%).

[176] The "*All / several*" gathers all interventions that either cover all energy sources, for instance the measures supporting energy efficiency and the EUA ETS, as well as all the measures combining energy sources classified in more than two different groups of energy, for instance a measure supporting CHP fuel with coal, natural gas and biomass.

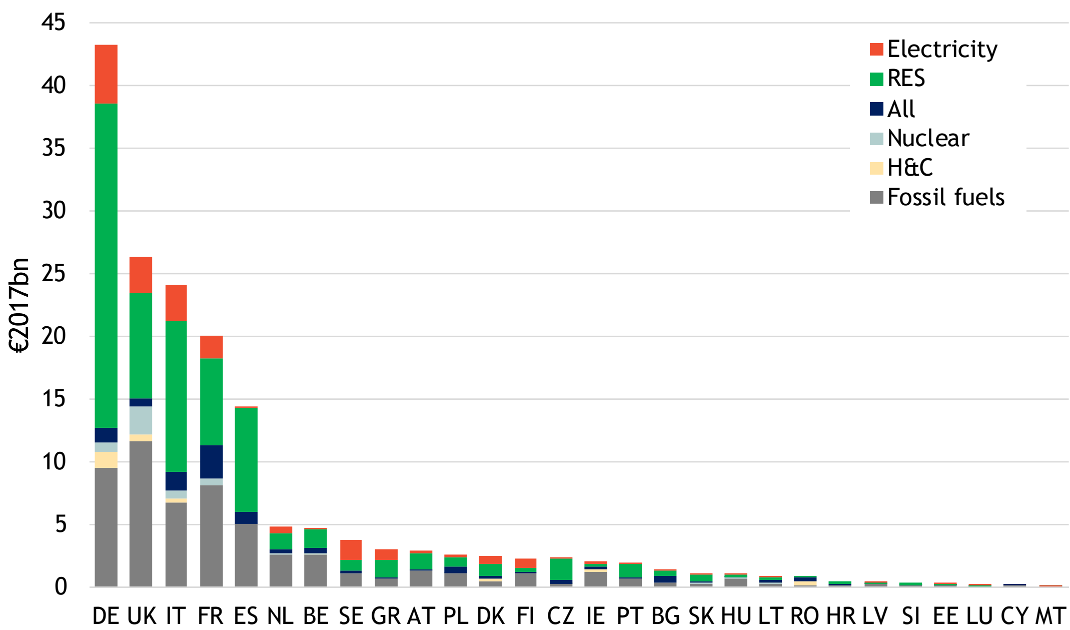
Figure 6-10: Financial support by country (2008-2016, €2017bn)



Source: Own calculations based on interventions database

After having presented the global evolution, Figure 6-11 presents a breakdown of the type of subsidies per MSs. From this we find that Germany, the country providing the highest amount of financial support in 2016, mainly supported the development of RES, while the country with the second largest financial support, the United Kingdom, favoured fossil fuels over the other energy sources. Italy and Spain had a similar profile as Germany with a much larger share of support to RES than to fossil-fuels, while France supported mostly fossil fuels.

Figure 6-11: Financial support by energy and by country (2016, €2017bn)



Source: Own calculations based on interventions database

The next step of the analysis will focus on the distribution of the financial support to fossil-fuels, EUA ETS and RES.

Energy subsidy benchmark

In our collection and estimation of subsidies for the updated energy subsidies inventory, we have tried to use methodologies that facilitate the comparability of the amounts found across the countries as this would also help to understand how 'generous' the policies of each country are in terms of the provision of subsidies, i.e. a sort of energy subsidy benchmarking of countries.

In our study we have chosen to mainly follow the methodology used by the OECD to calculate subsidies, discarding other approaches (price gap methodologies) which might be better in terms of comparability but that had to be discarded because of the reasons explained at the start of this chapter (see section 6.2).

Indeed, ensuring comparability was a very complex issue under the methodology we have used, as it was acknowledged by the OECD in 2013[177].

Following a comprehensive literature review, we have come to the conclusion that we had to narrow down the focus of improving the comparability of subsidies to tax expenditures. Indeed, tax expenditures are the most commonly used category of subsidies in the EU and are used in a rather homogenous way, while direct transfers and indirect transfers are more heterogeneous as they cover more diverse situations. However, despite restricting our effort to tax expenditures, comparison between the amounts proved to be unfeasible due to the information we had collected on the inventoried subsidies.

The major problem encountered for the comparability of the tax expenditure amounts between Member States results from the different methodologies used by each Member State to calculate those amounts. Furthermore, the low level of transparency on the actual calculation methods used by Member States made it impossible to come up with approaches to 'convert' figures to make them comparable.

Against that background, we tried to come up with indicators that contextualise the subsidies and to help understand the reasons why the figures can be higher in one country compared to another.

A first obvious indicator to be considered is the size of the economy. Indeed, energy subsidisation must be compared in relative terms and it does not make sense comparing the absolute value of energy subsidies in Germany (the biggest EU economy with 82 million people) with, for instance, that of Malta (0.4 million inhabitants). A tax expenditures/GDP ratio was calculated for all Member States

177 “In interpreting the figures, it is important to underscore that tax expenditures are measures of support only relative to the benchmark tax structure of the country in question. Since the figures measure relative support within the context of that country’s tax system, they are not comparable across countries. A country that applies high rates of taxation to fossil-fuel end products within the context of a highly differentiated excise-tax system may thus have higher measured support to fossil fuels than a country with lower but uniform excise-tax rates, even if the tax system of the former country has higher taxes than the latter country on each type of fuel. Further, the comprehensiveness of tax expenditure reporting varies significantly between countries.”
Inventory of Estimated Budgetary Support and Tax Expenditures for Fossil Fuels 2013, page 21, OECD, 2013. Available at: https://www.oecd-ilibrary.org/environment/inventory-of-estimated-budgetary-support-and-tax-expenditures-for-fossil-fuels-2013_9789264187610-en

but it has not allowed for relevant conclusions to be drawn on the 'generosity' of subsidy policies as the resulting dispersion of ratios was too low.

A second attempt to find an indicator to assess the relative 'generosity' of subsidy policies of Member States was to compare tax expenditures relative to the energy tax revenue[178] (an indicator of the level of tax rates) with the subsidies / GDP ratio (a relative measure of subsidies provided). The hypothesis we expected to prove was that countries with higher tax rates would be providing higher subsidies. However, the results of the analysis did not show any significant correlation.

This is because the energy taxation policies pursued differ significantly across countries, therefore the tax revenue levels also vary widely depending on the taxation strategy developed by each MS. The level of tax rates is not always reflected in the revenue figures.

Indeed, the diversity of energy taxation policy also complicates the comparability of tax expenditure as the latter depends on aspects that vary widely across Member States such as: i) the level and structure of taxation rates applied to each energy product; ii) the structure of the market (a high taxation level can be implemented for a given energy product, but it may only apply to a very small portion of the total consumers in a given country). One could easily assume that these differences can have a significant impact on the subsidies calculated. Thus, for instance, one could expect that full tax exemptions in Member States with higher tax rates may bring higher tax expenditures (subsidies) compared to the tax expenditures found in Member States with lower taxes rates. However, the amount of the tax expenditure also depends on the level consumption of the energy product (e.g. a full exemption on a very high taxation rate on an energy product does not necessarily bring higher tax expenditures as the consumption of the product can be negligible in that country due to that high level of the rate).

Tax expenditures are relative preferences within a country’s tax system that are measured with reference to a benchmark tax treatment set by that country. Since the benchmark tax treatment varies considerably from country to country, the value of this type of support is not comparable across countries.

As mentioned by the OECD in a study of 2013 and for all these reasons, energy subsidy comparison is a complex exercise. Consequently, such comparison has been left open to future research.

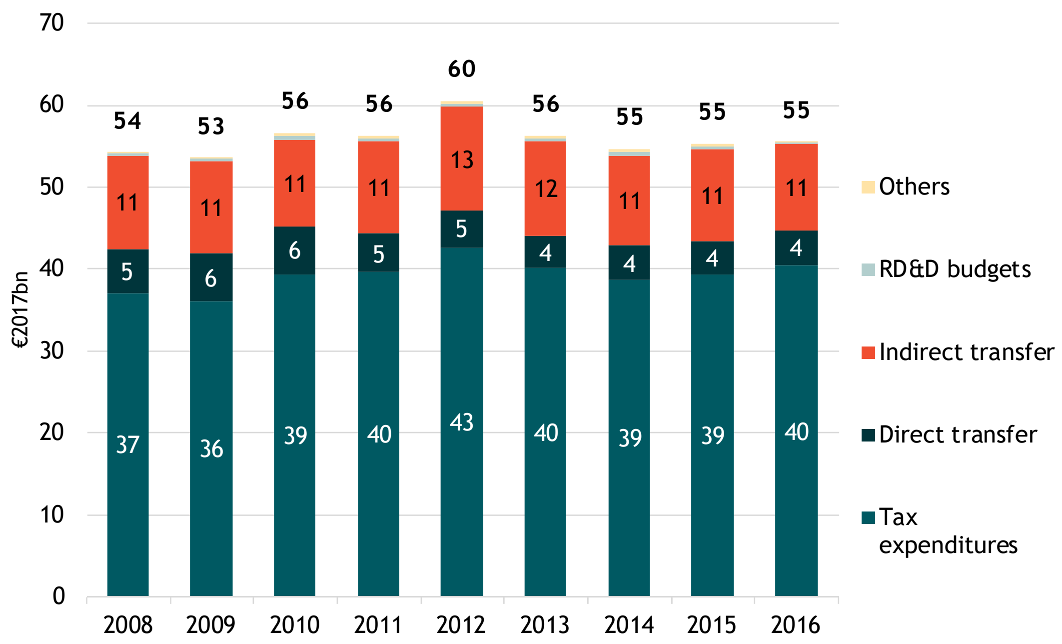
Subsidies to fossil-fuels have been growing between 2008 and 2016

Subsidies to fossil-fuels have been increasing over the 2008-2016 period by 3%, representing an additional amount of €0.5 bn. After an important rise until 2012[179], total fossil fuel subsidies fell for two years before rising again to reach €55 bn/year in 2016 (at 2017 prices). Most of the growth over the period was due to increases in the form of *tax expenditures* that have raised from €37 bn to €40 bn (Figure 6-12).

[178] From Eurostat. Available at : https://ec.europa.eu/taxation_customs/business/economic-analysis-taxation/data-taxation_en

[179] Noticeable increases have been detected in Italy (+€1.2 bn, driven by a €0.8 bn rise of the intervention “Reduction of excise duty on diesel used in freight and other categories of passenger transport”) and in France (+0.6 bn, mainly driven by the change of calculation methodology by the MS for the intervention called “Exclusion of the Overseas Departments from the scope of the internal fuel consumption tax applicable to fuels”).

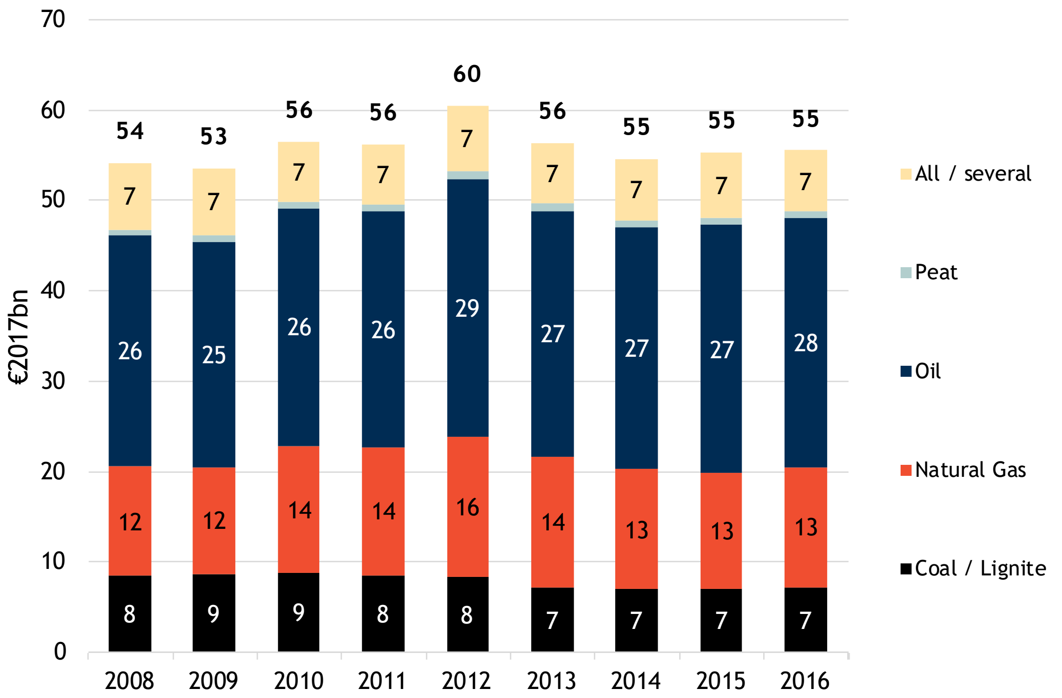
Figure 6-12: Financial support by energy and by country (2008-2016, €2017bn)



Source: Own calculations based on interventions database

Subsidies for petroleum products represent around 48% of the total subsidies for fossil fuels and account for two thirds of the increase (+€1.5bn) over the period (Figure 6-13).

Figure 6-13: Financial support for fossil fuels - split by energy source (2008-2016, €2017bn)



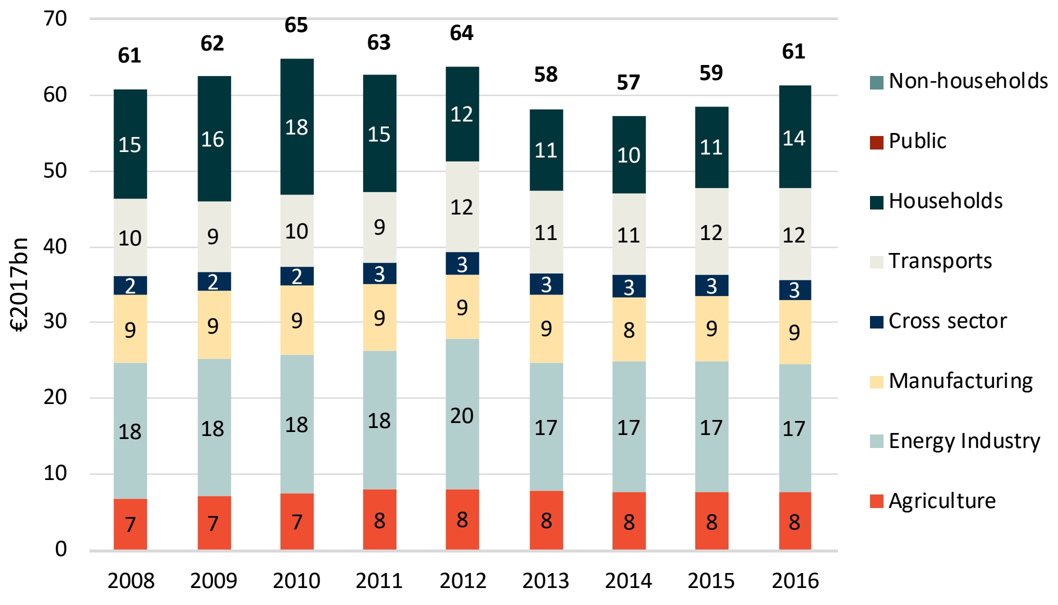
Source: Own calculations based on interventions database

Fossil fuels subsidies in the transport and agriculture sectors

The extension of the current inventory to the agriculture and transport sectors shows that transport was among the primary drivers in the overall growth of fossil fuel subsidies. Indeed, the transport sector has attracted an additional €1.5bn of subsidies over the period (all the growth in fossil fuel subsidies over the period) reaching a total of €13bn in 2016[180], exceeding the subsidies given to the energy industry (€17bn in 2016) which have shrunk by 6% (-€1bn), driven down by significant reduction in the Italian CIP6 scheme (-€1.7bn[181]) between 2008 and 2016. Almost all the subsidies received by the transport sector are in the form of tax expenditures.

According to the current inventory, fossil fuels subsidies to the agriculture sector have been quite stable over the period at around €8bn[182].

Figure 6-14: Financial support for fossil fuels - split by economic sectors (2008-2016, €2017bn)



Source: Own calculations based on interventions database

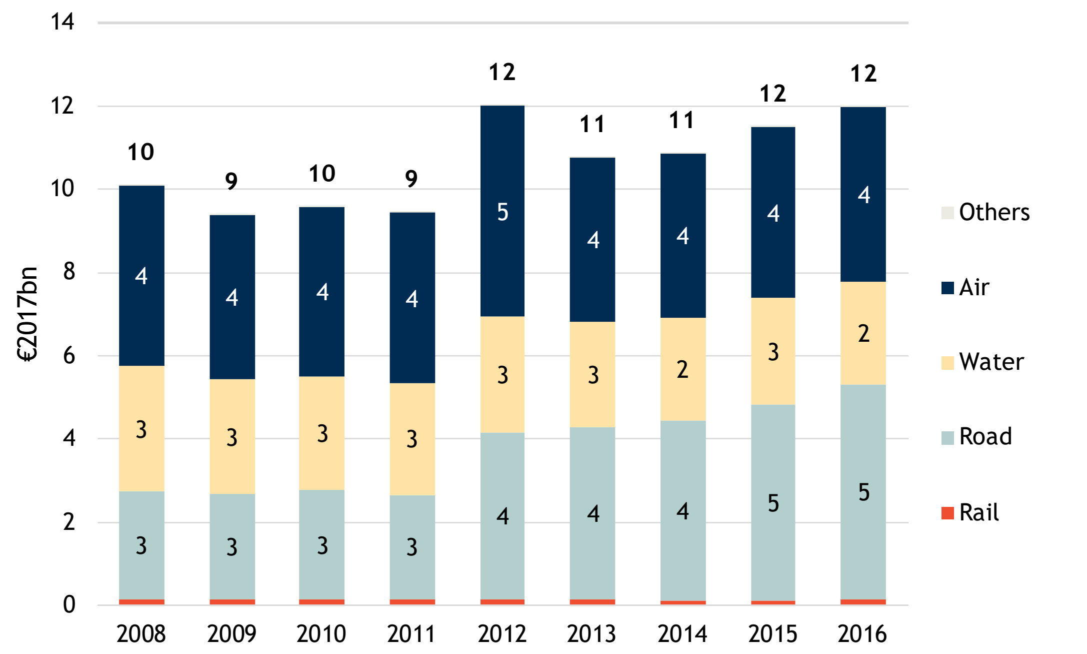
Within the transport sector, the road transport mode has been responsible for the full increase of subsidy (+€2.6 bn) over the period, while other transport modes have recorded drops of financial supports (-0.7 bn) – see Figure 6-15.

[180] A €0.7bn increase is attributable to a change of methodology in the transport sector in France between 2011 and 2012, namely the intervention named *"Exclusion of the Overseas Departments from the scope of the internal fuel consumption tax applicable to fuels"*.

[181] CIP6 concerns incentives to electricity produced using renewable sources and "assimilated" ones. The word "assimilated" was added to the original forecast at the time of the approval of the measure in order to include sources of various kind, that were not expressly provided by European legislation. The cost of such incentives are funded by the A3 component which is a surcharge of 6-7% of the cost of electricity charging directly final consumers in in the count of all bills.

[182] 70% of the subsidies for agriculture are from France (22%), Italy (27%) and UK (21%)

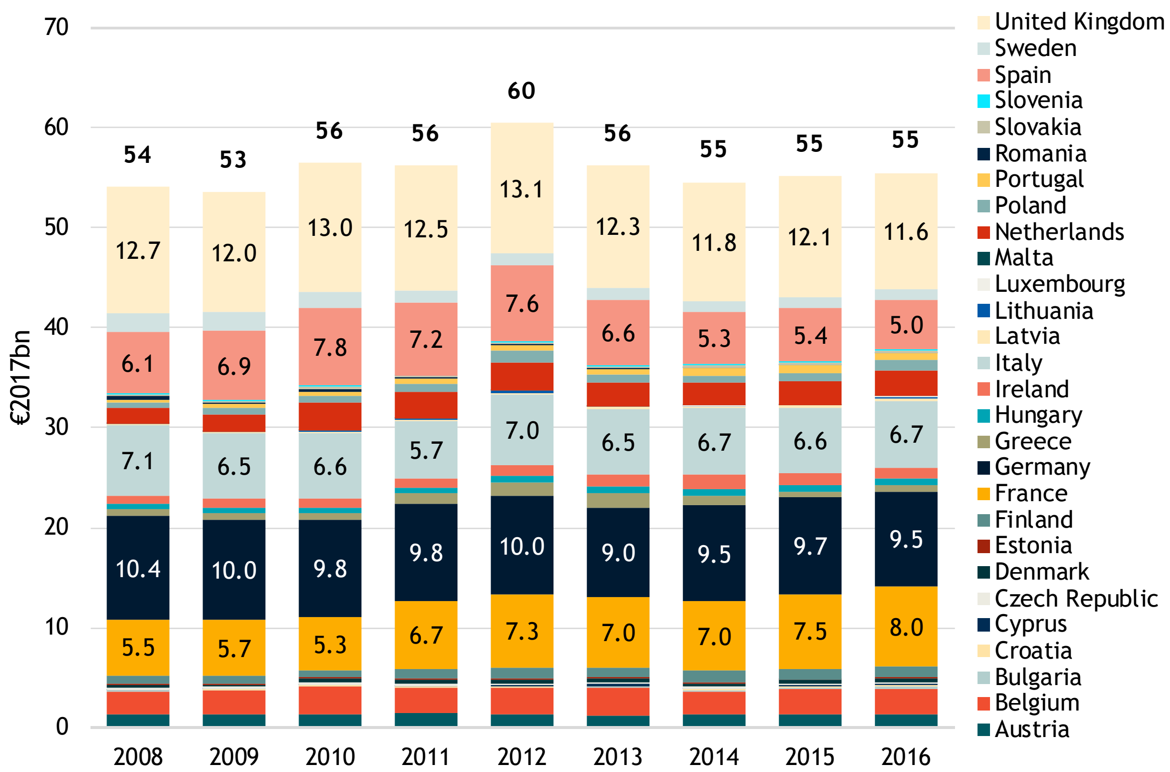
Figure 6-15: Financial support for fossil fuels - split by transport type (2008-2016, €2017bn)



Source: Own calculations based on interventions database

The United Kingdom is the largest provider of subsidies to fossil fuels with €11.6 bn accounting for 21% of the total amounts in 2016, followed by the Germany (€9.5bn, 17%), France (€8 bn, 15%), Italy (€6.7 bn, 11%), Spain (€5 bn, 9%), Belgium and the Netherlands (€2.6, 4%, each) (Figure 6-16).

Figure 6-16: Financial support to fossil fuels by country (2008-2016, €2017bn)



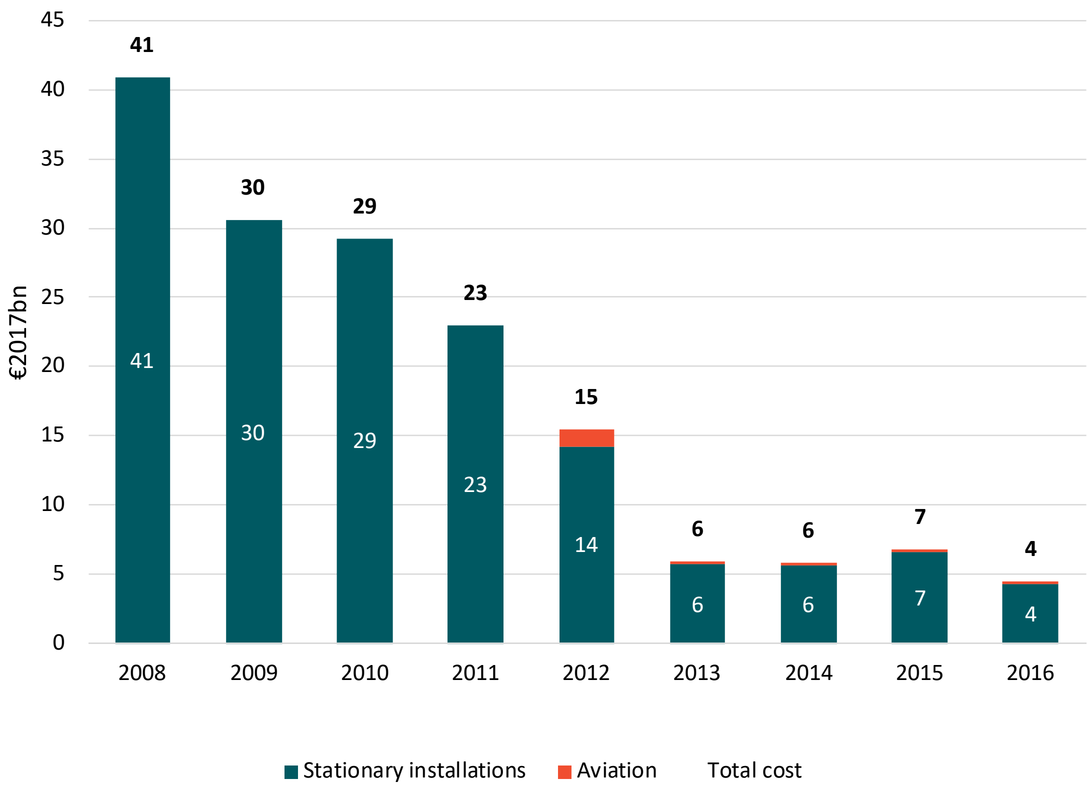
Source: Own calculations based on interventions database

We will now look at the historically most important interventions in terms of amounts which encourage the transition to the low carbon energy system: those related to ETS and RES.

ETS-related allocation of free allowances has significantly decreased

The estimated costs of the ETS allowances, given for free, fell almost tenfold over the period from €41bn in 2008 to €4bn in 2016 (in 2017 prices)), including the aviation sector introduced in 2013 (Figure 6-17).

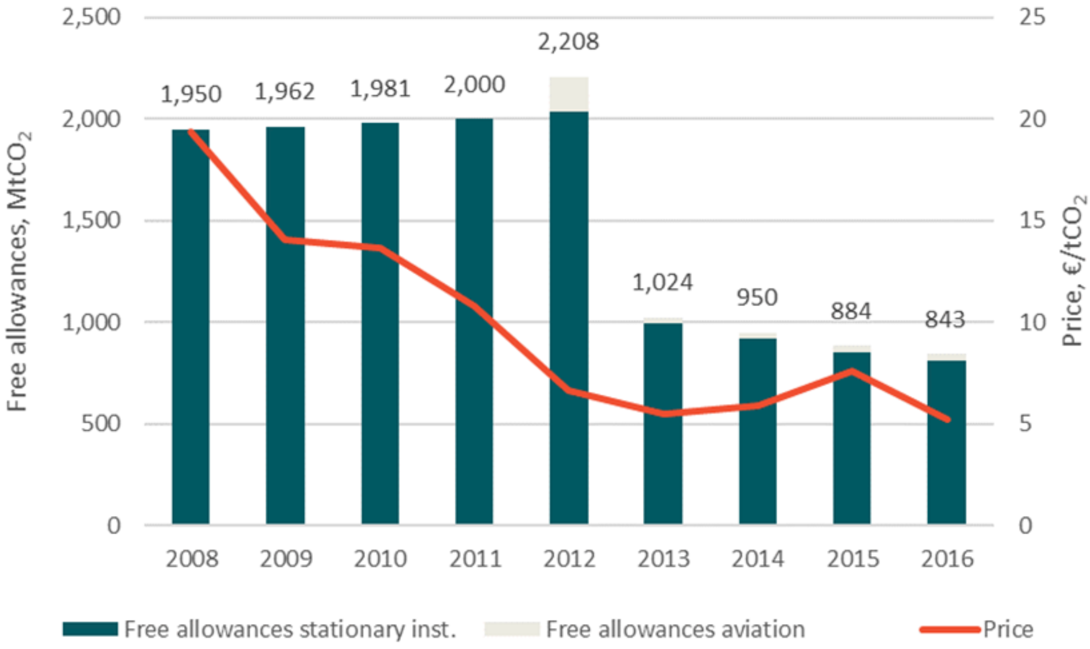
Figure 6-17: Estimated costs of free ETS allowances (2008-2016, €2017bn)



Source: Own calculations based on interventions database

Indeed, the effects of a strong reduction of the EUA prices (from €19.4/tCO2 in 2008 to €5.2/tCO2 in 2016) combined with the increased limits on free allocation of emission allowances has driven a reduction of €36.5bn in costs over the period (Figure 6-16). Between 2008 and 2012, the reduction was driven by the EUA price reduction, while the amount of free allowances was reduced drastically from 2012 to 2013; after that, the free allowances have continued to slowly decline.

Figure 6-18: Volumes of free ETS allowances and average annual prices (2008-2016, €2017bn)



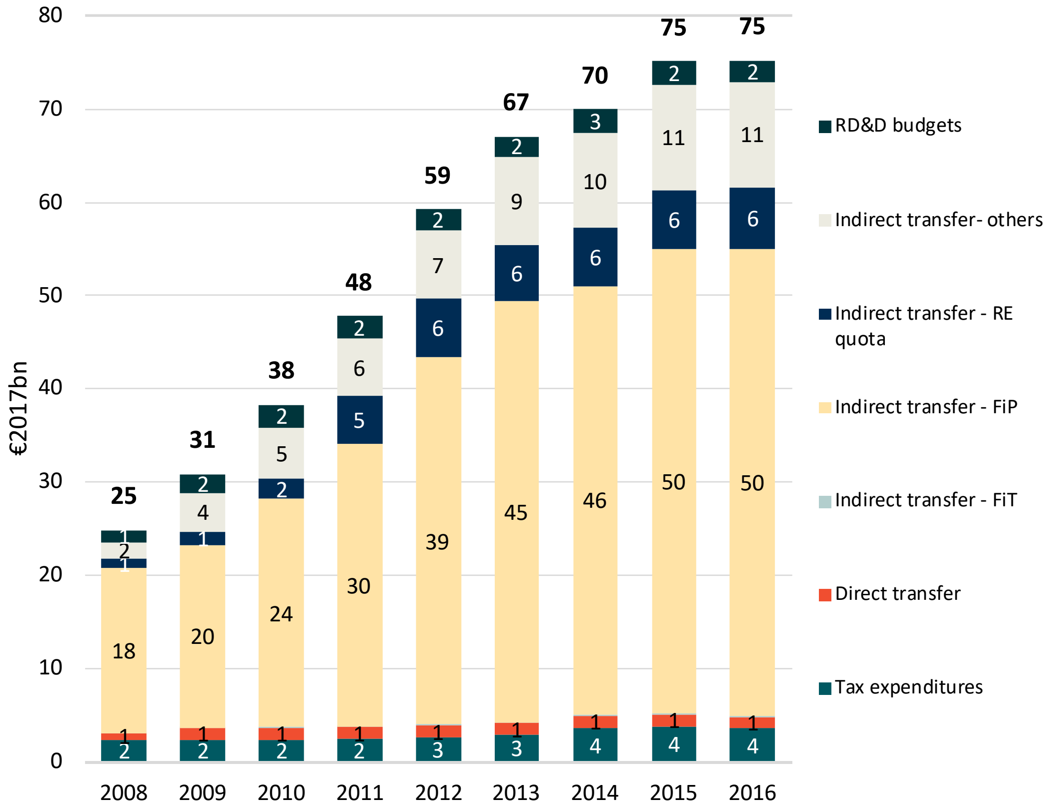
Source: Own calculations based DG CLIMA

Support to RES increased in line with the EU's climate and energy objectives

Financial support to renewable energy sources has tripled over the period, from €29bn in 2008 to €75bn in 2016 (in 2017 prices), in line with EU's 2020 renewable and climate goals (Figure 6-19). The increase may be split in two periods: the first from 2008 to 2012 that shows a fast increase in expenditures (+€32bn, +110%); the second, from 2012 to 2016, shows a dramatic slowdown of the increase (+€17bn, +28%). During the same time, power generation capacity using RES technologies almost doubled from 240 GW in 2008 to 450 GW in 2016 (Figure 6-20). Several reasons can explain the slowdown: the halt in the support of new or existing contracts (for instance in Spain since 2012, in Italy in 2014 for PV, etc.), the reductions in new contracts for Feed-in-Tariff (FiT) and Feed-in-Premium (FiP) triggered by the fall in costs (mainly for the solar PV technology), new regulations introducing the concept of "development corridors" to control the development of the installed capacities.

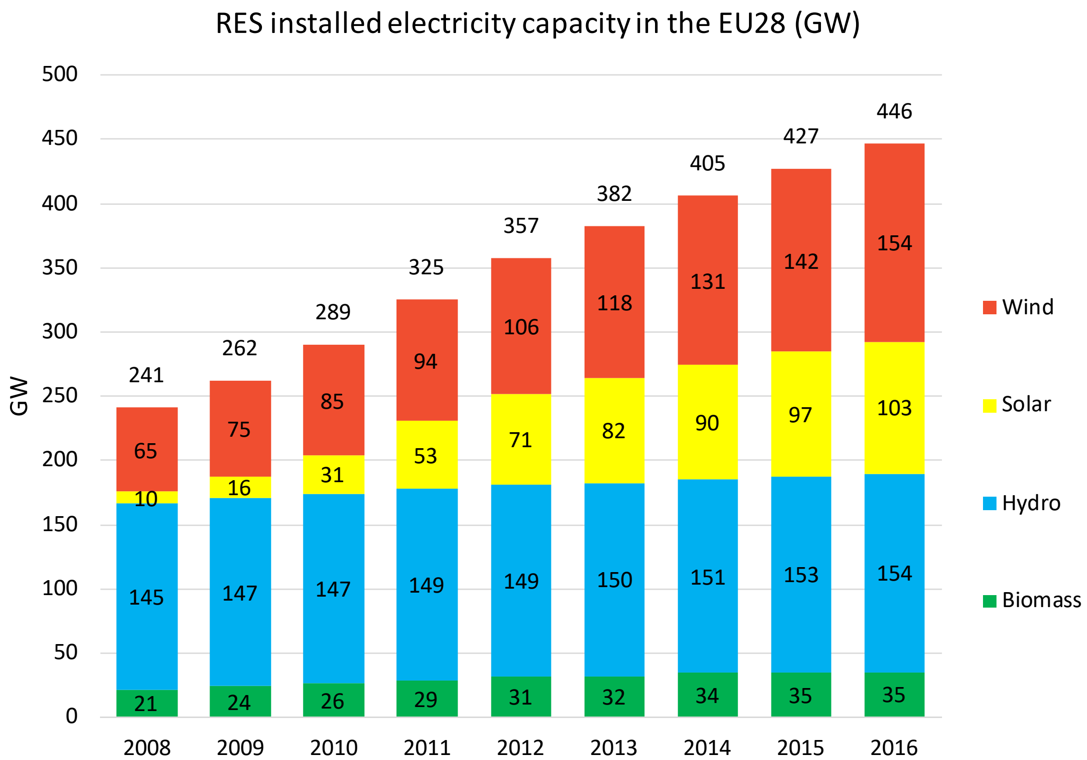
Conversely, the decline in wholesale prices in the power market in Europe over the same period (see also chapter 3) has driven the amount of subsidies upward by increasing the difference between the wholesale price and the FiT contracts, the latter being fixed. It is noteworthy that financial support for RES has been stable from 2015 to 2016 (see figure 6-19) while the installed RES capacity has continued to increase as in the years before (see figure 6-20). This indicates a RES growth trend based on cost reductions of RES technologies combined with the diffusion of more cost-efficient policies such as reverse-auction mechanisms for large installations.

Figure 6-19: Financial support to RES by intervention type (2008-2016, €2017bn)



Source: Own calculations based on interventions database

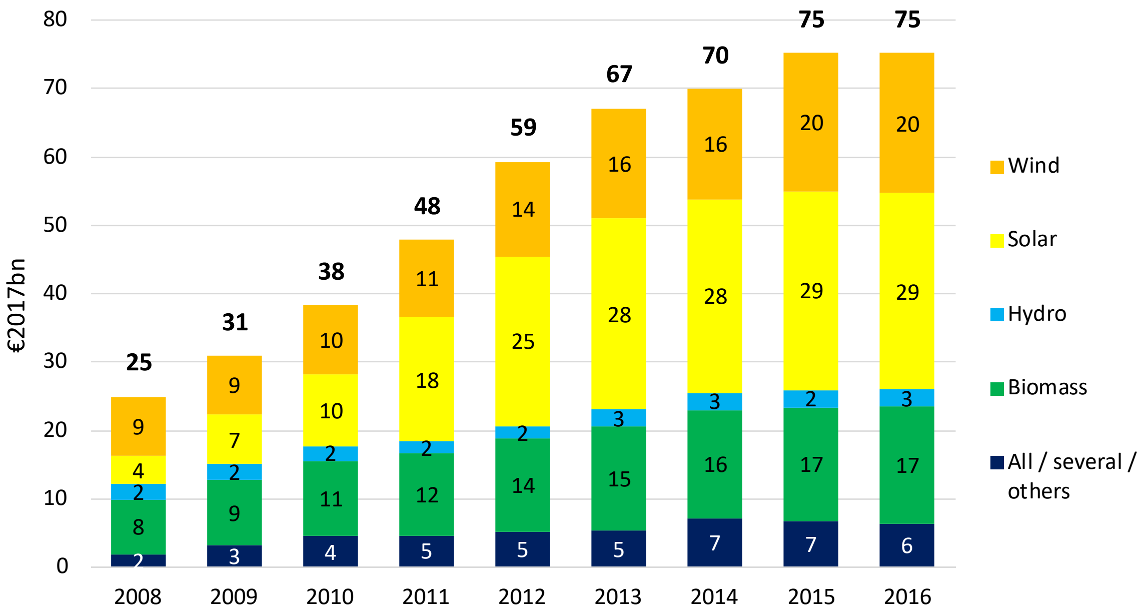
Figure 6-20: Development of renewable power generation installed capacity (2008-2016, GW)



Source: Own calculations based on interventions database

Solar and wind energy sources received most of the financial support representing 37% and 26%, respectively, of the total amounts disbursed in 2016 (see figure 6-21). As a result of policy changes and the cost reductions in the solar PV sector and policy adjustments, the total volume of support to this technology has stabilised in the EU since 2013. Since then, wind technology attracts most of the additional subsidies.

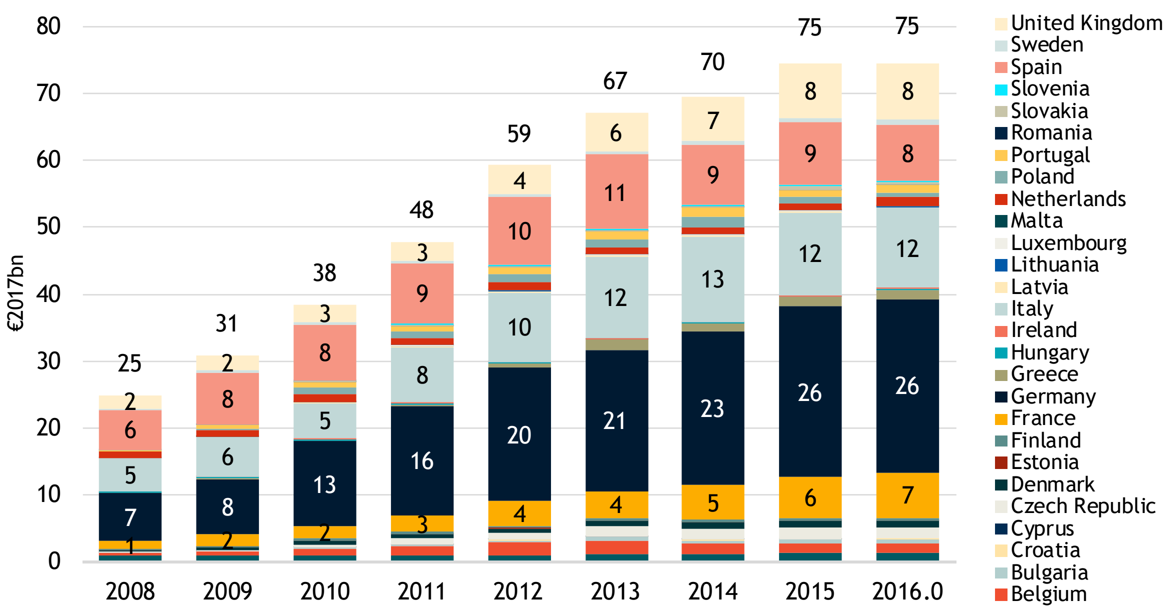
Figure 6-21: Financial support to RES by energy source (2008-2016, €2017bn)



Source: Own calculations based on interventions database

As shown in figure 6-22 among the countries providing the largest amounts to the development of the renewable technologies Germany ranks first (+€18.6bn increase), followed by Italy (€7.1bn), the United Kingdom (€6.4bn), France (€4.6bn) and Spain (€2.4bn).

Figure 6-22: Financial support to RES by energy source (2008-2016, €2017bn)

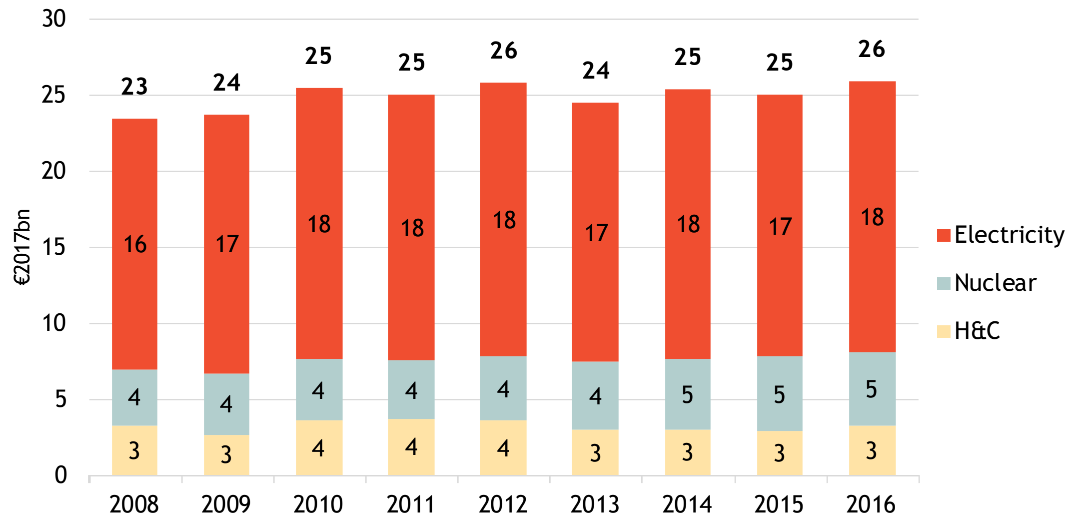


Source: Own calculations based on interventions database

Support for other energies than fossil fuels and RES are rising very slowly

The financial support received by energy and technologies other than fossils fuels, ETS related support and RES, i.e. the support to heating and cooling technologies, nuclear and electricity (irrespective of the technology used to produce it) has slightly increased from €23bn to €26bn (in 2017 prices) – see figure 6-23. The amounts dedicated to nuclear and electricity have increased by 28% and 8%, respectively, while amounts directed to heating and cooling technologies remained stable over the period

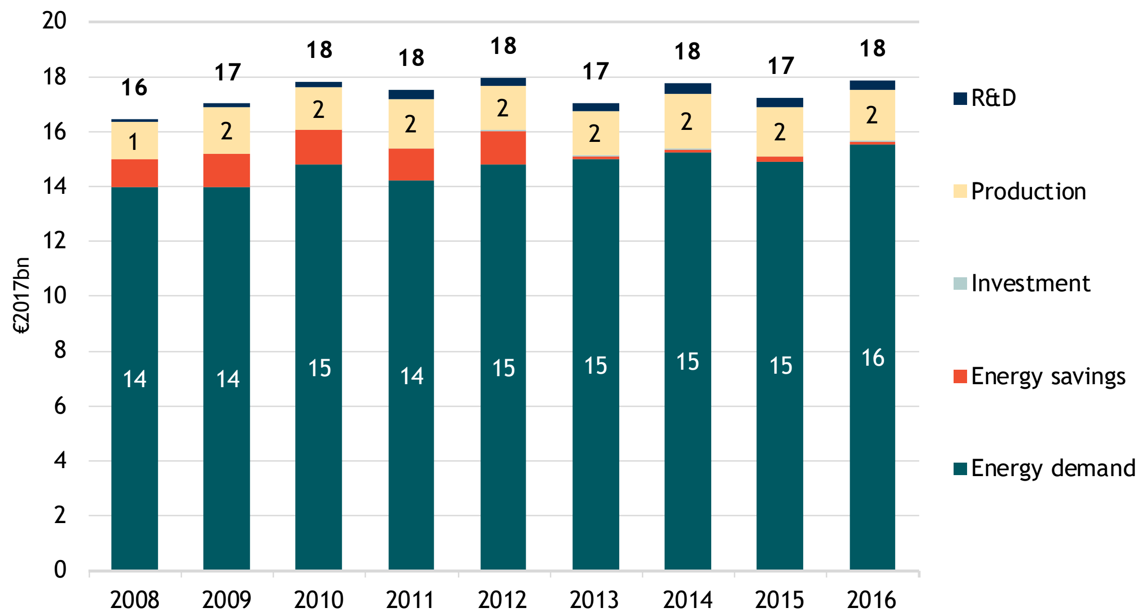
Figure 6-23: Financial support for non-fossil fuels and RES energy source (2008-2016, €2017bn)



Source: Own calculations based on interventions database

Close to 80% of financial support related to electricity (irrespective of the technology used to produce it) takes the form of tax expenditure that are mostly used to stimulate power demand, while around 11% of the financing support power generation (see figure 6-24).

Figure 6-24: Financial support for electricity by intervention type (2008-2016, €2017bn)



Source: Own calculations based on interventions database

Energy subsidies in Norway and Switzerland

As part of the extension of the inventory, we have looked at financial supports to energy related purposes in two major European partner countries, namely Norway and Switzerland.

The two countries have large differences but also similarities in their energy profiles, on the one-hand Norway being a large oil and gas producer while Switzerland does not have any of its own fossil fuel resources; whilst on the other hand both source major shares of their electricity production from hydropower, e.g. >99% in Norway and around 60% in Switzerland. Despite the difference in domestic fossil resources most of the energy subsidies identified in our research go to fossil fuels in both countries. Although it should be noted that the subsidy database for these countries is not exhaustive and other relevant subsidies may be missing from the estimates.

Norway, through its intervention called “Investment Deductions in Petroleum Resource Tax”, supports investments in its oil and gas exploration and production sector for over €2 bn in 2016 (at current prices 2017), representing 75% of the subsidy amounts inventoried in 2016 in the country.

Switzerland’s largest energy subsidies programmes takes the form of forgone tax revenue on the excise and CO_2 taxes for various sectors amounting to close to €0.7 bn in 2016, representing 38% of the country’s total subsidy inventory. Support to RES accounted for 32% of the support in that year (€0.6 bn).

Summary of subsidies analysis

Thanks to robust a methodology combined with an efficient network of experts, the update of the previous inventory, as well as its extension to the agriculture and transport sectors, enables the reader to have a better overview of energy related financial supports distributed in the European Union. Although, the coverage of the subsidies has not been fully exhaustive, mainly due to issues with availability of the information, one of the main findings is that annual financial supports have increased over the nine years covered from €150 bn in 2008 to €168 bn in 2016 (+€18 bn, in 2017 constant prices), representing a 12% increase. In total, the cumulative financial support to energy-related purposes represented around €1,450 bn. Most of these amounts (close to 90%) have been directed to the production and the consumption of energy, while subsidies for R&D, investments and energy savings together represent only slightly over 10% of the overall amounts in 2016.

Although EU has committed to phase out fossil-fuels subsidies, the current inventory delivers an opposite direction since financial support to these energy sources have increased by 3% (+1.4 bn) between 2008 and 2016 to €55 bn (in 2017 prices). Conversely, efforts by the MS to make the EU the renewable energy world leader is noticeable with financial support to renewable energy sources that has tripled over the period to €75bn in 2016 (in 2017 prices). Noteworthy, the rise of financial support has significantly slowed down as from 2013 while the installed RES capacity has continued to increase, which could reveal a reversing trend resulting from cost reductions of RES technologies combined with more cost-efficient policies supporting the development of renewable technologies.

6.4 Impacts of energy subsidies on gas and electricity prices

The purpose of this sub-task was to estimate the average impact of energy subsidies on gas and electricity prices for energy-intensive industries, other industries and households in the EU.

We estimate the impact of energy subsidies in the EU on gas and electricity prices in cases where:

- we have data showing the value of the subsidy in each year over the period 2008-2016 (or a robust estimate has been made for the value of the subsidy over the period 2008-2016); and
- the subsidy is likely to have had a significant impact on retail gas or electricity prices over the period 2008-2016.

Subsidies are not included for the energy price analysis in cases where there is insufficient data on the value of the subsidies or where there is high uncertainty around any estimates that have been provided. Furthermore, if, following initial data analysis, there is reason to believe that the impact on retail gas or electricity prices is negligible (for example if the subsidy targets fuels other than gas and electricity or targets energy producers), then these subsidies were not included in the scope of the analysis.

While some energy subsidies affect energy prices directly, other subsidies have indirect impacts on wholesale and retail energy prices. Our approach for this task involves estimating both direct and indirect impacts of quantifiable energy subsidies on gas and electricity markets in the EU. The subsidies were grouped for presentational purposes and results are presented as average impacts for:

- Prices and energy demand variables;
- Gas and electricity energy carriers;
- Households and industry sectors.

To take account of the different channels through which subsidies can affect energy prices, the energy subsidies were categorised into three groups:

- Tax exemptions and reductions;
- Loans, grants and other lump-sum payments;
- Subsidies on energy production.

6.4.1 Tax exemptions and tax reductions for final consumers

The first set of subsidies comprise tax exemptions and reductions on gas and electricity, including price guarantees, as well as relief from excise duty, and other taxes levied on final energy consumers, such as VAT (in the case of households) or levies related to climate and renewables. These types of subsidies represented one third of the total number of energy interventions in the EU for which data was collected[183].

Energy tax exemptions and reductions exist in some EU countries to mitigate energy consumers' exposure to rising energy prices and they directly impact on the energy prices faced by these groups, with the potential to trigger wasteful consumption or at least supress energy savings.

To calculate the impact of these tax exemptions on final prices paid by different energy consumer groups, data for the value of spend on these tax relief policies (in euros) is divided by fuel consumption

[183] Refer to Figure 6-4 and **Error! Reference source not found.**, which show that tax rebate policies represent 33% of the total number of energy subsidies and around 40% of the total EU expenditure on energy subsidies.

data for the broad energy consumer groups which are eligible to receive the subsidy. This calculation is broken down and explained in more detail in the following box-text.

Estimating the impact of tax exemptions and reductions on gas and electricity prices

To calculate the average impact of tax exemptions on industry and household electricity and gas prices, we take the following steps:

1. Sum policy-level data from the subsidies and interventions database on the value of energy tax exemptions or energy tax reductions, to derive the total value of tax rebates by consumer group, by Member State and by fuel type (in million euros)
2. Aggregate the data to a high-level consumer group classification (namely: energy intensive industries; other industry; households).
3. Collate data on energy consumption (by fuel type and Member State) for these broad consumer group categories
4. Divide total policy expenditure (in euros) by total fuel consumption (in MWh) to derive an average tax reduction per consumer group, per Member State and per fuel (in € per MWh)
5. In cases where the tax rebate is applied to multiple consumer groups and/or multiple fuel types, the rebate is shared out by consumer group and fuel according to the relative share of total energy consumption that each accounts for.

Below we present example calculations for the tax exemptions and reductions on electricity for energy intensive industries in France in 2016 and for households in the Netherlands in 2016.

Energy intensive industries in France

Over the period 2008-2016, energy-intensive industries in France benefitted from four different electricity tax exemptions or reductions (as outlined in Table 6-4). In aggregate, the value of these policies summed to €550m in 2016.

Table 6-4: Excerpt from the subsidies and interventions database - electricity tax exemptions and reductions for energy intensive industries in France

ID	Name of Policy	NACE_2	Value 2016 (€m)
268	Exemption of TICFE (Taxe Intérieure sur la Consommation Finale d'Électricité)	C_Energy_intensive_manufacturing_industry	0
270	Reduced CSPE (contribution au service public de l'électricité) for electro-intensive industrial installations that are exposed to a significant risk of carbon leakage	C_Energy_intensive_manufacturing_industry	150
271	Reduced CSPE (contribution au service public de l'électricité) for hyperelectro-intensive installations	C_Energy_intensive_manufacturing_industry	85
272	Reduced CSPE (contribution au service public de l'électricité) for electro-intensive industrial installations	C_Energy_intensive_manufacturing_industry	320

These subsidies are not defined at the sectoral level and so it is not possible to assess the impact on industries at the sectoral level. Instead we estimate the impact of these subsidies on the *average* energy-intensive industry.

For energy intensive industry energy consumption (the denominator in our calculation), we define energy intensive industry as the following fuel users:

- Iron and steel
- Non-ferrous metals

- Chemicals
- Non-metallic minerals
- Ore-extraction (non-energy)
- Paper and pulp

Electricity demand in France for these sectors in 2016 sums to 56TWh. To derive the average tax reduction for electricity consumed by the average energy intensive in France (as defined above), we divide €550m by 56TWh to get €9.74/MWh.

To put this figure into context for a representative plant, we use industrial energy price data from Eurostat[184] for band IE (consumption between 20GWh and 70GWh):

Table 6-5: Components of final electricity prices for representative energy-intensive plant

	A. Wholesale Price (excl. all tax)	B. Tax (excl recoverable tax)	C. Retail price (excl. recoverable tax) = A+B	D. Estimated tax exemption	E. Scale of tax rebate (relative to price) = D/(C+D)
2016 €/MWh	56.5	8.3	64.8	9.7	13%

Source: Eurostat, CE calculations

Households in the Netherlands

In the Netherlands, households benefit from a reduction in energy taxes. The value of this subsidy in 2016 was €2.5 bn and the subsidy is applied to consumption of all fuel types. To calculate the net impact on the retail gas and electricity price faced by households, the value of the subsidy is divided among the fuels, according to their shares in total household energy consumption. From this calculation we can obtain the total value of the subsidy for households (by fuel type). The value is then divided by household consumption of each fuel type, to derive the impact on final retail energy prices (in €/MWh)[185]. In the Netherlands, electricity represents 23% of energy consumption by households and gas represents 70% of household energy consumption. In this case, we assume that €0.57bn (23% x €2.494bn) is support for household electricity consumption and €1.76bn (70% x €2.494bn) is support for household gas consumption. In 2016, residential electricity consumption in the Netherlands was 24.4TWh and gas consumption was 75.5TWh. Therefore, the impact on retail electricity prices for households was estimated as -€23.3/MWh (1000*€0.57bn/24.4TWh) and the impact on retail gas prices for consumers was also estimated as -€23.3/MWh (1000*€1.76bn/75.5TWh).

[184] Electricity prices for non-household consumers - bi-annual data (from 2007 onwards) [nrg_pc_205]

Sector mappings

Table 6-6: Mapping from sectors defined in subsidies database to aggregated fuel user (for charts presented in this chapter of the report)

NACE sector (from subsidies database)	Aggregate Fuel User (for charts)
Cross_sector	All
C_Manufacturing	All Industry
C_Energy_intensive_manufacturing_industry	Energy Intensive industry
C20_chemicals_and_chemical_products	Energy Intensive industry
C22_rubber_and_plastic_products	Energy Intensive industry
C23_other_non_metallic_mineral_products	Energy Intensive industry
C24_basic_metals	Energy Intensive industry
F_CC11_Residential_buildings	Households
F_CC11-Residential buildings	Households
HH_Households	Households
A_Z_All_sectors	Other industry
Z_Non_households	Other industry

Note: For sectors marked as 'All' or 'All industry', these policies are split across all relevant fuel users. For example 'All Industry' sectors would be shared between energy intensive industries and other industry based on fuel demand shares in those sectors.

Table 6-7: Mapping energy consumption data by industry sector to aggregate fuel user (for charts presented in this chapter of the report)

Aggregate Fuel User (for charts)	Industry sector
Energy Intensive	Iron and steel
	Non-ferrous metals
	Chemicals
	Non-metallic minerals
	Ore-extraction (non-energy)
	Paper and pulp
Other Industry	Food, drink and tobacco
	Textiles, clothing & footwear
	Engineering etc
	Other industry
Households	Households

This high-level approach to estimating the impact of energy subsidies on retail gas and electricity prices (in €/MWh) involves simplifications that should be considered when interpreting the results in this section of the report. In the case of energy-intensive industries, the total value of the subsidy is divided by energy consumption across a broadly-defined energy-intensive industry group (see Table 6-7). The results therefore represent an estimate of the *average* subsidy (in €/MWh) across all energy intensive industry sectors. If only certain energy-intensive plants or processes are eligible for the tax rebate, we would under-estimate the true value of the subsidy to those specific plants and process because the denominator in our calculation includes a wider group of energy-intensive industry sectors (see Table 6-7) and the results reflect the (energy consumption) weighted-average impact on this broadly-defined group[186]. Similarly, for households and other industry/services, the subsidies may only apply to certain specific energy uses, or to certain consumer groups (e.g. those at risk of fuel poverty). Our approach does not isolate these impacts on specific consumer groups but calculates the average impact across a more broadly defined group of energy consumers, namely:

- Energy-intensive industry;
- Other industry/services;
- All households.

Energy-intensive industry

Tax relief for energy-intensive industries supports at-risk sectors to remain competitive in world markets by reducing the risk of production moving off-shore to regions with lower energy costs. By reducing cost-pressures from policies to promote low-carbon investments firms benefit, but on the downside, such tax relief can stifle energy and/or emission-saving innovations.

Over the period 2008-2016 robust data for tax relief on energy consumed by energy-intensive industry sectors was found for the following Member States:

- Austria (electricity and gas);
- Bulgaria (gas);
- Finland (electricity and gas);
- France (electricity and gas);
- Germany (electricity and gas);
- Greece (electricity);
- Latvia (gas);
- Lithuania (electricity);
- Netherlands (electricity);
- Slovenia (electricity);
- Sweden (gas and electricity);
- UK (gas and electricity).

In many of these cases, tax exemptions only existed for certain industry sectors or processes that were particularly energy-intensive (e.g. mineralogical and metallurgical processes), those sectors for which energy tax payments account for over a certain share of value added and those sectors that are identified as being at risk of carbon leakage. The energy-intensive industry sectors that are eligible for support are a heterogenous group and the industrial sectors or processes that are eligible for tax relief differ across the listed Member States. For practical and presentational purposes, the charts below show the weighted-average impact of energy tax exemptions and reductions across a selected list of energy-industry sectors (defined at NACE 2-digit level)[187]. It is noted that some energy-intensive sectors may be eligible for higher levels of support than others (in which case the results presented here underestimate the true scale of the subsidy in €/MWh), while other industrial processes may not be eligible for any

[186] The energy-intensive definition used here includes the following industries: Iron and steel; Non-ferrous metals; Chemicals; Non-metallic minerals; Ore-extraction (non-energy); Paper and pulp. These industries are selected because they are the most energy intensive and include sub-sectors with energy intensity greater than 0.5 toe/€1,000 EUR GVA (see Section 4.4). We would expect energy consumption by many plants and processes within these industry sectors to fall into electricity consumption bands ID-IG (consuming over 2,000 MWh electricity pa) and/or gas consumption bands I4-I6 (over 100,000 GJ gas pa).

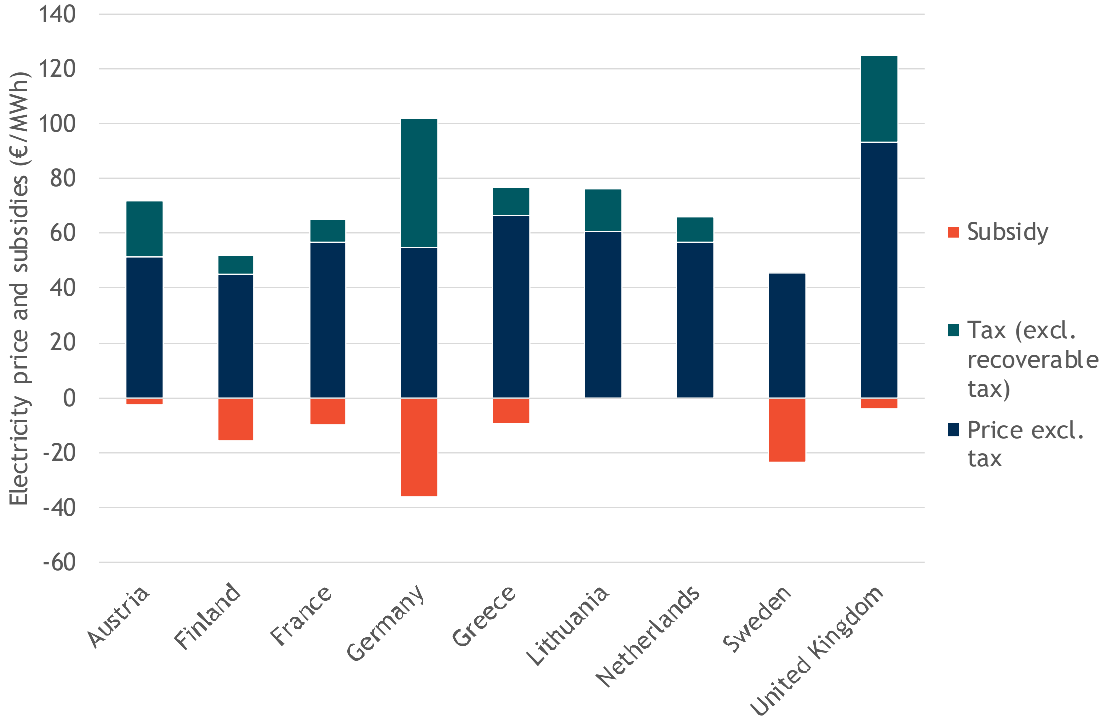
[187] The energy-intensive definition used here includes the following industries: Iron and steel; Non-ferrous metals; Chemicals; Non-metallic minerals; Ore-extraction (non-energy); Paper and pulp. These industries are selected because they are the most energy intensive and include sub-sectors with energy intensity greater than 0.5 toe/€1,000 EUR GVA (see Section 4.4). We would expect energy consumption by many plants and processes within these industry sectors to fall into electricity consumption bands ID-IG (consuming over 2,000 MWh electricity pa) and/or gas consumption bands I4-I6 (over 100,000 GJ gas pa).

support. The subsidy estimates should be interpreted with the caveat that they reflect *average* impacts (in €/MWh) across a large number of industry sectors.

Figure 6-25 and Figure 6-26 below show the scale of tax reductions and exemptions for the average energy-intensive industry (in orange). Data for final electricity and gas prices are not available for the 'average energy-intensive industry', so the electricity and gas price and tax data in the charts instead show prices faced by a representative benchmark energy-intensive plant. In this case, the benchmark industrial plant is assumed to consume 20,000 MWh – 70,000 MWh electricity pa (band IE) and 1,000,000 GJ – 4,000,000 GJ gas pa (band I5). It is important to note that not all energy-intensive sectors fall into these consumption bands and not all sectors in these consumption bands are energy-intensive. This sectoral benchmark level of consumption is used for illustrative purposes only.

The stacked bar charts presented below and in subsequent sections show the impacts of tax reductions and exemptions on gas and electricity prices faced by final energy consumers. The height of the stacked bar reflects the price of energy paid by final consumers after taking account of tax relief. The final energy price faced by each consumer group is the sum of the wholesale and distribution component (the dark blue bar) and the tax component (the green bar). The orange bar reflects the value of the subsidies that would otherwise be paid by final consumers, if no tax exemptions or reductions were available. In the case of Finland, for example, the average electricity price (excl recoverable tax) faced by energy-intensive sectors consuming 20,000 MWh – 70,000 MWh in 2016 was €51.9. We estimate that tax relief on energy-intensive sectors in Finland reduced the average electricity tax paid by €16.0/MWh in 2016. Therefore, if there was no tax relief, we estimate that the electricity price faced by industrial consumers in electricity consumption band IE would have been €66.9/MWh.

Figure 6-25: Effect of tax relief on average energy-intensive industry electricity prices in 2016 (€/MWh, current prices)



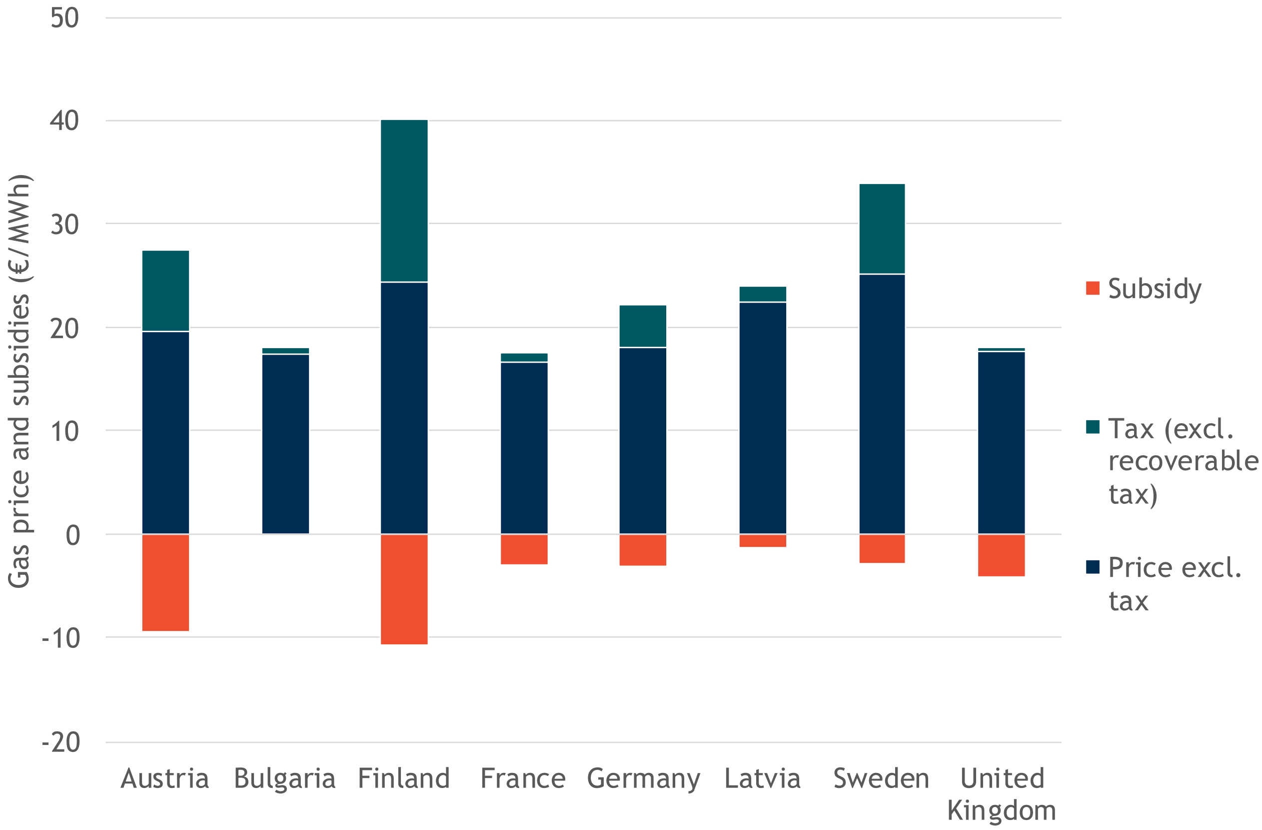
Source: Eurostat, subsidies database, own calculations.
Note: Subsidy value in €/MWh is estimated based on data for the value of the subsidy (in €millions) divided by energy-intensive industry sector energy consumption. Price and tax components reflect data for a benchmark industry with electricity consumption within Band IE (20,000 MWh – 70,000 MWh pa)

Table 6-8: Effect of tax relief on electricity prices faced by the average energy-intensive industry (€/MWh, current prices)

	2008	2009	2010	2011	2012	2013	2014	2015	2016
Austria	-6.7	-6.3	-6.4	-6.5	-3.8	-3.4	-3.1	-3.0	-2.8
Finland	-6.0	-6.2	-6.0	-9.4	-9.5	-9.8	-12.2	-15.6	-16.0
France	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-9.7
Germany	-37.2	-45.5	-44.7	-38.9	-49.1	-27.4	-37.5	-36.4	-36.0
Greece	-8.3	-7.6	-9.1	-12.6	-14.8	-14.7	-13.0	-11.7	-9.3
Italy	0.0	0.0	0.0	-0.1	-0.1	-0.2	-0.3	-0.2	0.0
Lithuania	0.0	0.0	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Netherlands	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.2	-0.3	-0.3
Slovenia	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	-0.1	0.0
Sweden	-23.0	-21.9	-24.1	-25.4	-27.4	-27.2	-24.3	-24.1	-23.3
United Kingdom	-2.3	-2.4	-1.7	-1.4	-2.3	-2.6	-3.6	-4.0	-3.9

Source: Own calculations
Note: Results presented for Member States where data is available (or estimates have been made) and where the average value of the subsidy is greater than 0.05 €/MWh.

Figure 6-26: Effect of tax relief on average energy-intensive industry gas prices (€/MWh, current prices)



Source: Eurostat, subsidies database, own calculations.

Note: Subsidy value in €/MWh is estimated based on data for the value of the subsidy (in €millions) divided by energy-intensive industry sector energy consumption. Price and tax components reflect a benchmark industry with gas consumption within band I5 (1,000,000 GJ – 4,000,000 GJ pa).

Table 6-9: Effect of tax relief on average energy-intensive industry gas prices (€/MWh, current prices)

	2008	2009	2010	2011	2012	2013	2014	2015	2016
Austria	-12.3	-14.5	-13.6	-13.7	-12.4	-11.4	-11.1	-10.2	-9.5
Bulgaria	-0.5	-0.6	-0.6	-0.6	-1.1	-1.1	-0.8	-0.6	-0.2
Finland	-0.3	-0.3	-0.3	-0.3	-3.3	-7.2	-10.5	-10.3	-10.8
France	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-1.3	-3.0
Germany	-2.9	-3.5	-3.3	-3.2	-3.4	-3.1	-3.3	-3.2	-3.1
Latvia	0.0	0.0	0.0	0.0	-2.4	-2.1	-1.5	-1.5	-1.4
Slovenia	0.0	-2.1	-2.0	-1.8	-1.4	-1.4	-1.1	-1.9	-1.5
Sweden	-17.8	-17.7	-5.4	-5.5	-6.0	-7.4	-7.5	-4.6	-2.8
United Kingdom	-2.4	-2.5	-1.8	-1.6	-2.4	-2.7	-3.8	-4.3	-4.1

Source: Own calculations

Note: Results presented for Member States where data is available (or estimates have been made) and where the average value of the subsidy is greater than 0.05 €/MWh.

The impacts of energy tax relief on average electricity prices faced by energy-intensive industry sectors over this period were largest in Germany, where firms using certain energy-intensive manufacturing processes receive privileges worth an estimated €36/MWh to the average energy-intensive industry sector in 2016. Other Member States with notable industry tax exemptions and rebates included: Sweden, where there was an energy tax reduction for electricity used in manufacturing processes; Finland, where energy-intensive firms have the right to apply for a tax refund of up to almost 85% if energy tax payments exceed 0.5% of value added in the firm; and Austria, where the *Energieabgabevergütungsgesetz* entitles energy-intensive companies to a refund of energy taxes paid in excess of 0.5% of their net production value. In the case of Sweden and Finland, the value of the subsidy was estimated to be €23.3/MWh and €16.0/MWh, respectively, in 2016, while in Austria, the tax relief was lower (at around €2.8/MWh). In Greece, there are price guarantees for electricity consumers on islands to pay a similar electricity price to electricity consumers on the mainland, even though the cost of power generation on the islands is much higher. France is an interesting case, where several support measures for electro-intensive industry have been introduced in recent years. These measures include exemption of the electricity consumption tax, TICFE (*Taxe Intérieure sur la Consommation Finale d'Électricité*), which has been available since 2011, and reduced rates of contribution to the public electricity service (CPSE), which was only recently introduced, in 2015/2016.

In the UK, some of the most energy-intensive manufacturing processes are eligible for a Climate Change Agreement (CCA), which entitles them to a discount on the Climate Change Levy that is otherwise charged on industry gas and electricity consumption. The value of this support to the average energy-intensive industry sector has increased gradually over the period since 2008, as most industry associations sign-up to the CCAs. In 2016, industrial energy consumers with a CCA were entitled to a 90% reduction to the rate of CCL that is applied to electricity purchases and a 65% reduction to the rate of CCL that is applied to consumption of other fuels. From April 2014, energy consumed by mineralogical and metallurgical processes in the UK became completely exempt from the CCL.

Tax exemptions on consumption of fossil fuels for energy-intensive industries also existed in Austria and Finland. We estimate the value of these subsidies to the average energy intensive industry reached 9.5 €/MWh gas consumption (in Austria) and €10.8/MWh gas consumption (in Finland) in 2016. Lower value tax rebates were available for energy intensive-industries' consumption of natural gas in France, Germany, Latvia, Slovenia, Sweden (in each case, estimated to be worth around €1- €3 per MWh of gas consumption in 2016).

In most cases, the current price value of the energy subsidies has not substantially changed over time, as tax rebates have been continued over the entire period. There are a few exceptions to this. In Sweden, there was a relatively large tax relief available for energy-intensive sector gas consumption in 2008 (of around €19/MWh in 2008), but the value of carbon dioxide tax-relief on industry heating fuels was substantially reduced in 2012 and, since 2012, there has been a further, more gradual decline in the level of support available. By contrast, in Finland, the value of the energy tax refund for energy-intensive industry consumption of gas has increased three-fold between 2012-2016.

Other industry and services

Energy subsidies are less common for other sectors that have a lower energy intensity. These sectors are less exposed to energy cost pressures that reduce international competitiveness and, so are less at risk of carbon leakage. In this section, we present our estimates of the *average* impact of tax relief in each Member State across all non-energy-intensive industry[188].

For these other, less energy-intensive sectors, robust data for energy tax relief over the period 2008-2016 was found for the following Member States:

- Bulgaria (gas);
- Denmark (electricity);
- Finland (electricity);
- Germany (gas);
- Greece (electricity);
- Latvia (gas);
- Lithuania (electricity);
- Netherlands (gas);
- Slovakia (electricity and gas);
- Slovenia (gas);
- Sweden (electricity and gas);
- United Kingdom (gas).

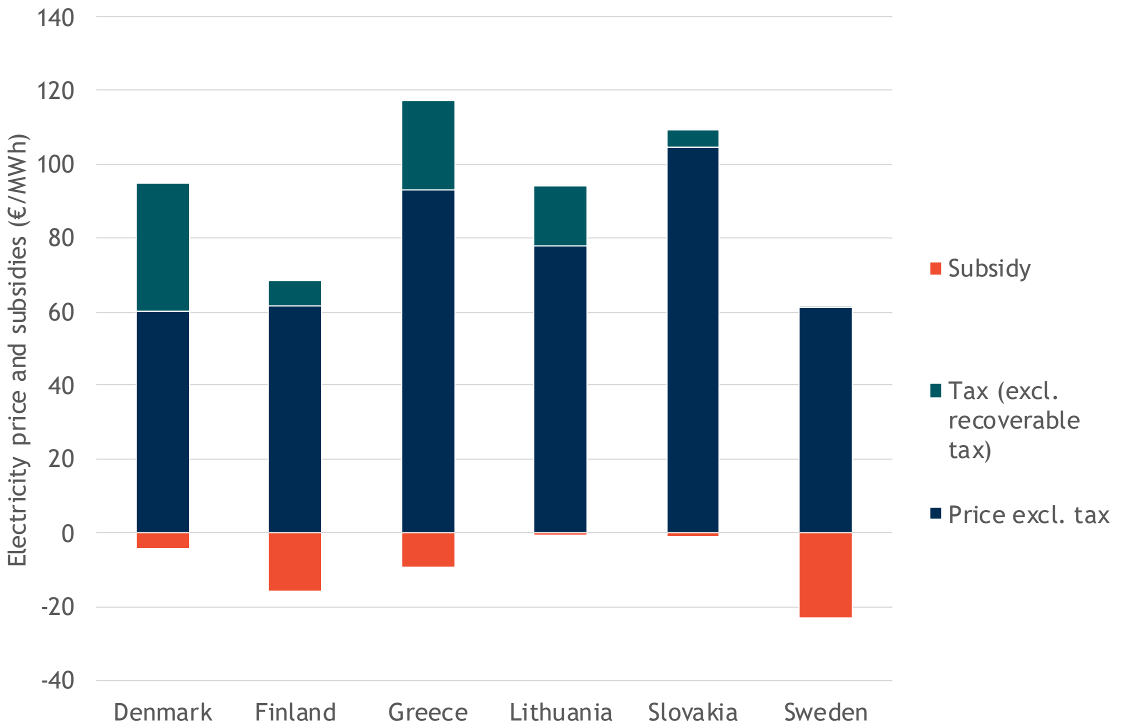
These less energy-intensive sectors typically face higher energy prices, as they are not able to access the same price discounts as larger energy consumers. Furthermore, for these industry sectors, the impact of energy subsidies on energy costs are considerably more modest (in most cases, less than €2/MWh). These sectors are typically less protected, as they are at less risk of carbon leakage.

In Finland and Sweden, there are substantial tax relief on energy purchases, even for these less energy-intensive firms. In the case of Finland, this lower tax rate on electricity use is applied to all industry, mining, server halls and greenhouse cultivation. In Greece there are price guarantees in place, so that electricity consumers located on Greek islands are charged the same electricity prices as consumers on the mainland. The effect of these price guarantees on the *average* industry in Greece are particularly difficult to quantify. Industries located on the Greek mainland will see no benefit of this policy, but

[188] In this case, our definition of 'non-energy-intensive industries' includes all industries, excluding Iron and steel; Non-ferrous metals; Chemicals; Non-metallic minerals; Ore-extraction (non-energy); Paper and pulp (which are classified as energy-intensive).

industries located on small islands, where electricity generation is particularly costly, may benefit from considerably lower electricity rates enforced through the price guarantees.

Figure 6-27: Effect of tax relief on industry electricity prices in 2016 (€/MWh, current prices)



Source: Own calculation

Note: Subsidy value in €/MWh is estimated based on data for the value of the subsidy (in €millions) divided by industry energy consumption. Price and tax components reflect a benchmark industry with electricity consumption within Band IC (500 MWh – 2,000 MWh pa).

Table 6-10: Effect of tax relief on other industry electricity prices (€/MWh, current prices)

	2008	2009	2010	2011	2012	2013	2014	2015	2016
Austria	-3.2	-1.4	-2.1	0.0	0.0	0.0	0.0	0.0	0.0
Denmark	-0.1	-0.6	-0.3	-0.4	-1.0	-1.0	-2.1	-4.6	-4.4
Finland	-6.0	-6.2	-6.0	-9.4	-9.5	-9.8	-12.2	-15.6	-16.0
Greece	-8.3	-7.6	-9.1	-12.6	-14.8	-14.7	-13.0	-11.7	-9.3
Italy	0.0	0.0	0.0	-0.1	-0.1	-0.2	-0.3	-0.2	0.0
Lithuania	0.0	0.0	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Slovakia	0.0	0.0	0.0	0.0	0.0	-1.0	-1.1	-1.1	-1.0
Slovenia	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	-0.1	0.0

Source: Own calculation

Note: Results presented for Member States where data is available (or estimates have been made) and where the average value of the subsidy is greater than 0.05 €/MWh.

The scale and prevalence of energy tax relief on non- energy-intensive industry consumption of natural gas and other fossil fuels in the EU is more limited. There are three notable examples of Member States in the EU where tax relief is available for gas consumption, namely: Sweden, Slovenia and Latvia.

In Sweden, industries outside of the EU ETS benefit from reduced carbon dioxide tax on heating fuels in industry. The scale of the tax relief was reduced from 79% relief to 70% relief in 2011. It was then further reduced to 40% from 2015 and 20% as from 2016.

In Latvia, there is an excise tax exemption for natural gas used by manufacturing industries and agriculture. The tax relief policy was introduced in 2011 and was estimated to be around €1.4/MWh in 2016. An excise tax refund policy also exists for the manufacturing and agriculture sectors' use of fossil fuels in Slovenia.

Figure 6-28: Effect of tax relief on other industry gas prices in 2016 (€/MWh, current prices)

Source: Own calculation

Note: Subsidy value in €/MWh is estimated based on data for the value of the subsidy (in €millions) divided by industry energy consumption. Price and tax components reflect a benchmark industry with gas consumption within band I5 (10,000 GJ – 100,000 GJ pa).

Table 6-11: Effect of tax relief on other industry gas prices (€/MWh, current prices)

	2008	2009	2010	2011	2012	2013	2014	2015	2016
Bulgaria	-0.5	-0.6	-0.6	-0.6	-1.1	-1.1	-0.8	-0.6	-0.2
Germany	-0.1	-0.2	-0.2	-0.2	-0.3	-0.3	-0.2	-0.2	-0.2
Latvia	0.0	0.0	0.0	0.0	-2.4	-2.1	-1.5	-1.5	-1.4
Slovakia	0.0	0.0	0.0	0.0	0.0	-0.4	-0.4	-0.4	-0.3
Slovenia	0.0	-2.1	-2.0	-1.8	-1.4	-1.4	-1.1	-1.9	-1.5
Sweden	-16.7	-17.2	-4.9	-5.0	-5.5	-6.9	-7.0	-4.6	-2.8
United Kingdom	-0.1	-0.1	-0.1	-0.2	-0.2	-0.1	-0.2	-0.2	-0.2

Source: Own calculation

Note: Results presented for Member States where data is available (or estimates have been made) and where the average value of the subsidy is greater than 0.05 €/MWh.

Households

In households, one of the main motivations for VAT and other tax exemptions is to reduce the incidence of fuel poverty, particularly where the housing stock is energy inefficient and of poor quality, or where there is a high share of rented accommodation (as tenants typically do not have the authority to make energy efficient investments).

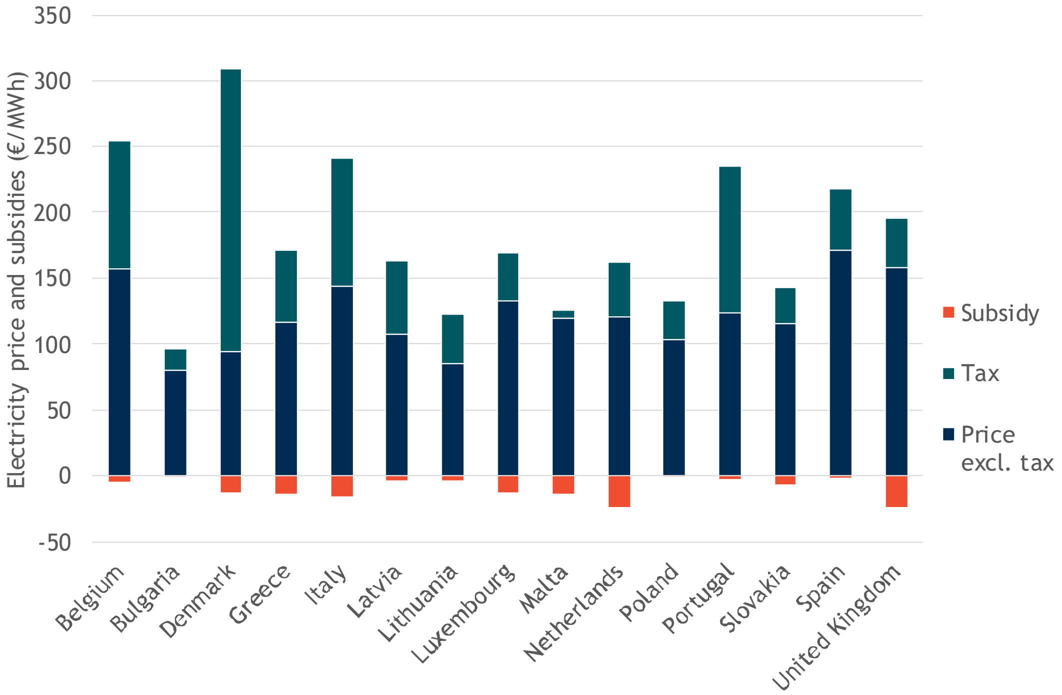
For households, energy tax relief over the period 2008-2016 existed in the following Member States:

- Belgium (electricity and gas);
- Bulgaria (electricity and gas);
- Denmark (electricity and gas);
- Cyprus (electricity used by low-income households);
- Greece (electricity);
- Italy (electricity and gas);
- Latvia (electricity and gas);
- Lithuania (electricity and gas);
- Luxembourg (electricity and gas);
- Malta (electricity);
- Netherlands (electricity and gas);
- Poland (electricity);
- Portugal (electricity and gas);
- Slovakia (electricity and gas);
- Spain (electricity and gas used by low-income households);
- UK (electricity and gas).

The impact of energy tax relief policies on household electricity prices over 2008-2016 were largest in the UK, where households are eligible for a reduced VAT rate of 5% for electricity and gas (compared to a standard VAT rate of 20%). The value of this subsidy to final household consumers is €23.5 per MWh electricity consumed and €11.0 per MWh gas consumed. Households in Luxembourg and Italy also faced reduced VAT rates for electricity and gas, with a VAT rate of 8% in Luxembourg and 10% in Italy, compared to standard VAT rates of 22% and 17%, respectively. This reduced rate generated estimated electricity cost savings for final consumers of €15.9 per MWh electricity consumed in Italy and €12.9 per MWh of electricity consumed in Luxembourg, as well as gas cost savings for households. Households in Malta benefit from a reduced rate of VAT only on electricity purchases (with a 5% rate charged, instead of the standard rate of 18%). In Latvia and Lithuania, there were reduced VAT rates for energy used in heating. The respective VAT rates applied in these countries were: 12% (Latvia) and 9% (Lithuania). In Portugal, reduced VAT rates for natural gas and electricity were implemented in 2011, at a rate of 6%, but in 2012 the reduced rate VAT policy was cancelled. In Cyprus, a reduced VAT rate for electricity is available only for low-income families with more than four children. The level of support received by eligible households is €21 per MWh electricity consumed although, because only a small share of households qualify for the payment, the weighted-average impact on households in Cyprus is negligible. In Denmark, there is an income tax allowance, 'the green check', to compensate for increased energy and environment costs imposed on consumers[189]. In Netherlands, there are reduced energy taxes for household consumers and in Bulgaria, there is zero excise duty charged on sales of electricity and coal to households. Figure 6-29 and Figure 6-30 below show the impact of tax reductions and exemptions on average industry electricity and gas prices.

In most cases, the scale of energy subsidies available to households has increased gradually over time, in line with increases in current energy prices as, in many cases, energy subsidies for households are defined as a reduced VAT rate (%). France is the only Member State that has completely phased out energy subsidies for households over the period since 2008. By contrast there are a few Member States (e.g. Denmark, Portugal, Slovakia, Spain) that have introduced new energy subsidies for households over the period since 2008.

Figure 6-29: Effect of tax relief on household electricity prices in 2016 (€/MWh, current prices)



Source: Own calculation

Note: Subsidy value in €/MWh is estimated based on data for the value of the subsidy (in €millions) divided by total household energy consumption. Price and tax components reflect a benchmark household with electricity consumption within band DC (2,500 kWh – 5,000 kWh pa)

Table 6-12: Effect of tax relief on household electricity prices in 2016 (€/MWh, current prices)

	2008	2009	2010	2011	2012	2013	2014	2015	2016
Belgium	-3.5	-3.5	-6.0	-4.8	-3.1	-5.3	-3.5	-3.8	-5.0
Bulgaria	-0.6	-0.6	-0.9	-0.9	-0.8	-1.1	-0.9	-1.0	-1.0
Denmark	0.0	0.0	-12.0	-13.4	-13.5	-15.3	-15.8	-12.3	-12.3
Greece	-8.9	-8.2	-9.7	-13.2	-16.3	-17.2	-16.7	-15.8	-13.8

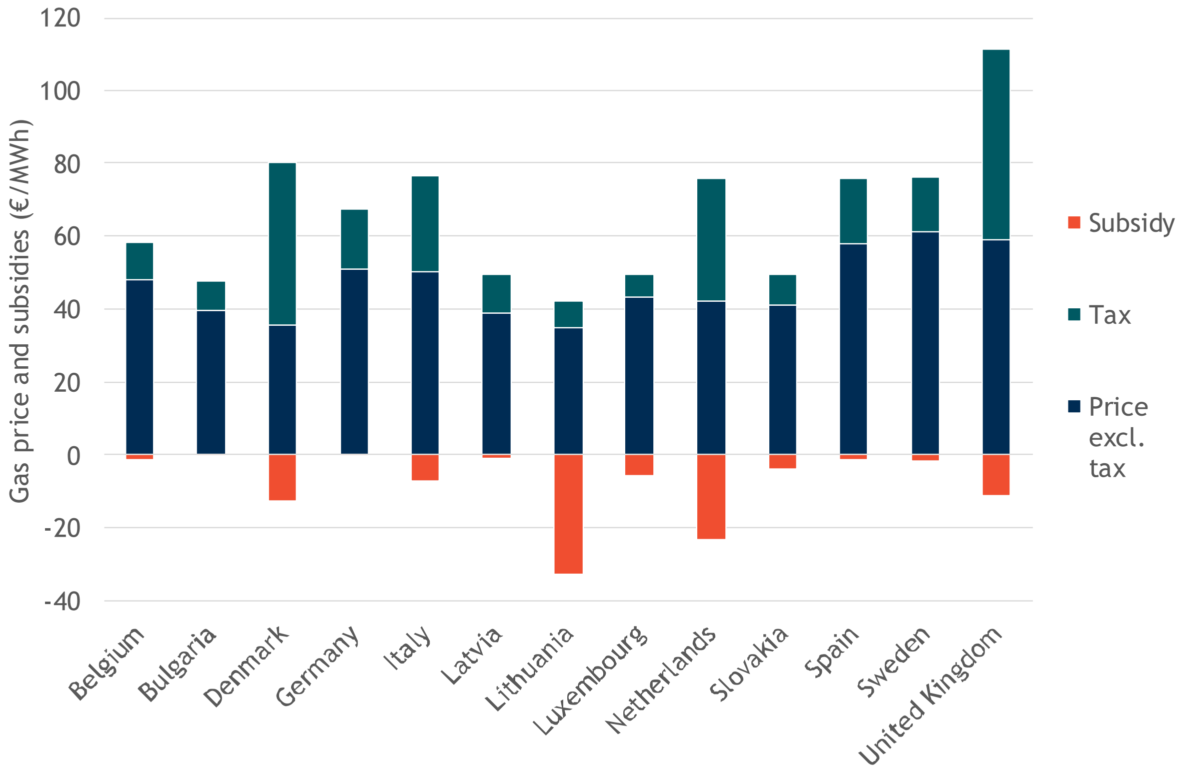
[189] It is noted that, in Denmark, the support to consumers is in the form of an income tax allowance. A tax-exempt compensation - the green check - provides compensation for increased energy and environment costs. This lump sum redistribution mechanism would not have the same effect on energy prices and behaviour as some of the other tax exemptions which affect gas and electricity prices directly. The amount constitutes 1300 DKK for each person over the age of 18, and 300 DKK for children. The check is given to all citizens, and as such reduces the taxable amount of their income.

Italy	-7.4	-7.2	-6.7	-8.5	-8.7	-14.8	-14.9	-15.6	-15.9
Latvia	-3.3	-2.2	-2.6	-2.5	-3.3	-3.1	-3.3	-3.3	-3.2
Lithuania	0.0	0.0	-3.2	-3.6	-4.0	-3.7	-3.4	-3.1	-3.1
Luxembourg	-14.2	-13.8	-14.8	-14.2	-14.5	-13.2	-14.2	-13.1	-12.9
Malta	-10.9	-18.8	-18.1	-18.2	-18.4	-18.3	-16.2	-13.8	-13.8
Netherlands	-12.6	-12.3	-17.6	-21.0	-21.4	-21.5	-22.4	-22.9	-23.3
Poland	0.0	0.0	0.0	0.0	0.0	0.0	-1.0	-1.0	-1.0
Portugal	0.0	0.0	0.0	-7.4	-0.5	-0.3	-0.1	-2.3	-2.7
Slovakia	0.0	0.0	0.0	0.0	0.0	-7.8	-7.2	-6.7	-6.8
Slovenia	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	-0.1	0.0
Spain	0.0	0.0	0.0	-0.4	-0.9	-0.7	-0.7	-1.2	-1.1
United Kingdom	-16.0	-15.1	-19.0	-24.5	-25.5	-22.5	-25.4	-26.1	-23.5

Source: Own calculation

Note: Results presented for Member States where data is available (or estimates have been made) and where the average value of the subsidy is greater than 0.05 €/MWh.

Figure 6-30: Effect of tax relief on household gas prices in 2016 (€/MWh, current prices)



Source: Own calculation

Note: Subsidy value in €/MWh is estimated based on data for the value of the subsidy (in €millions) divided by household energy consumption. Price and tax components reflect a benchmark household with gas consumption within band I2 (20 GJ - 200 GJ pa).

Table 6-13: Effect of tax relief on household gas prices in 2016 (€/MWh, current prices)

	2008	2009	2010	2011	2012	2013	2014	2015	2016
Belgium	-1.6	-1.6	-2.1	-2.0	-3.0	-3.6	-2.1	-1.7	-1.3
Bulgaria	-0.5	-0.6	-0.6	-0.6	-1.1	-1.1	-0.8	-0.6	-0.2
Denmark	0.0	0.0	-12.0	-13.4	-13.5	-15.3	-15.8	-12.3	-12.3
France	-1.2	-1.4	-1.5	-1.9	-1.9	-2.0	-0.4	0.0	0.0
Germany	-0.1	-0.2	-0.2	-0.2	-0.3	-0.3	-0.2	-0.2	-0.2
Italy	-7.4	-7.2	-6.7	-6.9	-6.9	-6.6	-6.5	-6.8	-7.0
Latvia	-2.3	-1.2	-1.3	-1.3	-1.6	-1.4	-1.3	-1.1	-1.1
Lithuania	0.0	0.0	-2.2	-2.6	-3.0	-2.7	-2.4	-2.1	-2.7
Luxembourg	-5.1	-4.7	-4.3	-5.2	-6.2	-7.5	-6.3	-6.3	-5.7
Netherlands	-12.6	-12.3	-17.6	-21.0	-21.4	-21.5	-22.4	-22.9	-23.3
Portugal	0.0	0.0	0.0	-7.1	0.0	0.0	0.0	0.0	0.0
Slovakia	0.0	0.0	0.0	0.0	0.0	-3.5	-3.1	-3.5	-3.5
Slovenia	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	-0.1	0.0
Spain	0.0	0.0	0.0	-0.4	-0.9	-0.7	-0.7	-1.2	-1.1
Sweden	-1.4	-1.5	-1.0	-1.6	-2.3	-2.5	-3.1	-2.4	-1.8
United Kingdom	-5.5	-5.7	-7.0	-10.2	-11.5	-10.4	-11.1	-11.5	-11.0

Source: Own calculation

Note: Results presented for Member States where data is available (or estimates have been made) and where the average value of the subsidy is greater than 0.05 €/MWh.

6.4.2 Subsidies on energy production

The effect of energy production subsidies on retail gas and electricity prices for final consumers is more difficult to quantify. For these types of subsidies, the impact on energy prices depends on the structure of energy markets, the extent to which prices are set by international or domestic markets, and the extent to which domestic suppliers can, and do, pass on cost savings to consumers.

Due to the very different nature of the markets for electricity and natural gas, only electricity production subsidies are included in the analysis, as explained below.

Gas production subsidies

The EU relies on gas imports to meet over 70% of its domestic gas needs[190]. Due to the high import dependency, the marginal price of gas in the EU regional markets is determined by supply and demand interactions in international energy markets. Grants, loans and tax exemptions for gas extraction may reduce the cost of gas production for EU producers and could incentivise investments in the extractive industries. These energy market interactions could also affect the amount of gas that is produced domestically in the EU[191]. However, producer subsidies for the extractive energy industry are unlikely to have a significant effect on the retail energy prices that are ultimately faced by consumers. For this analysis, the impact of production subsidies for the extractive industries are assumed to have no effect.

[190] Eurostat (2017)
[191] If subsidies reduce the marginal cost of production in the EU, this could make new extraction projects profitable and gas production would increase. To the extent that this gas displaces higher cost production in global markets, there could be some very small impacts on gas prices. However, as gas production in the EU contributes a minimal share of global gas supply, it is expected that these effects will be negligible.

Electricity production subsidies

Gas production subsidies are unlikely to impact on gas prices (which are set in EU regional markets in interaction with international gas markets). However, as compared to gas, electricity markets in the EU are more strongly regionalised or even 'nationalised' and generally depend much less on interactions with non-EU neighbours. Electricity production subsidies, such as Feed-in-Tariffs and/or investment grants, are likely to have affected the electricity generation mix. Through these impacts on the electricity generation mix, the electricity production subsidies could have had subsequent (indirect) impacts on wholesale electricity prices, due to the merit order effect.

For many countries in the EU, if support for renewables did not exist, less renewables capacity would have been installed over the past 10 years: these emerging technologies would not have initially been able to compete with other generation technologies, due to the large initial investment cost required and relatively high levelised costs of renewable electricity generation when these technologies were in their infancy.

To assess the potential impact of subsidies for renewable electricity production on wholesale electricity markets, we undertake a two-stage modelling analysis for Germany and Spain, as case study examples. Germany and Spain are chosen as case studies as they are two of the Member States where most robust data are available and where there has been high growth in deployment of renewables for electricity generation, following the introduction of favourable renewables policy, such as Feed-in-Tariffs. There is evidence that the increased uptake of renewables has had a sizeable effect on electricity markets and has caused the wholesale price of electricity to fall to zero on occasion. Another reason for choosing Germany and Spain is that they are two of the largest EU Member States. Germany accounts for 20% of EU net electricity generation[192] and a high share of EU industry is located within Germany. Similarly, Spain, is a comparatively large EU Member State, which accounts for around 9% of net electricity generation in the EU. For other Member States, a qualitative discussion of the potential impact of electricity production is provided below.

Firstly, to estimate the impact of subsidies to electricity generators on installed capacity (by technology), we run ex-post simulations using the combined E3ME-FTT model. E3ME-FTT determines a generating technology mix at Member State level, under a given set of policy assumptions for: carbon prices, subsidies, Feed-in-Tariffs and regulations by generation technology.

The power sector in the macroeconomic E3ME model is represented using an advanced framework for the dynamic selection and diffusion of innovations. It uses a decision-making core for investors wanting to build new electrical capacity, facing several options. The decision-making takes place by pairwise levelised cost of electricity (LCOE) comparisons. The diffusion of technology follows a set of coupled non-linear differential equations which represent the better ability of larger or well-established technologies to capture the market, and the life expectancy of technologies. More information about E3ME-FTT is provided in Annex F.

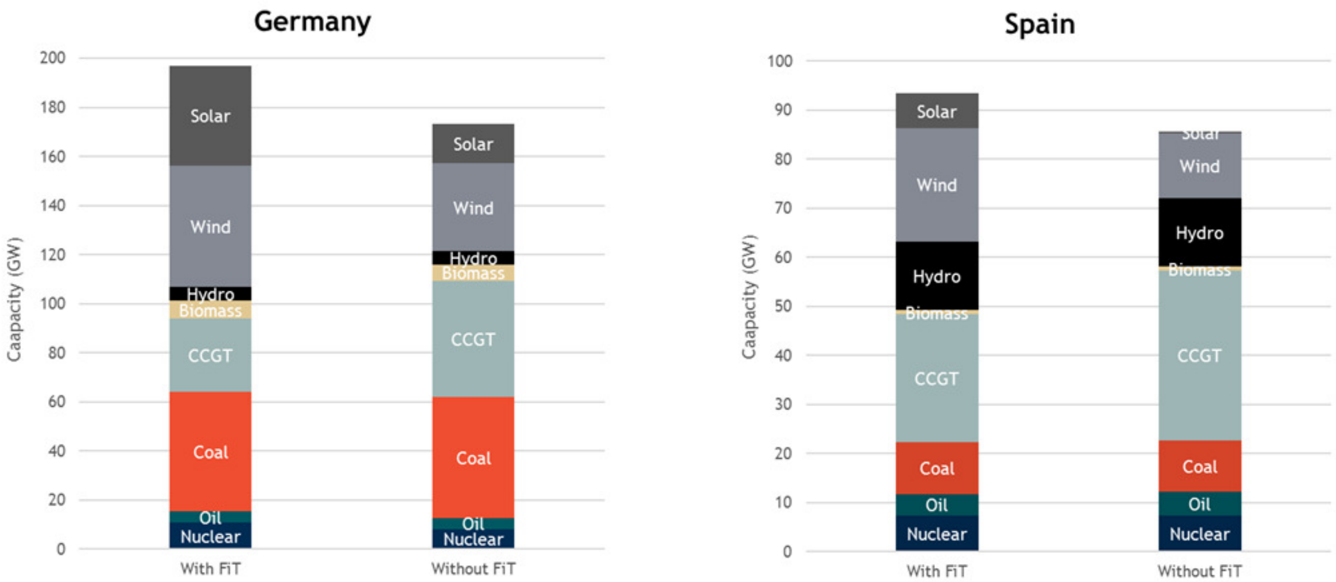
By allowing E3ME-FTT to solve under a counterfactual scenario (where it is assumed that there are no feed-in tariffs for renewable generation), we obtain estimates of installed capacity (by technology) if Feed-in-Tariff policy did not exist. Comparing these estimates to the true data shows the impact that

192 Eurostat (2018) 'Electricity production, consumption and market overview', see: http://ec.europa.eu/eurostat/statistics-explained/index.php/Electricity_production,_consumption_and_market_overview

these generation subsidies have had on the generation mix and, specifically, on the share of intermittent renewables in the mix (which is a key driver of wholesale electricity prices through the merit order effect).

The results for Germany and Spain show that Feed-in Tariffs over 2008-2016 have driven new investments in solar PV and onshore wind capacity. As shown in Figure 6-31, our results show that, in a counterfactual scenario without Feed-in-Tariffs, wind generating capacity in Germany in 2016 would have been 14GW lower and solar PV capacity would have been 25 GW lower. In Spain, our counterfactual scenario without the existence of Feed-in-Tariffs over 2008-2016, suggests that, by 2016, total solar capacity would have been 7GW lower and total wind capacity 10 GW lower, if these renewable support policies did not exist. In both cases, the results suggest that the additional renewables generating capacity partially replaced the amount of new gas CCGT capacity that was installed over the same period.

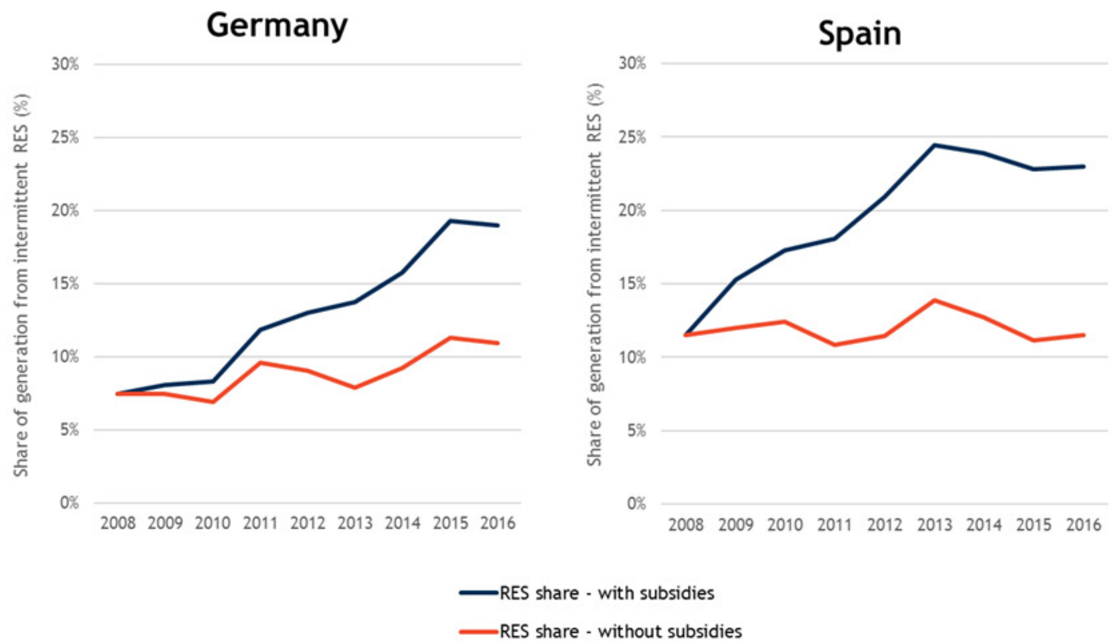
Figure 6-31: Generating capacity in Germany and Spain in 2016, compared to a counterfactual scenario without Feed-in-Tariffs



Source: Own calculations

As shown in Figure 6-32, without Feed-in-Tariffs, growth in renewables capacity and generation over the period 2008-2016 would have been much slower. The results from E3ME-FTT suggest that, in Germany, the share of intermittent renewable generation would have reached around 11% by 2016 in a counterfactual scenario without Feed-in-Tariffs, compared to a 19% share of generation from renewables in the observed data for 2016. Feed-in-Tariffs are estimated to have had a slightly larger impact in Spain, owing to the higher Feed-in Tariff rates over the period to 2013. We estimate that Feed-in-Tariffs in Spain have contributed to an 11% increase in the share of generation from wind and solar compared to in a counterfactual scenario. In 2013, the Spanish government introduced a number of reforms, including the retraction of Feed-in-Tariffs for new RES capacity and, as shown in the chart below, growth in RES has been more subdued since that date.

Figure 6-32: Share of intermittent renewables in total generating capacity (with FiTs) compared to a counterfactual scenario (without FiTs) in Germany and Spain



Source: Own calculations

Changes to installed renewables capacity change the nature of the merit order curve and, as such, are a key driver of wholesale electricity prices. After estimating impacts of energy subsidies on renewable capacity, we use panel data to estimate the impacts of changes in the share of renewables on wholesale electricity prices. Here, we benefit from a large sample size of 2,085 observations, as we are able to make use of monthly electricity price and electricity generation data. As with the econometric equations that are used to assess the effects of loans and grants on energy demand, the choice of panel estimator is determined by a series of diagnostic tests to establish which estimator is both consistent (i.e. unbiased in large samples) and efficient (i.e. has the lowest variance of the class of unbiased estimators available). The Hausman test shows that the random effects estimator is consistent and so random effects is the chosen model in this case (see full results in Annex L).

The equation that is estimated is:

$$Wholesalse\_Price_{it} = \beta_0 + \beta_1 RES\_Share_{it} + \beta_2 Electricity\ Demand_{it} + \beta_3 Gas\_price_{it} + Other\_Factors_{it} + \varepsilon_t$$

t=1,2,….,T
i=1,2,….,N (countries)

Where,

- *Wholesale_Price = the wholesale price of electricity;*
- *RES_Share = the share of intermittent renewables in total installed capacity ;*
- *Demand = electricity demand;*
- *Gas_price = wholesale gas price which, for most Member States, will be the marginal fuel in the generation mix for majority of the time;*
- *Other_Factors = other exogenous variables, such as other fossil fuel prices, weather indicators.*

Using panel data across all EU Member States, the results show that a 1 percentage point increase in the share of renewables would lead to a €0.5/MWh reduction in the wholesale price of electricity in that Member State (refer to Annex L). Therefore, the results for Germany suggest that Feed-in-Tariffs over 2009-2016 have had a small dampening effect on wholesale electricity prices, of around €4/MWh[193]. In Spain, Feed-in-Tariffs over the same period have driven an increase in intermittent RES capacity, that we estimate have contributed to a €5/MWh reduction in the wholesale electricity price compared to a counterfactual scenario without this level of support for renewables.

Whilst the results for Germany and Spain show that subsidies for renewable generation have had a significant impact on the share of renewables and the wholesale electricity price, renewable subsidies are often financed through levies on final consumption of electricity and therefore can inflate the retail electricity prices faced by final consumers. Furthermore, the more intermittent electricity generation from renewables can lead to increases in grid costs due to issues of grid instability and grid congestion.

In the absence of information about the scale of renewables taxes and levies in each Member State and their impacts on network costs, it is impossible to make a conclusive statement about the overall impacts of support for renewable energy on final user electricity prices. Final energy consumers will not necessarily observe the dampening effects (driven by higher shares of renewables) in the retail electricity prices they face.

In the case of Germany, the EEG-Umlage is levied on electricity consumers to fund the feed-in tariffs for renewable electricity generation. The overall impact on electricity prices for final consumers would therefore depend on the balancing of the dampening effect of renewables on the wholesale electricity price (because of the merit order effect) against the impact of financing the scheme through taxes and levies. We estimate that financing the EEG-Umlage scheme cost electricity consumers in Germany €45/Mwh[194] in 2016, on average. However, it is noted that the financing burden is not spread evenly among final consumers. According to UNB, the EEG surcharge faced by household consumers in 2016 was €63.54/MWh.[195] By contrast, many energy-intensive industry sectors are exempt from the EEG Umlage surcharge to finance the cost of renewable generation. Therefore, while many consumers may see increases in electricity prices, due to renewables policy support, it is likely that many of the most energy-intensive industry sectors have benefitted from lower wholesale electricity prices (as Feed-in-Tariffs have driven an increase in renewables) and exemptions to renewables taxes and levies that are designed to finance the Feed-in-Tariff schemes.

Likely impacts in other EU Member States

The analysis above focuses on Germany and Spain, as case study examples. The results for our modelling suggest that, in the absence of renewables support in Germany, the share of renewables in the generation mix would be 8 percentage points lower and wholesale electricity prices €4/MWh higher than was experienced. As shown in Table 6-14 Germany and Spain are two of the countries that has seen the largest increase in capacity of intermittent renewable technologies (Solar and Wind) over the past ten years, with wind and solar PV accounting for almost 40% of total capacity (and 19% of total power generation) in Germany, in 2016.

[193] -€0.5/MWh * 8 (pp change in RES share) = -€4/MWh

[194] The total value of the EEG-Umlage subsidy in 2016 was €23.17bn and total electricity for final consumption in Germany in the same year was 517.3GWh. The renewables support costs were financed entirely by final consumers. The average impact on final consumers is therefore estimated as €23.17bn/517.3TWh= €44.6/MWh.

[195] Übertragungsnetzbetreiber (ÜNB) (2015): Prognose der EEG-Umlage 2016 nach AusglMechV.Prognosekonzept und Berechnung der ÜNB. Stand: 15.10.2015.

Table 6-14: Wind and Solar PV generation as a share of total electricity generation, by Member State

	2008	2009	2010	2011	2012	2013	2014	2015	2016
EU28	4%	5%	5%	7%	9%	10%	11%	13%	13%
Belgium	1%	1%	2%	4%	6%	8%	11%	13%	10%
Bulgaria	0%	1%	2%	2%	5%	7%	6%	6%	7%
Czech Republic	0%	0%	1%	3%	3%	3%	3%	4%	3%
Denmark	20%	20%	21%	29%	36%	35%	44%	53%	47%
Germany	7%	8%	8%	12%	13%	14%	16%	19%	19%
Estonia	1%	2%	2%	3%	4%	4%	5%	8%	6%
Ireland	8%	11%	10%	17%	15%	18%	20%	24%	21%
Greece	4%	5%	5%	7%	9%	15%	16%	18%	18%
Spain	12%	15%	17%	18%	21%	24%	24%	23%	23%
France	1%	2%	2%	3%	4%	4%	4%	5%	6%
Croatia	0%	0%	1%	2%	3%	4%	6%	8%	9%
Italy	2%	3%	4%	7%	11%	13%	14%	14%	14%
Cyprus	0%	0%	1%	3%	5%	7%	6%	8%	8%
Latvia	1%	1%	1%	1%	2%	2%	3%	3%	2%
Lithuania	1%	1%	4%	11%	11%	14%	17%	19%	30%
Luxembourg	2%	2%	2%	2%	3%	5%	6%	8%	9%
Hungary	1%	1%	2%	2%	2%	3%	3%	3%	3%
Malta	0%	0%	0%	0%	1%	1%	3%	8%	16%
Netherlands	4%	4%	4%	5%	5%	6%	7%	8%	9%
Austria	3%	3%	3%	3%	4%	5%	7%	9%	9%
Poland	1%	1%	1%	2%	3%	4%	5%	7%	8%
Portugal	13%	16%	18%	18%	23%	25%	24%	24%	22%
Romania	0%	0%	1%	2%	5%	9%	13%	15%	14%
Slovenia	0%	0%	0%	0%	1%	1%	2%	2%	2%
Slovakia	0%	0%	0%	2%	2%	2%	2%	2%	2%
Finland	0%	0%	0%	1%	1%	1%	2%	4%	5%
Sweden	1%	2%	2%	4%	4%	7%	8%	10%	10%
United Kingdom	2%	3%	3%	5%	6%	9%	11%	15%	15%

Source: Eurostat (2018), code: nrg_105a, net solar and wind electricity generation as a share of net generation across all technologies.

By contrast, intermittent renewables accounted for only 1%-25% of total generating capacity in most other EU Member States. The reason that take-up is relatively high in Germany and Spain is principally due to greater policy support for renewables, as well as attractive conditions for investment: a large number of available sites, high load factors for wind and solar, and high shares of prosumers who are willing to engage in electricity markets.

The impact of renewables on wholesale electricity prices is non-linear. The impact is higher in Germany and Spain than in most other EU Member States, because Germany and Spain have a relatively high share of renewables in the generation mix and, on occasion (under certain weather conditions), these low marginal cost renewables have set the wholesale electricity price. Whilst it is likely that renewables policy support has driven an increase in renewables capacity among many EU Member States, in most cases, it is unlikely that this has had as large an impact on wholesale elasticity prices as that estimated for Germany and Spain. Thus, we can conclude that the impact of increased renewables support over 2008-2016 on wholesale electricity prices in other Member States is likely to be small (less than €5/MWh).

In most cases, support for renewable electricity generation and investments were financed by taxes and levies on final electricity consumption. To quantify the cost to electricity consumers of financing electricity generation subsidies, we take the total value of support to RES electricity production divided by total end user consumption of electricity. Table 6-15 and Table 6-16 provide the breakdown of this calculation by Member State and year, respectively.[196] Figure 6-33 and Figure 6-34 show the estimated average cost to consumers of the financing of the levy (in €/MWh). The estimates presented in the charts below should be interpreted as the additional tax or levy paid by electricity consumers (on average) to finance the cost of renewable subsidies and other means of support for electricity generation. The results show that the financing burden of renewable support costs have hit electricity consumers hardest in Germany and Italy. This is principally because these countries had the highest levels of subsidies for electricity producers. It is noted, however, that many energy-intensive industries in Germany are exempted from the EEG tax. Figure 6-34 shows that the average renewable policy cost burden for final energy consumers in the EU increased threefold over the period 2008 to 2013, from €7.0/MWh to €20.4/MWh. Since 2014, the average cost burden for RES support has increased slightly, to €22.2/MWh in 2016.

As a robustness check, we compared our estimates of the RES support burden for final consumers to other estimates in the published literature. In a recent study by the Council of European Energy Regulations (CEER)[197], EU average RES support costs per unit of gross electricity supplied in 2014 was estimated at €17.1/MWh, slightly lower than our 2014 estimate.

Table 6-15: Average RES support costs for electricity consumers in 2016 (by EU Member State)

	Electricity consumption (GWh)	RES support financed by endusers (€million)	RES support (€/MWh)
EU28	2,786,137	61,909	22.2
Austria	61,852	1,011	16.3
Belgium	81,725	1,378	16.9
Bulgaria	28,939	682	23.6
Croatia	15,300	203	13.3
Cyprus	4,399	-	0.0
Czech Republic	57,997	599	10.3
Denmark	31,152	768	24.7
Estonia	7,139	-	0.0
Finland	80,759	-	0.0
France	440,971	6,660	15.1
Germany	517,377	23,169	44.8

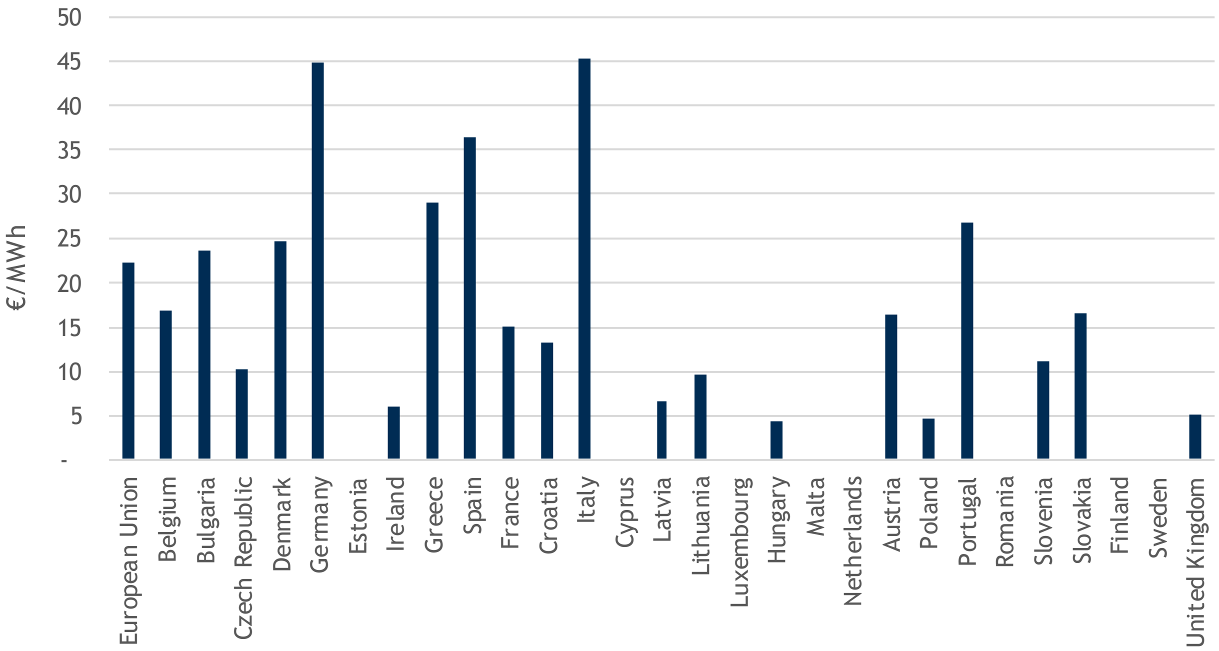
[196] For example, in Germany, in 2016, RES support through the EEG Umlage totalled €23,169 million. This comprised: €394 million hydropower support; €61 million biogas support; €6,632 million biomass support; €39 million geothermal power support; €4,589 million onshore wind support; €1,948 million offshore wind support and €9,506 million solar power support. The EEG Umlage is financed by means of a levy on final electricity consumers. Total electricity available for final consumption in Germany was 517,377 GWh in 2016. The average financing burden on final consumers is therefore estimated as:
$\frac{€23{,}169 \text{ million}}{517{,}377 \text{ GWh}} = €44.8 \text{ per MWh}$

[197] Council of European Energy Regulations (2017), 'Status Review of Renewable Support Schemes in Europe'. Available online at: https://www.ceer.eu/documents/104400/-/-/41df1bfe-d740-1835-9630-4e4cccaf8173 (ref Table 7, pp 18/79)

	Electricity consumption (GWh)	RES support financed by endusers (€million)	RES support (€/MWh)
Greece	53,463	1,554	29.1
Hungary	37,541	162	4.3
Ireland	26,099	156	6.0
Italy	286,027	12,943	45.3
Latvia	6,482	44	6.7
Lithuania	9,750	93	9.6
Luxembourg	6,372	-	0.0
Malta	2,114	-	0.0
Netherlands	105,332	-	0.0
Poland	132,839	626	4.7
Portugal	46,353	1,244	26.8
Romania	43,569	-	0.0
Slovakia	24,987	415	16.6
Slovenia	13,026	147	11.3
Spain	233,172	8,485	36.4
Sweden	127,496	-	0.0
United Kingdom	303,902	1,570	5.2

Source: Electricity consumption data taken from Eurostat (nrg_105a), 'Energy Available for Final Consumption'; RES support data taken from subsidies database accompanying this report. Average RES support figure calculated as RES support divided by electricity consumption.

Figure 6-33: Average RES support costs for electricity consumers in 2016 (by EU Member State)



Source: Own calculations

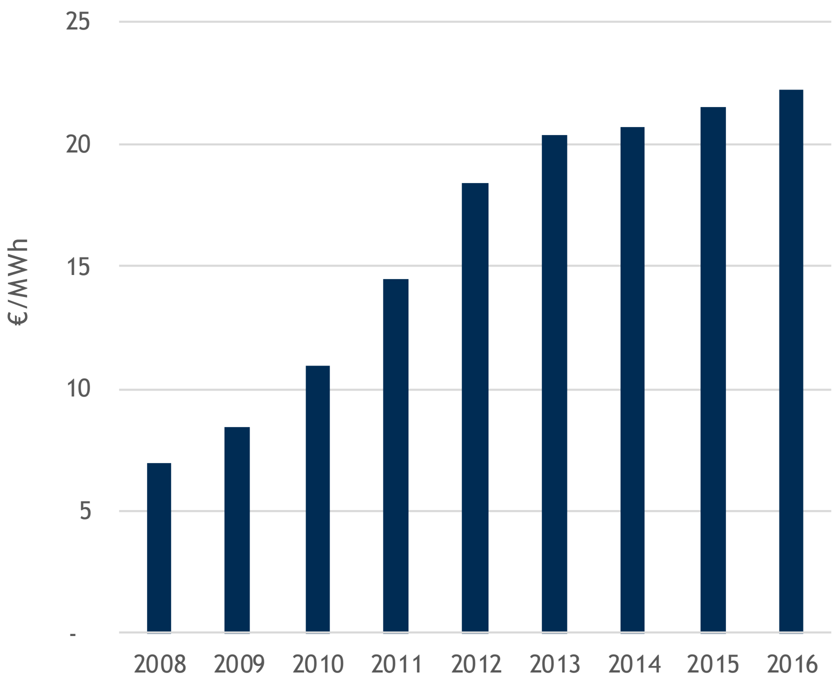
Note: Figures presented in this chart only include subsidies that are financed by levies on final electricity consumers and do not include subsidies that are paid for by government or other means. Estimates presented in the chart are calculated as the total value of RES subsidies for electricity producers that are financed by endusers, divided by total electricity available for final energy consumption.

Table 6-16: Average RES support costs for electricity consumers in the EU

	Electricity consumption (GWh))	RES support financed by endusers (€million)	RES support (€/MWh)
2008	2,863,356	20,065	7.0
2009	2,711,158	22,683	8.4
2010	2,840,092	31,018	10.9
2011	2,793,929	40,290	14.4
2012	2,802,936	51,497	18.4
2013	2,779,742	56,615	20.4
2014	2,717,745	56,270	20.7
2015	2,754,711	59,301	21.5
2016	2,786,137	61,909	22.2

Source: Electricity consumption data taken from Eurostat (nrg_105a), 'Energy Available for Final Consumption'; RES support data taken from subsidies database accompanying this report. Average RES support figure calculated as RES support divided by electricity consumption.

Figure 6-34: Average RES support costs for electricity consumers in the EU



Source: Own calculations

Note: Figures presented in this chart only include subsidies that are financed by levies on final electricity consumers and do not include subsidies that are paid for by government or other means. Estimates presented in the chart are calculated as the total value of RES subsidies for electricity producers that are financed by endusers, divided by total electricity available for final energy consumption.

6.4.3 *Loans and grants*

Loans and grants that target energy demand, energy savings or energy investments by final consumers account for around 40% of all the energy subsidises in the EU.

These types of subsidy do not have a direct impact on gas and electricity prices but do affect gas and electricity demand and, through their impact on total energy consumption, affect energy costs faced by final users. Loans and grants available to final energy consumers are categorised into three groups:

- The *energy savings* grants and loans are targeted to improve energy efficiency and reduce energy consumption. These energy efficiency subsidies include grants or loans to install new, more efficient boilers, insulation and other energy efficient appliances or energy efficiency management programs;
- The *energy demand* subsidies reimburse consumers' energy costs and typically comprise a lump sum payment for certain energy consumers (for example those at risk of fuel poverty). The lump sum payments from energy demand subsidies are designed to relieve energy cost pressures for consumers and facilitate the basic levels of consumption. These subsidies do not directly target investment in energy savings;
- The *investment* subsidies include grants for energy efficiency improvements, CHP, micro-generation and other energy investments.

To assess the impact of grants and loans on energy consumption for certain users we use an econometric analysis. To improve the consistency and efficiency of our estimates, we use panel data (by EU Member State and time), which gives a sample size of 224 observations (28 EU Member States x eight years of data, from 2008-2015). For energy savings and energy investment support, we regress the cumulative value of energy grants and loans on gas and electricity demand for households/commerce and industry. It is the *cumulative* energy investments (rather than annual investments) that most closely correspond to energy consumption[198], and so it is cumulative grants and loans that are used as our explanatory variables of interest in the energy demand equation. In the case of support to energy demand, we regress annual subsidy values, as these reflect annual lump-sum payments, which facilitate energy consumption and are not targeted towards energy efficiency measures.

We estimated four separate equations to determine the impact of loans and grants on:

- Household and commercial gas demand;
- Household and commercial electricity demand;
- Industry gas demand;
- Industry electricity demand.

Subsidies for the household and commerce sectors are combined to increase sample size, as these subsidies are typically targeted towards similar measures (i.e. energy efficiency improvements in buildings) and are therefore expected to have similar effects on energy consumption per €1 million of spend.

As individual gas and electricity demand equations are estimated, in cases where subsidies target multiple fuels (e.g. general energy saving and efficiency measures), fuel shares are used to attribute the total value of the subsidy to the various fuels for the estimation.

The specification of the equations that were estimated are:

[198] To demonstrate this concept, if a household invested in better insulation ten years ago, then this will still affect their energy consumption today.

$$Fuel\ Demand_{it} = \beta_0 + \beta_1 Price\ of\ fuel_{it} + \beta_2 Economic\ activity_{it} + \beta_3 Support\ for\ energy\ demand_{it} + \beta_4 Support\ for\ energy\ savings_{it} + \beta_5 Support\ for\ energy\ investment_{it} + Other\_Factors_{it} + \varepsilon_{it}$$

t=1,2,….,T (years)
i=1,2,….,N (countries)

Where,

- *Fuel demand = total gas or electricity demand by households or industry;*
- *Price of fuel= index of average retail prices of gas or electricity for households or industry;*
- *Economic activity = Gross output (for industry equations); real income (for household equations);*
- *Support for energy demand= value of annual energy demand loans and grants since 2008 ;*
- *Support for energy savings= value of cumulative energy savings loans and grants since 2008 ;*
- *Support for energy investment= value of cumulative energy investment loans and grants since 2008;*
- *Other Factors = other control variables, including heating degree days and cooling degree days.*

As shown above, the support for energy demand, energy savings and energy investments are each included separately as explanatory variables in the estimated equation. The reason for estimating the impacts of each of these subsidies independently is that we would expect the different types of subsidies to have different effects on gas and electricity demand. As explained above, whilst the energy savings subsidies support energy efficiency measures, the energy demand subsidies are typically lump-sum payments that increase incomes for certain social groups and so would not necessarily drive energy savings (and could even increase energy consumption through the income effect).

There are three different estimators that could be applied to estimate the econometric relationships in the panel data, namely, Pooled OLS, Fixed Effects and Random Effects estimators. The choice of estimator is determined by a series of diagnostic tests that established the estimator was both consistent (i.e. unbiased in large samples) and efficient (i.e. has the lowest variance of the class of unbiased estimators available). The pooled OLS estimator is discounted because there is evidence of unobserved heterogeneity, as an F-test shows presence of time-invariant, country-specific characteristics that affect energy consumption but are not captured by the other explanatory variables in the model. In a pooled OLS regression, these country-specific effects form part of the error term and, where correlated with explanatory variables in the model, would cause endogeneity and biased results. Rejection of the null hypothesis in the Hausman test indicated that the Random Effects estimator is inconsistent. The diagnostic tests therefore show that the Fixed Effects estimator is the most appropriate estimator to use for each of the four equations that were estimated. We do not correct for serial correlation, due to the short time series dimension and large cross-sectional dimension of the data.

Table 6-18 shows the estimated impact of €1 million energy investment or energy efficiency subsidy on annual gas and electricity consumption in industry, households and commerce. Lump-sum energy demand subsidies are omitted due to high correlation with the activity indicator which causes issues of multicollinearity in the model. The impact of energy demand subsidies on energy demand is ambiguous, in any case, as they typically consist of lump-sum payments that are not well-targeted.

Table 6-17: Estimated elasticities to show the effect of cumulative spending on investment and energy efficiency loans and grants (in € millions) on final gas and electricity consumption (in GWh)

	Support for investment	Support to energy savings
Households/commerce electricity consumption	26.1	-5.42**
Industry electricity consumption	-3.9	-7.7**
Households/commerce gas consumption	7.04	-2.14
Industry gas consumption	-30.2**	-16.4**

Source: Own calculations

Note: ** indicates statistical significance at the 5% level

The results from the panel estimation show that the support to energy efficiency savings has a negative impact on household and industry gas and electricity demand. The effect is most prominent for industry gas demand, where a grant or loan of value €1 million in a given year is estimated to reduce industry demand for gas by 16.4 GWh annually. Grants and loans that are targeted towards investment are also estimated to have a significant impact on industry gas consumption (in the region of 30.2 GWh per €1 million subsidy). Our estimates for the impact of energy efficiency loans and grants on household and commerce annual gas savings are insignificant at the 5% level.

Limitations of the econometric analysis

There are several limitations of the econometric analysis and the results from the regressions (as shown above) should be interpreted with these caveats in mind.

Firstly, there are limitations due to the small sample size. We used panel data to maximise the size of the sample (to improve the efficiency and consistency of our estimates). However, this still only provides us with 224 observations and, in some cases, there were only a few countries in which subsidies existed. We are therefore heavily reliant on only a few countries as the basis of our estimates for the policy impacts.

There is also the potential that our model suffers from omitted variable bias, as several other policies (e.g. product efficiency standards and labelling) were introduced over a similar time period and, to the extent that the introduction of these other energy savings measures coincided with the years and Member States that introduced loans and grants for energy savings and energy investments, the estimated effect of loans/grants could be picking up other policy effects.

There is clearly a lot of unobserved variation that the equation is not able to control for, which may partly explain why no statistically significant impacts of grants and loans on household energy consumption are identified, despite theory suggesting that spending on energy efficiency loans and grants would reduce energy consumption by households. It is noted that the insignificant impact of energy savings loans and grants could also be, in part, due to the rebound effect.

Comparison with values in the literature

Due to the limitations of the results from the econometric estimation for households and commerce in particular, for these sectors, we compare the results from our econometric analysis with values for the elasticity of energy savings per €million subsidies from the recently published literature. Rosenowa and Galvin (2013)[199] evaluate the impact of energy efficiency programmes in Germany and the UK on energy

[199] Rosenowa and Galvin (2013), 'Evaluating the evaluations: Evidence from energy efficiency programmes in Germany and the UK'

consumption, as shown in the table below. For each of the case study energy efficiency programs, Rosenowa and Galvin estimate lifetime energy savings attributable to the scheme, as well as the lifetime of the energy efficiency measures, from which we can calculate annual energy savings per million euros of spend on these particular energy efficiency subsidies. The results show household energy efficiency savings of 1.4-4.6 GWh/m€ subsidy. This estimated impact is similar in scale to the results from our econometric analysis, where we estimate savings of 2.14 GWh/m€ subsidy for gas and savings of 5.12 GWh/m€ subsidy for electricity.

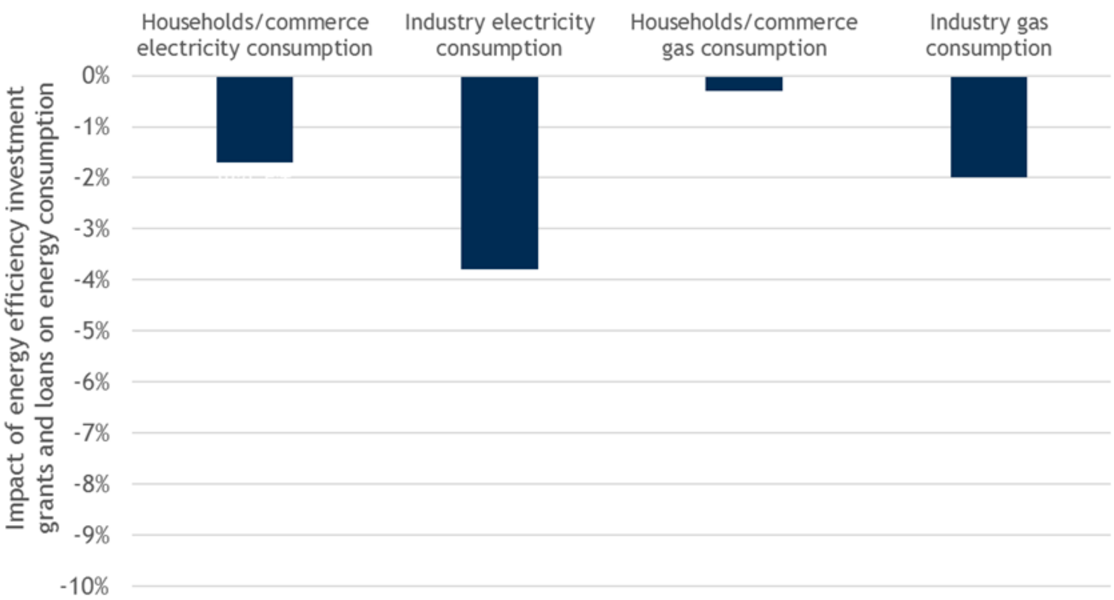
Table 6-18: Estimated impact of energy efficiency loans and grants over 2008-2015 on final gas and electricity consumption in households and industry by 2015

	Lifetime savings (TWh)	Lifetime of measures	Annual savings (TWh)	Value of subsidy (bn€)	Energy savings MWh/m€
UK's Supplier Obligation (SO)	235	30	7.83	1.7	4,608
Germany's CO2 Building Rehabilitation Programme CBRP)	173	30	5.77	4	1,442
				Average impact:	3,024

Source: Own calculations, based on Rosenowa and Galvin (2013)

The elasticities from the econometrically-estimated equations, multiplied by the cumulative value of each subsidy over the period 2008-2016 gives an estimate of the impact of energy subsidies over this period on total energy consumption. Figure 6-35 and Table 6-19 show the total impact of energy efficiency and energy investment loans and grants on annual electricity and gas demand in industry and households in 2015.

Figure 6-35: The impact of loans and grants for energy efficiency measures and/or other investments on EU28 household and industry energy consumption in 2015



Source: Own calculations

Table 6-19: Estimated impact of energy savings and other investment loans and grants over 2008-2015 on final gas and electricity consumption in households and industry in 2015, by Member State

	Estimated impact on household/ commerce electricity consumption (GWh, %)	Estimated impact on household/ commerce gas consumption (GWh, %)	Estimated impact on industry electricity consumption (GWh, %)	Estimated impact on industry gas consumption (GWh, %)
EU28	-27809.3 (-1.7%)	-4343.4 (-0.3%)	-39534.4 (-3.8%)	-18251.3 (-2%)
Austria	-429.7 (-1.3%)	-167.8 (-0.9%)	0 (0%)	0 (0%)
Belgium	-3.6 (0%)	-2.9 (0%)	-214.4 (-0.6%)	-9493.1 (-17.9%)
Bulgaria	-1045.9 (-5.3%)	-133 (-7.5%)	-1188.6 (-11.7%)	-235.9 (-2.2%)
Croatia	-91.6 (-0.8%)	-58 (-0.8%)	-101.2 (-2.9%)	-23.3 (-0.6%)
Cyprus	0 (0%)	#DIV/0!	0 (0%)	0 (0%)
Czech Republic	-63.5 (-0.2%)	0 (0%)	-13679.3 (-37.5%)	0 (0%)
Denmark	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Estonia	-329.5 (-6.8%)	-33.4 (-2.3%)	0 (0%)	-430.4 (-28.2%)
Finland	-160.6 (-0.4%)	-9.2 (-1.4%)	-161.7 (-0.4%)	-5.9 (-0.1%)
France	-5136.5 (-1.7%)	-830.4 (-0.4%)	-244.9 (-0.2%)	-2912.7 (-2.4%)
Germany	-304.4 (-0.1%)	-179.6 (-0.1%)	-17495 (-7.2%)	-3202.2 (-1.5%)
Greece	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Hungary	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Ireland	-361.5 (-2.4%)	-112.2 (-1%)	-268.9 (-2.7%)	-124.5 (-1.4%)
Italy	0 (0%)	0 (0%)	-147.5 (-0.1%)	-22 (0%)
Latvia	-713.5 (-13.7%)	-9.3 (-0.4%)	0 (0%)	-942.1 (-40.2%)
Lithuania	-939.2 (-14%)	-259.5 (-10.8%)	-213.7 (-6.1%)	-104.1 (-3.1%)
Luxembourg	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Malta	-368 (-18.2%)	0 (0%)	0 (0%)	0 (0%)
Netherlands	-12.5 (0%)	-23.2 (0%)	-721 (-2.1%)	-96.6 (-0.2%)
Poland	-356.4 (-0.5%)	-242.8 (-0.4%)	-130.4 (-0.3%)	-618.1 (-1.6%)
Portugal	-2.3 (0%)	-0.2 (0%)	-551 (-3.4%)	-15.4 (-0.1%)
Romania	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Slovakia	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Slovenia	-591.9 (-8.4%)	0 (0%)	-254.5 (-3.9%)	0 (0%)
Spain	-10494.3 (-6.9%)	-425.4 (-0.6%)	-4160.2 (-5.2%)	-25 (0%)
Sweden	0 (0%)	0 (0%)	0 (0%)	0 (0%)
United Kingdom	-6404.3 (-3.1%)	-1856.4 (-0.5%)	0 (0%)	0 (0%)

Source: Own calculations

The results suggest that loans and grants over 2008-2015 have driven particularly large reductions in industry energy consumption in:

- Latvia (40% reduction in industry gas consumption);
- Estonia (28% reduction in industry gas consumption);
- Bulgaria (12% reduction in industry electricity consumption);
- Belgium (18% reduction in industry gas consumption);
- Czech Republic (38% reduction in industry electricity consumption).

Energy efficiency loans and grants over 2008-2015 are estimated to have driven particularly large reductions in household energy consumption in:

- Latvia (14% reduction in household electricity consumption);
- Lithuania (14% reduction in household electricity consumption);
- Malta (18% reduction in household electricity consumption).

6.4.4 Overall impacts on energy costs

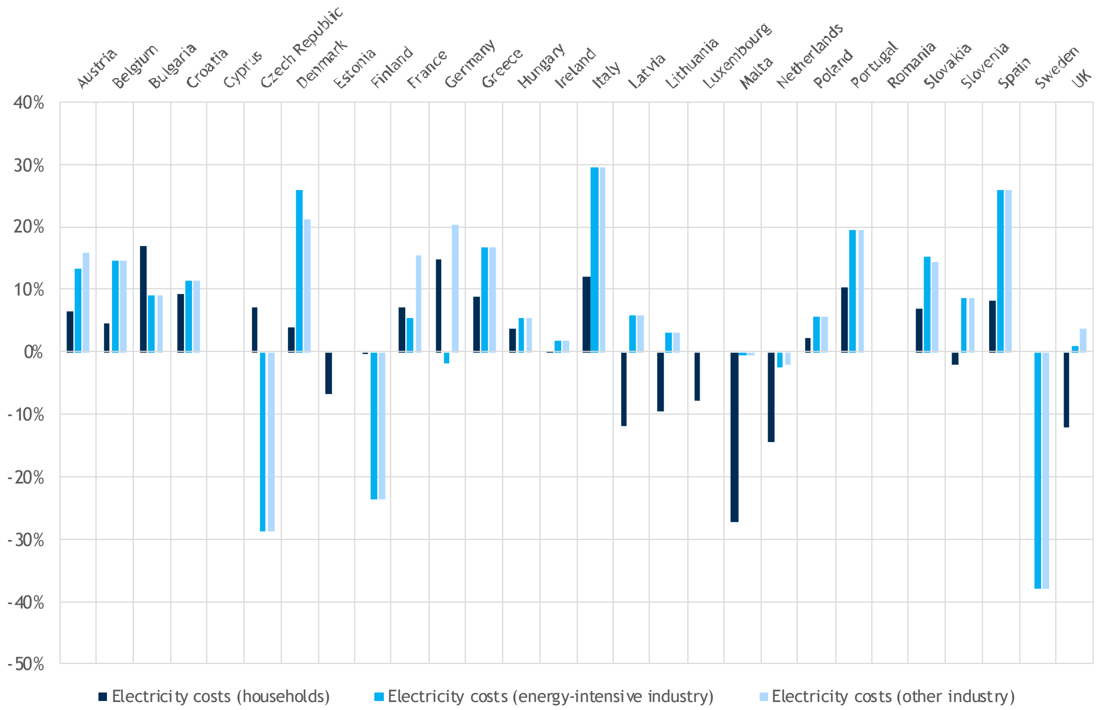
To assess the overall impacts of energy subsidies over 2008-2015 on energy costs for households and industry, we combine the impacts of tax exemptions and reductions (that have affected energy prices), energy loans and grants (that have affected energy consumption) and the financing cost for electricity production subsidies, that is borne by end-users. Our analysis shows that tax relief, loans and grants targeted towards energy prices and consumption have had a considerable impact on the energy costs faced by final consumers in a number of EU Member States. Figure 6-36 and Table 6-20 below shows the overall impact on energy costs resulting from energy tax relief subsidies and energy efficiency grants and loans in industry and households. The estimates include the financing cost of electricity production subsidies, which are typically paid for by a tax on final electricity consumption. The impact of energy production subsidies on wholesale gas and electricity prices are excluded. This is because it is unlikely that gas production subsidies have had a significant impact on wholesale or retail gas prices faced by final consumer. In the case of electricity, whilst production subsidies may have reduced wholesale electricity prices (by incentivising uptake of renewables), the impact this has had over the period 2008-2015 is estimated to be small or negligible in most Member States, particularly as the effect of higher renewables shares on the grid costs is likely to partially offset the higher.

Overall, the results show:

- Across all Member States, energy-intensive industry, other industry and households have benefitted from energy subsidies to varying degrees;
- In most Member States, the financing burden of subsidies for electricity production is imposed on final electricity consumers, through a tax that is levied on sales of electricity. Our results show that renewables (and other) support costs has led to a net increase in electricity costs over 2008-2016 for most final electricity consumers;
- The cost of financing subsidies for electricity producers tended to outweigh the effect of other subsidies in lowering electricity costs for final consumers. When taking account of the combined effect of all electricity subsidies and financing costs, there are only a few cases (households in Latvia, Lithuania, Estonia, Luxembourg, Malta, the UK, the Netherlands, and industry in Czech Republic, Sweden and Finland) where energy subsidies drove net electricity cost savings of over 5%;
- We estimate that the cost of financing subsidies for electricity production has increased electricity costs for industry by over 25% in some cases (e.g. in Italy, Spain and Denmark). In other cases (e.g. Germany and the UK), energy-intensive industries have been somewhat protected by tax exemptions and other means of support;
- Gas costs for households in Lithuania, Denmark, Luxembourg and the UK are estimated to be around 15-20% lower than they otherwise would have been due to energy subsidies targeted towards households (most notably, the VAT reductions for UK households and energy savings subsidies for Lithuanian households). In the Netherlands, energy tax exemptions for households drive an estimated 30% saving in gas costs;

- In Cyprus and Romania industry and households have not benefitted from energy subsidies at all over the period 2008-2015.

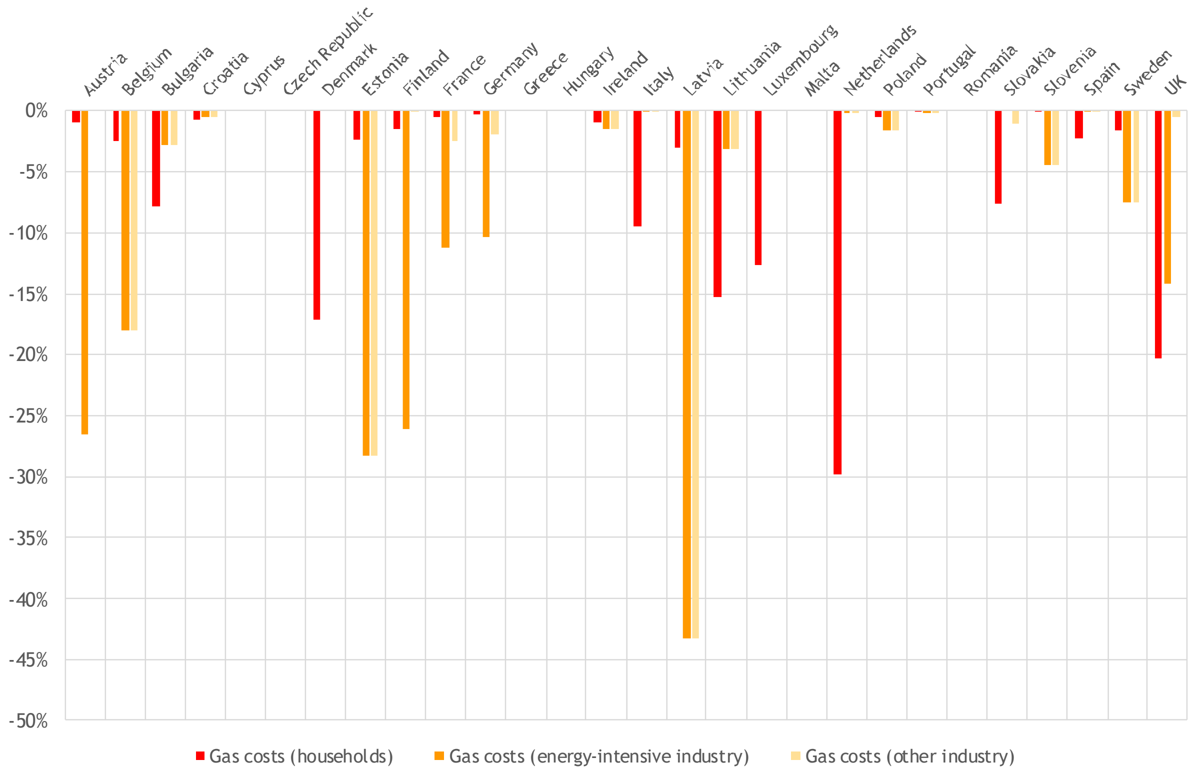
Figure 6-36: Estimated overall impact of energy subsidies over 2008-2016 on households and industry electricity costs (by EU Member State)



Source: Own calculations

Note(s): Results include the effect of tax exemptions, grants and loans for energy savings and investment, and the cost of renewables levies. Results are presented as percentage impact on energy costs.

Figure 6-37: Estimated overall impact of energy subsidies over 2008-2016 on households and industry gas costs (by EU Member State)



Source: Own calculations

Note(s): Results include the effect of tax exemptions, grants and loans for energy savings and investment, and the cost of renewables levies. Results are presented as percentage impact on energy costs.

Table 6-20: Estimated impact of energy subsidies (tax relief, energy efficiency loans and grants) over 2008-2016 on industry and household electricity costs in 2016

	Estimated impact on household electricity costs (%)	Estimated impact on energy-intensive industry electricity costs (%)	Estimated impact on other industry electricity costs (%)
Austria	7%	13%	16%
Belgium	5%	14%	14%
Bulgaria	17%	9%	9%
Croatia	9%	11%	11%
Cyprus	0%	0%	0%
Czech Republic	7%	-29%	-29%
Denmark	4%	26%	21%
Estonia	-7%	0%	0%
Finland	0%	-24%	-24%
France	7%	5%	15%
Germany	15%	-2%	20%
Greece	9%	17%	17%
Hungary	4%	5%	5%
Ireland	0%	2%	2%
Italy	12%	29%	29%
Latvia	-12%	6%	6%

	Estimated impact on household electricity costs (%)	Estimated impact on energy-intensive industry electricity costs (%)	Estimated impact on other industry electricity costs (%)
Lithuania	-9%	3%	3%
Luxembourg	-8%	0%	0%
Malta	-27%	0%	0%
Netherlands	-14%	-2%	-2%
Poland	2%	6%	6%
Portugal	10%	20%	20%
Romania	0%	0%	0%
Slovakia	7%	15%	14%
Slovenia	-2%	9%	9%
Spain	8%	26%	26%
Sweden	0%	-38%	-38%
United Kingdom	-12%	1%	4%

Source: Own calculations

Table 6-21: Estimated impact of energy subsidies (tax relief, energy efficiency loans and grants) over 2008-2016 on industry and household gas costs in 2016

	Estimated impact on household gas costs (%)	Estimated impact on energy-intensive industry gas costs (%)	Estimated impact on other industry gas costs (%)
Austria	-1%	-27%	0%
Belgium	-2%	-18%	-18%
Bulgaria	-8%	-3%	-3%
Croatia	-1%	-1%	-1%
Cyprus	0%	0%	0%
Czech Republic	0%	0%	0%
Denmark	-17%	0%	0%
Estonia	-2%	-28%	-28%
Finland	-1%	-26%	0%
France	0%	-11%	-2%
Germany	0%	-10%	-2%
Greece	0%	0%	0%
Hungary	0%	0%	0%
Ireland	-1%	-1%	-1%
Italy	-10%	0%	0%
Latvia	-3%	-43%	-43%
Lithuania	-15%	-3%	-3%
Luxembourg	-13%	0%	0%
Malta	0%	0%	0%
Netherlands	-30%	0%	0%
Poland	0%	-2%	-2%
Portugal	0%	0%	0%
Romania	0%	0%	0%
Slovakia	-8%	0%	-1%
Slovenia	0%	-4%	-4%

	Estimated impact on household gas costs (%)	Estimated impact on energy-intensive industry gas costs (%)	Estimated impact on other industry gas costs (%)
Spain	-2%	0%	0%
Sweden	-2%	-8%	-8%
United Kingdom	-20%	-14%	-1%

Source: Own calculations

Trinomics B.V.
Westersingel 34
3014 GS Rotterdam
The Netherlands

T +31 (0) 10 3414 592
www.trinomics.eu

KvK n°: 56028016
VAT n°: NL8519.48.662.B01

Trinomics