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Energy prices and costs in Europe

{COM(2020) 951 final}

6 Industry energy costs

Introduction

The chapter looks at the impact of energy prices and energy costs on selected European industrial sectors. We will first analyse to which extent energy costs are important for the overall economy, for industry and services. We will then map the energy costs of several manufacturing, services and agricultural sectors. Special attention is given to the most energy-intensive sectors, the profitability and competiveness of which can be significantly affected by energy price and costs changes. A decomposition analysis of the energy costs, gives insights on how energy prices, economic activity and energy intensity and other factors affecting these drivers, have influenced the evolution of energy costs over the last decade. Finally international comparisons of energy costs are made to the extent permitted by the limited available data.

Main findings

On the overall impact on the EU's economy

- Energy costs represent a small part of the gross value added in the economy.

- At EU level, its share is estimated at around 1.7% of the total production value of manufacturing (2% in 2014), 1% for services (1.2% in 2014) and around 1.1% of the combined group of industry and services in 2017 (1.4% in 2014).

- Over the past decade, we can notice two periods of time. Between 2008 and 2013 the indicator for EU27 oscillated between 1.44% and 1.73% (peak in 2009) for the share of energy for industry and services. This share is falling since 2014 with the continued decarbonisation of the EU's economy.

- For Member States (except for Latvia and Romania in 2009), the share of energy related costs in total production value, industry and services, remains under 6%, with most Member States recording shares under 3% and a general trend to decreasing.

Energy costs shares

- Energy costs shares in total (operational) production costs fell for all the *manufacturing* sectors studied between 2010 and 2017, with the most important declines being in *paper* (-5.7%), *cement* (-5.1%), *steel* (-2.9%) and *building materials* (-2.9%).
- Energy cost shares also declined for the majority of *non-manufacturing* sectors studied, with the exception of some *extractive-energy* industries and *air transport*.
- The fall in energy costs in *manufacturing* was more pronounced and generalised in recent years. Between 2010 and 2013 energy costs fell in most sectors with non-negligible rises in shares in only a few of the most energy-intensives sectors like *man-made fibres*, *stone*, *glass*, *refractory products*, *ceramics*, *building materials* and in less

energy-intensive sectors like *computers*. Between 2014 and 2017 energy cost fell in *all* manufacturing sectors.

- Energy costs in manufacturing accounted for around 1-10% of production costs. For some sectors of the most energy-intensive sectors, energy costs accounted for more than 10% of production costs in at least one year, e.g. for *paper, clay building materials, iron and steel* and *cement* (on the latter sector the energy costs share was consistently above 10%).
- Energy costs are typically 1-3% of production costs amongst the less energy-intensive sectors studied. *Computers*, *motor vehicles*, *electric equipment,* and *machinery* display energy costs shares around 0.6%-0.7% and *pharmaceuticals* reaches 1%.
- Amongst the *non-manufacturing* sectors studied, energy cost shares are comparable to or even higher than the most energy-intensive manufacturing sectors (see above) in the case of *land transport, air transport, mining of metal ores,* e*lectricity-gas* and o*ther mining*. Energy cost shares are also significant in *accommodation and restaurants (3-4.7%), waste management* (~2%) while rather small in *construction (~1%)* and *trade (0.4%).*

Drivers of energy costs for industry

- The aggregated energy costs of the sectors studied at EU level fell by 13% over 2010-2017. A lower energy intensity contributed to the reduction in energy costs (by inducing at least a -15% decrease in costs). The decomposition analysis shows that the decrease in energy costs happened despite slightly increasing *prices* (that induced +2% increase in energy costs) and significant increases of *output* (that induced a +11% of the increase in energy costs).

- A very significant part of the decrease in energy costs over the period could not be linked directly to any of these three factors (a -11% additional reduction in energy costs is explained by the residual). The possible data limitation on price data (which may not account for all tax exemptions and reductions) and in particular the low quality of the energy consumption data may explain the high residual which could be due to an underestimation on the reduction of energy intensity.

- The analysis of the drivers behind these effects, indicates that the increase in output was driven almost completely by growth in domestic demand and that external demand increases were negligible. The lower energy intensity was explained to a very small extent by sectoral structural changes and fuel switching, suggesting that energy efficiency improvements of the processes would have played an important role in reducing the energy intensity, in particular amongst the less energy-intensive industries. These could have exploited their high potential for improving energy efficiency, as opposed to high energy insensitive industries which have been improving energy efficiency already for decades.

- Energy costs have a negligible negative impact (-0,3%) on the increase of the Total Production Costs in the vast majority of manufacturing sectors analysed over the period of study.

- Over the period 2010-2017, energy cost shares have fallen in *all* the manufacturing sectors studied. The largest declines in energy cost shares were observed in the most energy-intensive sectors like *cement* and *paper* (around -5%). *clay building materials* and steel (around -3%), *glass* and *chemicals* (-2%). Many other of the less energy-intensive sectors show smaller declines in absolute numbers (between -0.1% and -0.6%). However, in proportional terms there were rather significant declines for some of the less energy-intensive sectors (~ a proportional decline of the share from 20% to 40% of their shares).

Energy intensity

- Energy intensity (energy consumption/GVA) varies considerably across the sectors studied depending predominantly the technological production process. In manufacturing sectors, the highest energy intensity values appear in *steel*, *cement*, *refineries*, *paper and basic chemicals.* In non-manufacturing sectors, the highest energy intensities are found in *land transport* and *electricity-gas.*

- Energy intensity fell in most of the highly energy-intensive sectors in *manufacturing*, including *non-ferrous metals*, *steel*, *refineries* and *paper.* Energy intensity, however, increased in a few sectors such as *cement*, *clay building materials*, *grain products*, *sawmills* and *basic chemicals*. In relative terms, the energy intensity indicator fell the most in *stone* (-60%), *man-made fibres* (-45%), *refineries* (-55%) and *paper* (-20%).

- Energy intensity decreased for the vast majority of the less energy-intensive manufacturing sectors in the EU between 2011 and 2017. The decreases were small but important in relative terms for many sectors like *textiles*, *articles of paper*, *electrical equipment*, *computers*, *machinery* and *motor vehicles.*

- In *non-manufacturing*, energy intensity decreased in sectors like *land transport* and *air transport*, although it increased in *electricity-gas.* Amongst those with lower energy intensity, the results were mixed.

International comparisons

- The situation did not change too much with respect to the previous report (which covered the period between 2008 and 2017, while the current one is covering until 2019)[51].

- For the most energy-intensive sectors, in most of the cases, the EU energy costs shares in production costs are lower or similar to those in the US sectors, with the exception of *non-ferrous metals (aluminium)* which display lower energy costs shares in the US. The result of the comparison of the energy costs shares of the EU most energy-intensive sectors with Japanese sectors is mixed. The Korean sectors displays the lowest energy costs shares in production costs of the countries studied.

- The energy intensity (proxy of energy efficiency)[52] of EU sectors studied is consistently lower that in China. The EU sectors display an overall comparable energy intensity to those in the US, yet with differences across the specific sectors.

- Electricity prices for industry in the EU are lower than Japan, slightly higher than China and higher than US prices (US prices are half the EU levels). Amongst the other non-EU G20 countries studied, only Brazil and UK have higher prices than the EU while Canada, India, Russia, Mexico, South Korea and Saudi Arabia have lower prices. Turkey's prices are lower but converging to the EU average in the last years.

- Electricity prices for industry in the EU increased over the period (from 95 EUR/MWh in 2008 to 115 EUR/MWh in 2019). Prices peaked in 2013 (125 EUR/MWh) and were declining until 2017, before rising again..

- The electricity price gap of the EU with the US and China (which has been favourable for these two countries since 2011) has widened in recent years, marginally with the US and more significantly with China (where prices continuously declined since 2011). The gap with Japan (which is favourable for the EU) widened in recent years as Japanese prices stopped to converge to EU price levels and are rising since 2017. In recent years, prices in South Korea were decreasing, widening the unfavourable price gap for the EU, while prices in Turkey increased sharply, reducing the unfavourable price gap for the EU.

- Gas prices for industries in the EU are higher than in most of the non-EU G20, particularly gas producing countries (e.g. in the US, Canada, Russia, and Brazil prices are around half the EU prices) but lower than in Asian trade partners (Japan, South Korea, China).

- Gas prices for industries in the EU have declined over 25% over the whole period 2008-2017. They have fluctuated, rising at the start of the period and then falling, but have remained at around 24 EUR/MWh since 2016. Over the same period prices declined in most of the other G20 countries even further than in the EU.

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[51] The latest data available is for the current period (2010-2019) was 2017. For the previous period (2008-2017) the latest data available was 2015.
[52] Data available across sectors and countries is rather limited

— The price gap developments were unfavourable for the EU when compared with the US and Canada (where prices due to the shale gas revolutions reached 10 EUR/MWh in 2016), South Korea and Brazil. Conversely, price gaps improved for the EU with China, Russia, Japan, Australia and Turkey as prices in some of these countries increased in recent years. It also improved with regards to Mexico, India, Saudi Arabia and South Africa were prices remained relatively stable over the last years.

— The evolution of nominal prices was significantly affected in some cases by inflation and exchange rate changes. Over the studied period, high inflation considerably pushed up prices in countries like Brazil and Indonesia while in Russia and Turkey the inflationary effects were mitigated by exchange rates depreciations. Overall appreciation of the Euro vs US dollar and Yuan since 2016 pushed down US and Chinese prices in recent years.

6.1 Energy costs and their impact at macroeconomic level

In this section we look at the overall impact of energy costs on the economy of the EU and its Member States. This is done by calculating the shares of energy costs in the total production value of the whole industry and services sectors in each Member State.

Energy costs are part of production costs of all sectors (we cannot produce without energy!). They represent a significant share of the production costs of energy-intensive sectors in manufacturing and services (see section **6.2**) and thereby they can also be significant for the production costs of countries where energy-intensive sectors account for an important part of their economies.

The calculated indicators will allow us to estimate that importance and also gauge the potential importance of energy costs for competitiveness. That said, energy costs make up just one of the many factors that contribute to the general competiveness of a country and its economy (see Box below).

Box - Energy costs and competitiveness

To understand the competitiveness of industrial sectors is complex. Their competiveness (i.e. their ability to compete in markets to sell or attract investments) depends on the prices and costs of their products (cost- competitiveness), the quality of their products and other characteristics beyond the products' costs and functionalities which correspond to consumers values (e.g. ecological impact, fair trade, human rights considerations, etc.).

The productivity of labour force (based on their skills and costs), the access to capital, and low costs of basic inputs (like energy) can contribute to reduce production costs and increase quality of products for a sector in a country or region.

However, other institutional factors of the country or region where the sector is located (access to big regional markets, lower barriers to trade, economic and political stability, legal certainty, reliability of energy supply, taxation, investment frameworks, etc.) are also important for producers to decide where to produce and invest or for consumers to decide from whom to buy final products or inputs.

Several international institutes and organisations have developed methodologies and composite indexes that measure the factors that influence the competitiveness of a given economy. Good examples of it are the *Global Competitiveness Indicator* of the World Economic Forum (WEF) [53], the *World Competitiveness Scoreboard* of the International Institute for Management Development (IMD)[54] and the *Economic Freedom of the World Index* of Fraser Institute (FI)[55]

This section will help us to position energy-related costs as part of the complex group of factors that impact competitiveness, productivity and economic decisions to invest. Energy is essential to produce but from the macro-economic perspective, as we will soon see, the importance of energy appears to be modest when compared to total production value.

The **relative share of energy in total factor production costs** can be proxied by the share of energy products in total production value, as reported by the Structural Business Statistics (SBS) tables in Eurostat. This approach has **several important limitations**, listed in the Box at the end of this section, but remains the only viable one in terms of harmonised and publically available data.

Figure 136 shows the evolution of the share of energy-related costs in total production value in the broad classes of industry and services[56]. At the EU level, and for the last decade of observed data, this share has decreased from 1.5-1.7% to around 1.0%-1.3%.

[53] World Economic Forum; Global Competitiveness Report 2017-2018. The Global Competitiveness Indicator of the World Economic Forum (WEF) https://www.weforum.org/reports/the-global-competitiveness-report-2017-2018

[54] The World Competitiveness Scoreboard of the International Institute for Management Development (IMD), https://www.imd.org/wcc/world-competitiveness-center-rankings/world-competitiveness-ranking-2018/

[55] Economic Freedom of the World indicator, Fraser institute, https://www.fraserinstitute.org/studies/economic-freedom

[56] Industry defined as the combination of Sections B (Mining and quarrying), C (Manufacturing), D (Electricity, gas, steam and air conditioning supply) and E (Water supply, sewerage, waste management and remediation activities) of NACE Rev. 2, the Statistical classification of economic activities. Services defined as the grouping of NACE Rev. 2 sections A (Agriculture, forestry and fishing), G (Wholesale and retail trade; repair of motor vehicles and motorcycles), H (Transportation and storage), I (Accommodation and food service activities), J (Information and communication), K (Financial and insurance activities), L (Real estate activities), M (Professional, scientific and technical activities) and N (Administrative and support service activities).

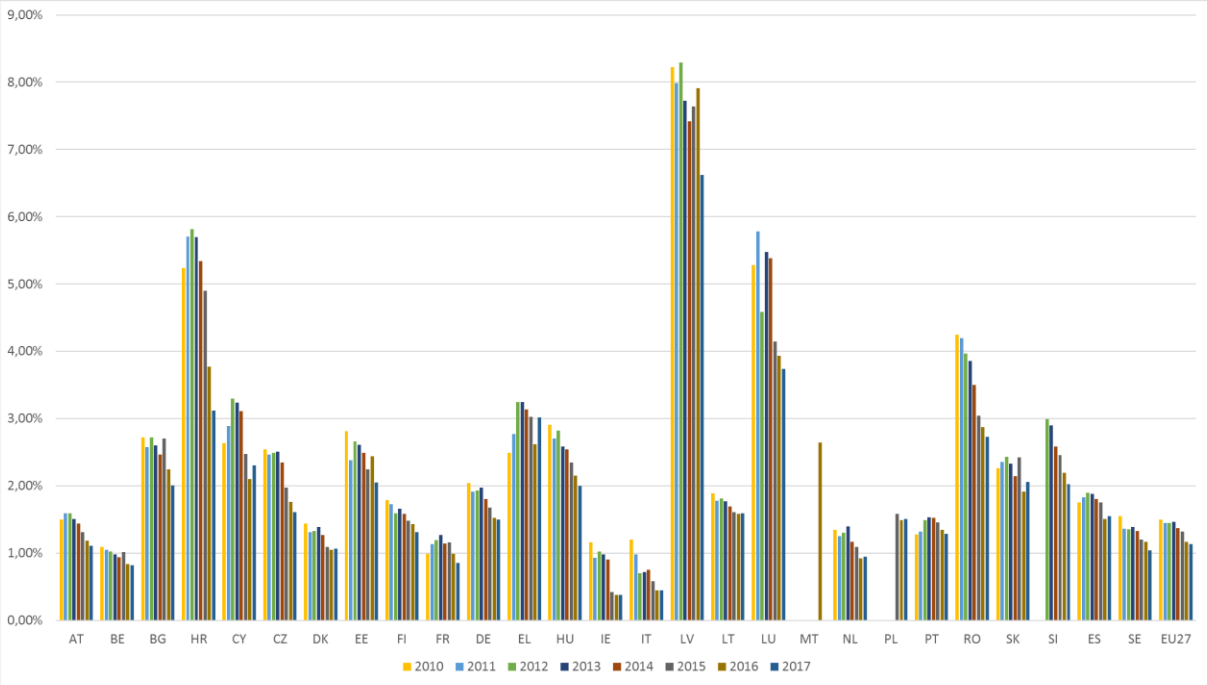

Figure 136- Evolution of energy costs shares in production value, industry and services

Source: Own calculations

Notes:

1. Data for Malta (prior to 2016 and for 2017), Poland (prior to 2015), Slovenia (prior to 2012) and Greece (prior to 2008) is not available. Data for 2018 was missing at the time of extraction

Figure 137 represents the share of energy-related costs for the manufacturing sector and across the EU Member States. Throughout the 2008-2017 period, and where data is available, the energy share has gradually decreased for the majority of Member States. At the EU level, it went from 2.2%-2.5% at the beginning of the period to 1.5%-2.0% at the end. In 2017, the share represented for industry is 1.7% (2.0 % in 2014) and for services 1% (1.2% in 2014). Member States with relatively smaller size would typically present a higher and more oscillating share than average; probably pointing to the fact that these economies have a relatively less diversified portfolio of manufacturing industries centred mainly on more energy-intensive sectors.

Data shows that the share of energy related costs in the EU is on a consistent downward trend. Some Member States such as Belgium, France, Italy, and the Netherlands have decreased in 2017 a share of energy related costs in total production value, industry and services (lower than 1%). On the other hand, Cyprus, Denmark, Estonia, Germany, Greece, Lithuania, and Spain show in 2017 a stagnation (or even a slight increase) of this indicator. Finally, only Croatia, Cyprus, Greece, Hungary, Latvia and Luxembourg still show a share of 3% or more in 2017.

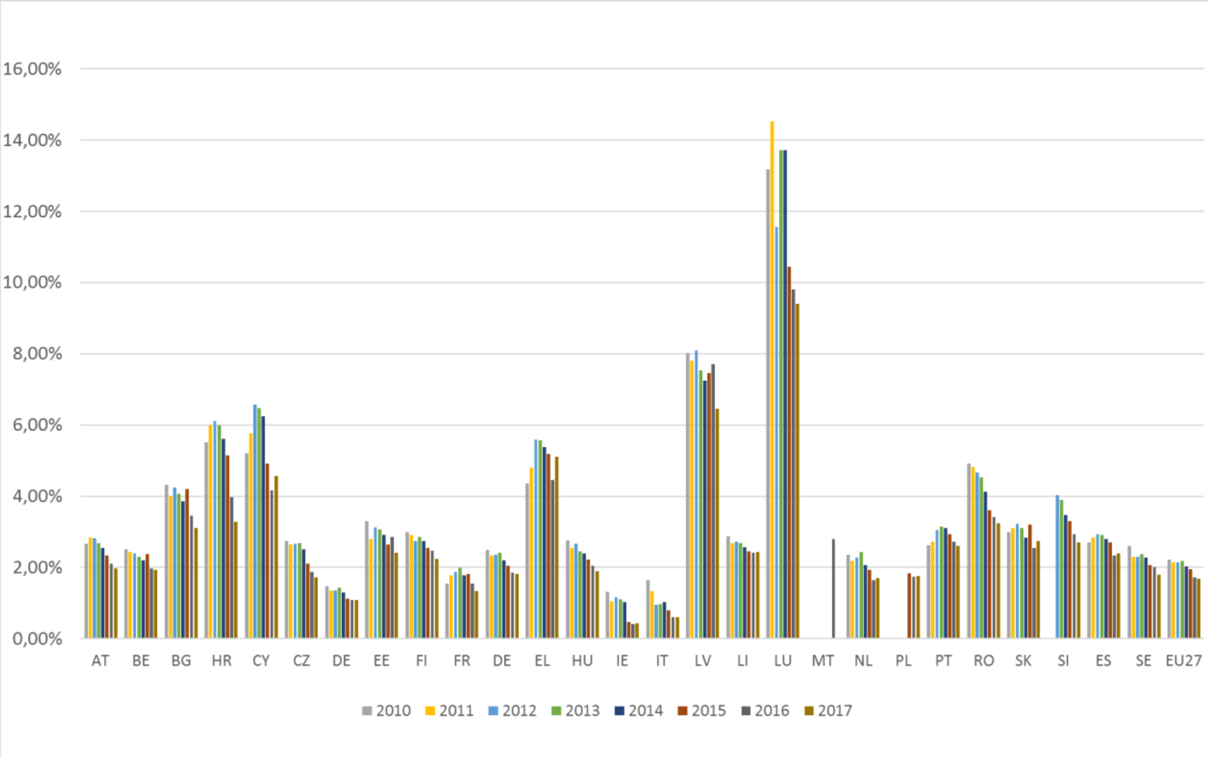

Figure 137: Evolution of energy costs shares in production value for Manufacturing

Source: Own calculations

Notes:
1. Data for Malta (prior to 2016), Poland (prior to 2015), Slovenia (prior to 2012) and Greece (prior to 2008) is not available. Data for 2018 was missing at the time of extraction

It is to be noted that in 2017 large Member States such as France, Germany, Italy and Poland have a share of energy products in total production value in manufacturing which is under 2%, but not Spain, which is slightly above 2% and even sees this share increase in 2017 compared to 2016.

Box- Data limitations

- There is no one-on-one mapping between the economic indicators of SBS and the profit and loss account of real companies;

- Capital expenditure (CAPEX) is difficult to collect in SBS, forcing the estimation of the energy component to rely solely on operating expenditure (OPEX); as a result the provided estimation is not assessing the long term investment and cannot determine the relative share of investment in improved energy performance tools over the total stock of investment;

- The purchases of energy product data is available only for NACE Rev. 2 sections B (Mining and quarrying), C (Manufacturing), D (Electricity, gas, steam and air conditioning supply) and E (Water supply, sewerage, waste management and remediation activities). It is not available for important industrial sections such as Section F (Construction) and energy-intensive sections such as H (Transportation and storage). More importantly, it is not available for all services sectors. According to the 2015 Commission report on single market integration and competitiveness, the relative share of the services sector in the 2014 Total Value Added in the EU 28 stood at almost 75%, as opposed to 15% for Manufacturing.

- Based on the definition of the Commission Regulation (EC) No 250/2009, the structural business statistics (SBS) code "20 11 0 Purchases of energy products" includes only energy products which are purchased to be used as a fuel. Energy products purchased as a raw material or for resale without transformation (such as crude oil) are excluded.

6.2 Energy costs for industry

Sources, scope and methodology

This chapter mainly relies on findings from studies commissioned by the European Commission to external consultants and the Commission's works. The study on *'Energy prices, costs and their impact on industry and households'* by *Trinomics et altri*[57] (2020), onwards *Trinomics (2020),* provides data and analyses of 43 sectors, mainly from manufacturing sectors but also including relevant sectors from agriculture, extractive industries and services. This information has been complemented by Commission staff direct inputs and studies (e.g. JRC Technical report on 'Production costs from the iron and steel industry in the EU and third countries' (2020) [58]).

The *study by Trinomics et altri* combines a *top-down approach* using aggregated statistical data (20 manufacturing sectors at NACE 3 level, 10 manufacturing sectors at NACE 2 level, 7 non-manufacturing level at NACE 2 level and 5 other non-manufacturing at NACE level 1) with a *bottom-up* approach, collecting plant data with questionnaires[59].

The use of these two methodological approaches is complementary and provides a comprehensive idea of the importance of energy prices and costs for the EU industries. Highly aggregated data (used in a top down approach) is useful for understanding long term trends. This data is available in official statistics, with stable methodologies and long time series. But aggregated data fails to capture the diversity of the subsectors contained in it, with different products and production processes. Plant data (bottom up approach) is much better for identifying targeted sub-sectors and represent their characteristics. There is however a caveat. Plant data is generally scarce and its 'representativity' of a sector depends critically on having a sufficiently large sample that properly replicates the structure and general characteristics of the subsector (geographic location of the plants, proportion of large or small firms, etc.)

Trinomics (2020) analysed energy costs and other indicators across 42 sectors (see **Table 11** and **Table 12**) of different levels of aggregation. The sectors studied were those which have been identified in the two previous editions of the energy prices and cost reports on the basis of i) the i*mportance of energy costs for the sector, proxied* by the energy cost per production value[60] ii) the sector's e*conomic relevance*, proxied by the share of sectoral value added in GDP of the country and its economic or strategic importance; and iii) the sector's *trade exposure*, proxied by the trade intensity of the sector[61].

[57] Consortium is made up by Trinomics B.V. in association with Enerdata, Cambridge Econometrics and Ludwig Bölkow systemtechnik.
[58] https://ec.europa.eu/jrc/en/publication/production-costs-iron-and-steel-industry-eu-and-third-countries
[59] This is similar to the approach used by in the previous edition of the Energy prices and cots report in which the study on 'Composition and drivers of Energy: case studies in selected Energy-intensive industries' by CEPS and Ecofys (2018) provided case studies of 8 energy-intensive subsectors.

[60] Calculated (where possible) by dividing purchases of energy by the total production value of each sector
[61] Trade intensity was calculated by dividing the sum of imports and exports of a product to and from the EU in total, by the size of the market which is represented by the sum of production value and imports

Table 11 - Coverage of manufacturing sectors

Coverage of Manufacturing of the *Study by Trinomics et altri (2020)*			
Aggregated data		*Plant data*	
Sector	Level of aggregation (NACE code)	Sector	Level of aggregation (NACE code)
Processing of **Fruits and vegetables**	C103		
Grain mill and starch products	C106		
Manufacturing of **Beverages**	C11		
Weaving of **textiles**	C132		
Sawmilling and planing of **wood**	C161		
Pulp, paper and paperboard	C171		
Articles of paper and paperboard	C172		
Refined petroleum products	C192	**Refineries**	C1920*
Basic chemicals and fertilisers	C201	**Nitrogen fertilisers**	C2015*
Man-made fibres	C206		
Basic pharmaceutical products	C21		
Plastics products	C222		
Glass and glass products	C231	**Flat glass**	C2311*
Refractory products	C232		
Clay building materials	C233		
Porcelain and ceramic products	C234		
Cement, lime and plaster	C235		
Cutting **stone**	C237		
Abrasive products and non-metallic	C239		
Basic **iron and steel** and of ferro-alloys	C241	**Iron and steel**	C2410+
Non-ferrous metals	C244	**Aluminium**	C2442+
		Lead, **zinc**, tin	C2443*
		Copper	C2444*
Casting of metals	C245		
Fabricated metal products (except	C25		
Computer, electronic and optical	C26		
Electrical equipment	C27		
Machinery and equipment n.e.c.	C28		
Motor vehicles, trailers and semi-trailers	C29		
Other transport equipment	C30		
Other manufacturing	C32		
Repair, installation of machinery	C33		

* The sector analysed is a subsector of the NACE code mentioned.
+ The sector was contacted but unable to provide data due to COVID-related circumstances
Source: European Commission Services

Note: Shaded sectors are those most energy-intensive

Table 12 - Coverage of other sectors, excluding manufacturing

Coverage of other agriculture, mining, construction and services *Study by Trinomics et altri*	
Sector	Level of aggregation (NACE code)
Agriculture, forestry and fishing	A
Mining and quarrying	B
Extraction of crude petroleum and natural gas	B06
Mining of **metal ores**	B07
Other mining and quarrying	B08
Electricity, gas, steam and air-conditioning supply	D35
Water supply, sewerage, water management and remediation activities	E38
Construction	F
Wholesale and retail **trade**	G
Land Transport	H49
Air Transport	H51
Accommodation and food service activities	I
Information and communication	J
Data Centres - Data processing, hosting and related activities; web portals	J631

Source: European Commission Services

Energy costs shares

The share of energy costs in the total production cost is a good indicator of the impact that energy costs can have on the financial health and on price competitiveness of the various industrial sectors. Using Eurostat SBS, energy cost shares are calculated by dividing the purchases of energy by total production costs, where total production costs are equal to total purchases of goods and services (including energy)[62] plus personnel costs.

When interpreting the energy costs shares based on SBS data, we should keep in mind that results of aggregated sectors usually underestimate the importance of energy costs for the industrial segments with the highest energy intensity. This is particularly true for chemicals, cement, non-ferrous metals, steel and paper sectors which include highly energy-intensive primary producers together with producers of low energy-intensive secondary products. Self-consumption of energy (not rare in energy-intensive sectors) is also not captured by SBS data. The plant data complements aggregated data and can provide better insight of the prices and costs of industrial segments.

Results on energy costs shares

Table 13 shows the evolution of the *shares of energy costs in total production costs* for all the manufacturing and non-manufacturing sectors studied between 2010 and 2017.

The results of the analysis of the energy cost shares over the last decade do not differ much from the trends analyses of previous editions of the study:

- Energy costs for the selected manufacturing sectors continue to typically account for around 1-10% of total (operational) production costs, although for some sectors the costs significantly exceed 10% (e.g. *Cement, lime and plaster* and *Clay building materials*)

- Amongst the most energy-intensive manufacturing sectors (energy costs typically >3%), energy costs accounted for more than 10% of production costs in at least one year in the *pulp and paper, clay building materials, iron and steel* and in particular, the *cement, lime and plaster* sectors.

- Amongst the less energy-intensive manufacturing sectors (energy costs typically < 3%) many sectors displayed quite low energy costs shares. For example, *computers and electronics, electrical equipment, machinery, motor vehicles, other transport equipment* and *pharmaceuticals* have energy costs shares between 0.5% and 1% of total production costs. *Metal products, beverages, textiles, plastics* energy costs shares are around 2%.

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

- Over the period 2010-2017, energy cost shares have fallen in all the manufacturing sectors studied. The largest declines in cost shares were observed in the most energy-intensive sectors like *cement* and *paper* (around -5%), *clay building materials* and steel (around -3%), *glass* and *chemicals* (-2%). Many other of the less energy-intensive sectors show smaller declines in absolute numbers but proportionally rather significant. For the vast majority of manufacturing sectors, energy costs fell while production costs rose between 2010 and 2017.

- Over the period, energy costs shares also fell for the majority of non-manufacturing sectors studied with the exception of *oil and gas* (+0.7), *air transport* (+2%) and other mining (+0.1%). The energy costs and production costs dynamics for non-manufacturing sectors were mixed.

Note on the sectors' energy costs and the fuel mix

Energy costs for industry are driven by energy prices and the quantities consumed of each product. In the short term, prices vary widely driving the changes in energy costs, while energy consumption tends to be more stable (as it depends on consumption patterns, the economic situation and energy efficiency). The consumption fuel mix of a sector tells us about the potential of price changes of each energy product to affect energy costs.

Figure 138 displays the average importance of fuels in terms of energy consumption by sector. We can observe that electricity and gas (depending upon the specific sector) are the most consumed energy products. Amongst the most energy-intensive sectors, gas is widely used in sectors like *glass, ceramics, refractory products* and *building materials,* while electricity is predominant in *non-ferrous metals, stone* and *metal products*. Amongst the less energy-intensive sectors, electricity tends to be the most consumed fuel, being particularly important for sectors like *computers, plastics, textiles electrical equipment, machinery, motor vehicles.* Gas is however relevant for the manufacturing of *grain, vegetables or beverages*. "Other energies", in particular biomass, represent an important consumption share in sectors like *sawmills* (>80% of consumption), *man-made fibres* (nearly 60%), *stone* (nearly 40%) and *paper* (nearly 30%).

Electricity is the most expensive product as compared to the other fuels and it has the proportionally largest impact on energy costs. Electricity costs shares are traditionally high for *non-ferrous metals* and less energy-intensive sectors like *computers or pharmaceuticals*. Natural gas has traditionally a major impact on sectors like *glass, ceramics* and *gas-intensive basic chemicals (e.g. fertilisers)*. Oil and coal have a small impact on the energy costs in most of the sectors. That said, oil costs are very important for *refineries* and significant for *cement, lime and plaster* and *basic chemicals.* Coal costs are relevant for *steel* and other sectors with a sizable coal consumption (e.g. *abrasive products, cement* and *casting of metals)*

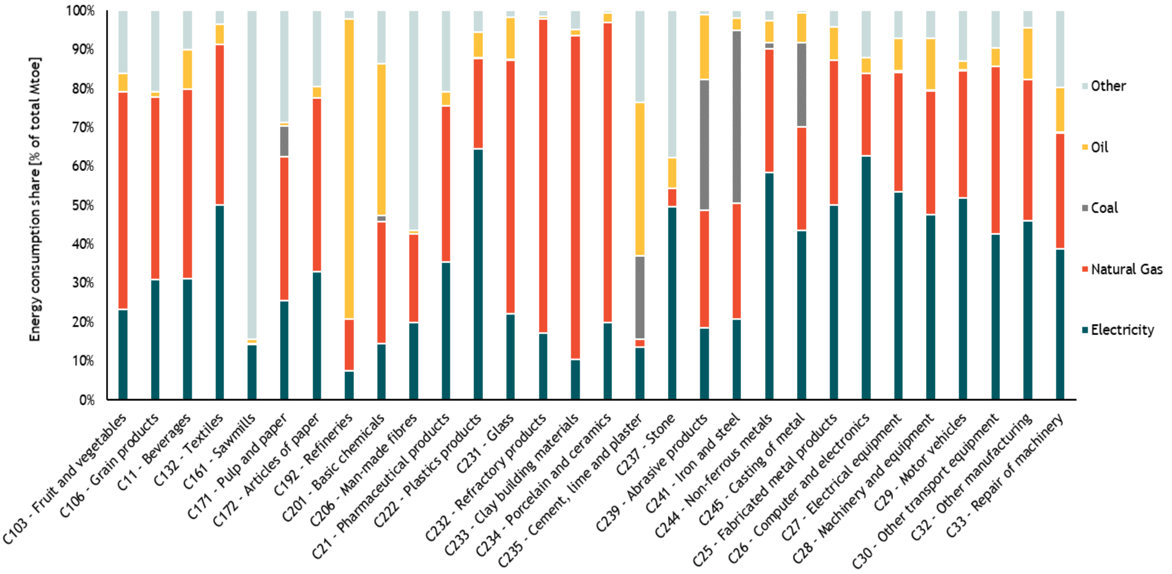

Figure 138 - Breakdown of the energy consumption per energy carrier, EU, 2008-2017 averages

Source: Trinomics et altri study (2020)
Note: “other” combines biomass and heat energy consumption

Table 13 - Energy costs shares in total production costs for manufacturing and non-manufacturing sectors, 2010-2017

Manufacturing (Section C0	2010	2011	2012	2013	2014	2015	2016	2017	Absolute change 2010-2013	Absolute change 2014-2017	Absolute change 2010-2017	Relative change 2010-2017	Average	Max. level
C103 - Fruit and vegetables	2.9%	2.9%	3.1%	2.9%	3.0%	2.5%	2.5%	2.3%	0.0%	-0.7%	-0.6%	-21.9%	2.8%	3.1%
C106 - Grain products	3.7%	3.4%	3.6%	3.4%	3.6%	3.3%	2.8%	2.6%	-0.4%	-1.0%	-1.1%	-30.5%	3.3%	3.7%
C132 - Textiles	3.7%	2.5%	2.7%	2.3%	2.2%	2.0%	2.1%	2.2%	-1.3%	0.0%	-1.5%	-40.4%	2.5%	3.7%
C161 - Sawmills	3.5%	4.0%	3.6%	3.5%	3.4%	3.1%	3.2%	3.1%	0.0%	-0.4%	-0.4%	-12.7%	3.4%	4.0%
C171 - Pulp and paper	11.4%	11.3%	10.7%	9.8%	9.0%	8.4%	6.9%	6.7%	-1.6%	-2.3%	**-4.7%**	-40.9%	9.3%	11.4%
C172 - Articles of paper	3.0%	2.7%	2.8%	2.9%	2.5%	2.4%	2.1%	2.1%	-0.1%	-0.4%	-0.9%	-29.3%	2.6%	3.0%
C192 - Refineries	2.2%	2.0%	2.2%	2.1%	2.0%	2.3%	1.8%	1.6%	0.0%	-0.5%	-0.6%	-28.0%	2.0%	2.3%
C201 - Basic chemicals	6.8%	7.1%	6.4%	6.4%	5.8%	5.5%	5.0%	4.6%	-0.4%	-1.2%	**-2.2%**	-32.7%	5.9%	7.1%
C206 - Man-made fibres	6.8%	6.8%	5.9%	8.5%	6.4%	6.2%	7.2%	5.3%	1.7%	-1.2%	-1.5%	-22.2%	6.6%	8.5%
C222 - Plastics products	2.9%	2.9%	2.7%	2.9%	2.7%	2.5%	2.3%	2.2%	0.0%	-0.5%	-0.7%	-23.1%	2.6%	2.9%
C231 - Glass	8.4%	8.4%	9.7%	9.5%	8.6%	8.0%	6.8%	6.6%	1.1%	**-2.0%**	-1.8%	-21.7%	8.2%	9.7%
C232 - Refractory products	6.5%	6.3%	7.0%	7.2%	6.3%	6.5%	6.8%	5.3%	0.7%	-1.0%	-1.2%	-18.6%	6.5%	7.2%
C233 - Clay building materials	12.1%	11.0%	12.4%	12.4%	11.2%	11.1%	9.6%	9.0%	0.3%	-2.2%	-3.0%	-25.1%	11.1%	12.4%
C234 - Porcelain and ceramics	5.2%	5.4%	5.6%	5.7%	5.3%	4.5%	4.4%	4.0%	0.5%	-1.3%	-1.2%	-22.6%	5.0%	5.7%
C235 - Cement, lime and plaster	20.3%	21.2%	19.1%	19.3%	18.6%	17.6%	15.4%	15.2%	-1.0%	**-3.4%**	**-5.1%**	-25.3%	18.3%	21.2%
C237 - Stone	3.5%	3.6%	2.9%	4.6%	3.1%	3.4%	2.6%	3.3%	1.1%	0.1%	-0.2%	-5.7%	3.4%	4.6%
C239 - Abrasive products	5.0%	4.8%	5.1%	5.2%	5.0%	5.0%	5.0%	4.6%	0.2%	-0.4%	-0.4%	-7.3%	5.0%	5.2%
C241 - Iron and steel	9.5%	7.5%	8.2%	8.2%	7.0%	7.5%	7.2%	6.6%	-1.3%	-0.4%	**-2.9%**	-30.8%	7.7%	9.5%
C244 - Non-ferrous metals	4.1%	4.0%	3.9%	4.1%	3.8%	3.8%	3.1%	3.1%	0.0%	-0.7%	-1.0%	-23.5%	3.7%	4.1%
C245 - Casting of metal	6.1%	5.3%	5.5%	5.5%	5.3%	4.9%	4.8%	4.6%	-0.6%	-0.7%	-1.5%	-24.4%	5.2%	6.1%
C11 - Beverages	2.6%	2.7%	2.7%	2.6%	2.6%	2.4%	2.2%	2.2%	0.0%	-0.4%	-0.4%	-15.8%	2.5%	2.7%
C21 - Pharmaceutical products	1.2%	1.2%	1.2%	1.2%	1.2%	1.1%	1.0%	1.0%	0.0%	-0.2%	-0.2%	-18.6%	1.1%	1.2%
C25 - Fabricated metal products	2.3%	1.9%	2.0%	2.1%	2.0%	1.9%	1.8%	1.7%	-0.2%	-0.3%	-0.6%	-24.9%	1.9%	2.3%
C26 - Computer and electronics	0.7%	0.7%	0.7%	0.8%	0.7%	0.7%	0.7%	0.6%	0.1%	-0.1%	0.0%	-0.5%	0.7%	0.8%
C27 - Electrical equipment	1.0%	1.0%	1.0%	1.0%	1.1%	0.8%	0.8%	0.7%	-0.1%	-0.3%	-0.3%	-27.7%	0.9%	1.1%
C28 - Machinery and equipment	1.0%	0.9%	0.9%	0.9%	0.9%	0.8%	0.8%	0.7%	0.0%	-0.2%	-0.2%	-24.0%	0.9%	1.0%

C29 - Motor vehicles	0.8%	0.8%	0.8%	0.8%	0.7%	0.7%	0.6%	0.6%	0.0%	-0.1%	-0.3%	-31.0%	0.7%	0.8%
C30 - Other transport equipment	0.9%	0.9%	0.9%	0.9%	0.7%	0.8%	0.6%	0.5%	0.0%	-0.2%	-0.3%	-38.8%	0.8%	0.9%
C32 - Other manufacturing	1.1%	1.1%	1.0%	1.0%	1.0%	0.9%	0.9%	0.8%	-0.1%	-0.2%	-0.3%	-29.5%	1.0%	1.1%
C33 - Repair of machinery	1.0%	1.1%	1.1%	1.1%	1.1%	0.9%	0.8%	0.8%	0.1%	-0.2%	-0.2%	-18.4%	1.0%	1.1%
Non- Manufacturing (Other sections)														
B - Mining and quarrying	2.9%	2.8%	2.8%	2.9%	2.9%	3.0%	3.1%	5.1%	0.0%	2.2%	**2.2%**	76.2%	3.2%	5.1%
B06 - Oil and gas	0.2%	0.2%	0.2%	0.2%	0.2%	0.3%	0.3%	0.9%	0.0%	0.6%	**0.7%**	380.6%	0.3%	0.9%
B07 - Mining of metal ores	19.7%	20.8%	19.6%	19.4%	17.7%	18.4%	16.7%	17.1%	-0.3%	-0.7%	-2.7%	-13.5%	18.7%	20.8%
B08 - Other mining	8.6%	9.6%	9.6%	9.7%	9.2%	8.9%	8.0%	8.7%	1.1%	-0.5%	0.1%	1.6%	9.0%	9.7%
D35 - Electricity, gas and steam	16.2%	15.8%	14.0%	12.7%	11.9%	11.9%	14.5%	13.0%	**-3.5%**	1.1%	**-3.2%**	-19.7%	13.7%	16.2%
E38 - Waste management	2.0%	1.9%	2.0%	2.3%	2.3%	2.0%	1.7%	1.7%	0.3%	-0.6%	-0.3%	-15.5%	2.0%	2.3%
F - Construction	1.2%	1.3%	1.2%	1.2%	1.2%	1.1%	1.1%	1.0%	0.1%	-0.2%	-0.2%	-18.0%	1.2%	1.3%
G - Wholesale and retail trade	0.4%	0.4%	0.4%	0.4%	0.4%	0.3%	0.4%	0.4%	0.0%	0.0%	-0.1%	-14.2%	0.4%	0.4%
H49 - Land transport	30.1%	36.3%	33.3%	31.4%	29.3%	24.8%	27.9%	26.7%	1.3%	**-2.6%**	**-3.4%**	-11.3%	30.0%	36.3%
H51 - Air transport	16.6%	18.7%	19.0%	16.3%	17.0%	15.3%	19.8%	18.6%	-0.4%	1.6%	**2.0%**	12.1%	17.7%	19.8%
I - Accommodation and restaurants	4.7%	4.3%	4.3%	4.2%	3.7%	3.4%	3.5%	3.3%	-0.5%	-0.4%	-1.4%	-29.6%	3.9%	4.7%
J - Information and communication	1.2%	1.0%	1.0%	0.9%	0.9%	0.8%	0.9%	0.9%	-0.3%	0.0%	-0.4%	-29.7%	0.9%	1.2%

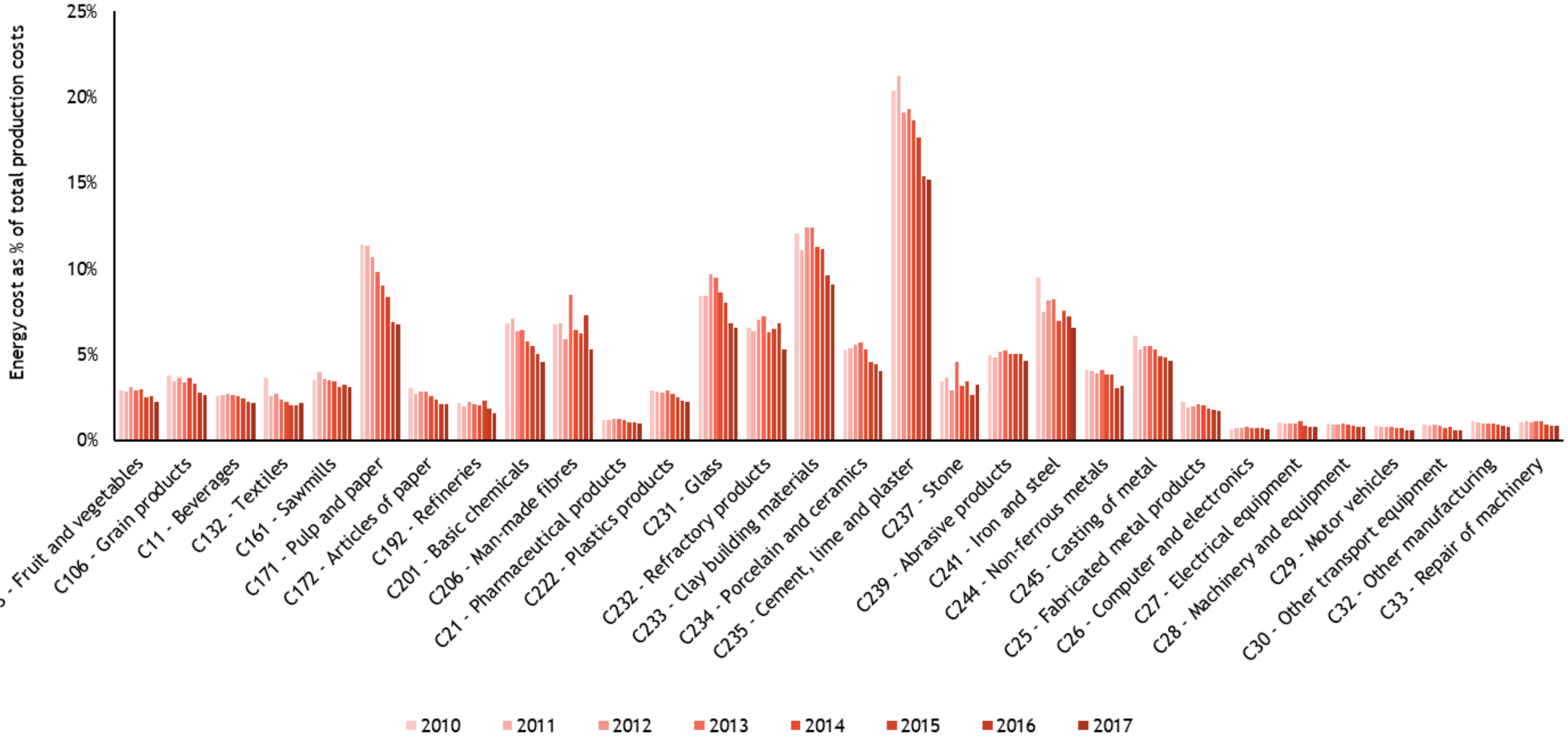

Figure 139 - Energy costs shares in total production costs in manufacturing sectors, 2008-2017

Source: Trinomics et altri study (2020)

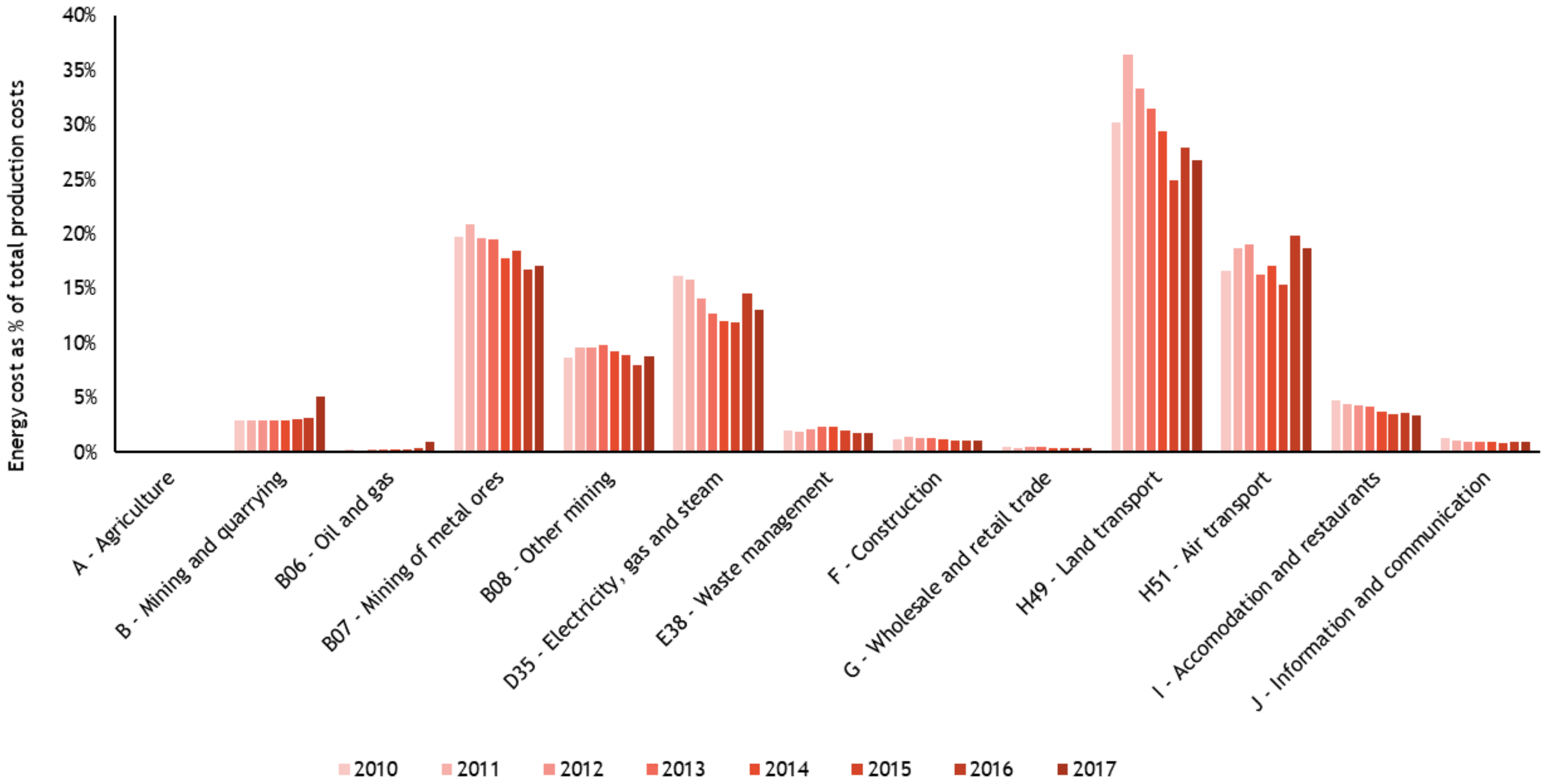

Figure 140 - Energy costs shares in total production costs in non-manufacturing sectors 2010-2017

Source: Trinomics et altri study (2020)

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 H49 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

Dynamics of the energy costs shares in total production costs

Energy costs shares in production costs changes result from the relative changes in energy costs and production costs. For instance, energy costs shares could fall if *energy costs* grow less than *production costs* over the period analysed. They could also rise when *energy costs* fall if *production costs* fall more. **Table 14** shows the change of each of these two variables for each sector in order to understand the costs dynamics that explain the evolution of the energy costs shares. We should bear in mind that the energy costs shares fell for all sectors studied except for a few non-manufacturing sectors (*air transport* and *mining & quarrying* and its subsectors of *oil and gas* and *other mining*).

Table 15 allows us to categorise the dynamics of the declines in energy costs shares. It shows that, between 2010 and 2017, for more than half of the sectors studied (22 out of 41), the energy costs fell while production costs grew, leading to a decrease in the energy costs shares. For about a quarter of sectors (9 out of 41), energy costs grew but less than the rise in production costs. In only one case, *air transport*, the energy costs grew more than the rise of production costs. For about another quarter of sectors (9 out of 41), both costs fell, but energy costs declined by more than production costs. Only in the case of *mining and quarrying* and its subsector *other mining*, the energy costs fell less than the production costs, leading to an increase in their energy costs shares. Finally, for only one sector (*oil and gas*), energy costs increased while production costs decreased, leading to an unavoidable increase of the energy costs shares indicator.

Table 14 – Drivers of energy costs shares in total production costs, manufacturing and non-manufacturing sectors (EU avrg)

Manufacturing sectors	Changes in total values across the EU27 2010-2017				Change in energy cost share 2010-2017 (simple average)	
	Absolute Δ Energy costs (M€)	Relative Δ Energy costs (%)	Absolute Δ Total production costs (M€)	Relative Δ Total production costs (%)	Absolute Δ energy costs as a share of total production costs (%)	Relative Δ energy costs as a share of total production costs (%)
C103 - Fruit and vegetables	38.9	4.0%	11080.4	24.9%	-0.6%	-21.9%
C106 - Grain products	-87.9	-10.9%	6049.1	22.0%	-1.1%	-30.5%
C132 - Textiles	-171.7	-41.8%	-268.5	-2.4%	-1.5%	-40.4%
C161 - Sawmills	-1.5	-0.2%	3333.7	12.5%	-0.4%	-12.7%
C171 - Pulp and paper	-2161.4	-33.6%	6955.3	11.0%	-4.7%	-40.9%
C172 - Articles of paper	-322.6	-19.0%	8194.2	12.6%	-0.9%	-29.3%
C192 - Refineries	-47.9	-37.9%	-805.9	-15.9%	-0.6%	-28.0%
C201 - Basic chemicals	-2014.9	-16.6%	42283.7	19.2%	-2.2%	-32.7%
C206 - Man-made fibres	-67.5	-18.8%	230.7	4.2%	-1.5%	-22.2%
C222 - Plastics products	-180	-4.7%	31704.2	19.3%	-0.7%	-23.1%
C231 - Glass	-393.8	-17.0%	1681.3	5.7%	-1.8%	-21.7%
C232 - Refractory products	-43.6	-18.6%	-0.5	0.0%	-1.2%	-18.6%
C233 - Clay building materials	-305.2	-20.2%	812.5	6.1%	-3.0%	-25.1%
C234 - Porcelain and ceramics	-44.5	-14.8%	577.3	9.1%	-1.2%	-22.6%
C235 - Cement, lime and plaster	-666.6	-27.7%	-381	-3.3%	-5.1%	-25.3%
C237 - Stone	-114.7	-28.0%	-2805.9	-30.9%	-0.2%	-5.7%
C239 - Abrasive products	33.8	4.3%	1957.6	11.1%	-0.4%	-7.3%
C241 - Iron and steel	-2769	-29.0%	2671.3	2.6%	-2.9%	-30.8%
C244 - Non-ferrous metals	-107.8	-3.4%	20126.7	20.8%	-1.0%	-23.5%
C245 - Casting of metal	-227	-14.5%	3388.4	11.6%	-1.5%	-24.4%
C11 - Beverages	-100.2	-6.8%	6084.7	9.7%	-0.4%	-15.8%
C21 - Pharmaceutical products	-83.3	-8.4%	10555.6	11.2%	-0.2%	-18.6%

C25 - Fabricated metal products	-792.4	-12.6%	45734.3	14.1%	-0.6%	-24.9%
C26 - Computer and electronics	-80.7	-7.1%	-11506.4	-7.1%	0.0%	-0.5%
C27 - Electrical equipment	-300	-15.2%	33430.4	14.8%	-0.3%	-27.7%
C28 - Machinery and equipment	64.1	1.6%	134079.4	25.2%	-0.2%	-24.0%
C29 - Motor vehicles	295.8	6.7%	287032	35.4%	-0.3%	-31.0%
C30 - Other transport equipment	-108.7	-16.0%	28488.1	27.1%	-0.3%	-38.8%
C32 - Other manufacturing	-72.6	-10.9%	15489	20.9%	-0.3%	-29.5%
C33 - Repair of machinery	-25.6	-3.3%	14038	15.6%	-0.2%	-18.4%
Other sectors						
B - Mining and quarrying	-320.4	-9.8%	-55231.7	-48.8%	**2.2%**	**76.2%**
B06 - Oil and gas	38.1	31.0%	-49815.4	-72.7%	*0.7%*	*380.6%*
B07 - Mining of metal ores	6.3	8.4%	96.5	25.3%	-2.7%	-13.5%
B08 - Other mining	-137.4	-7.6%	-1896.4	-9.0%	*0.1%*	*1.6%*
D35 - Electricity, gas and steam	-3388.1	-4.1%	98789.9	19.4%	-3.2%	-19.7%
E38 - Waste management	-16.8	-5.5%	1859.0	11.9%	-0.3%	-15.5%
F - Construction	-1815.2	-13.9%	54740.1	5.0%	-0.2%	-18.0%
G - Wholesale and retail trade	24.2	2.6%	43054.0	19.6%	-0.1%	-14.2%
H49 - Land transport	4594.7	15.1%	30085.9	29.8%	-3.4%	-11.3%
H51 - Air transport	155.6	22.5%	386.4	9.3%	**2.0%**	**12.1%**
I - Accommodation and restaurants	-18.5	-3.1%	4844.4	37.7%	-1.4%	-29.6%
J - Information and communication	-26.7	-13.7%	3668.1	22.8%	-0.4%	-29.7%

Table 15 – Categorisation of sectors according to the energy and production costs dynamics, 2010 -2017

	Reduced energy costs (2010-2017)	Increased energy costs (2010-2017)
Reduced production costs (2010-2017)	• C26 - Computer and electronics • C232 - Refractory products • C235 - Cement, lime and plaster • C237 - Stone • C192 - Refineries • C132 – Textiles • **B - Mining and quarrying** • B07 - Mining of metal ores • B08 - Other mining	• B06 - Oil and gas
Increased production costs (2010-2017)	• C33 - Repair of machinery • C244 - Non-ferrous metals • C222 - Plastics products • C11 - Beverages • C21 - Pharmaceutical products • C32 - Other manufacturing • C106 - Grain products • C25 - Fabricated metal products • C245 - Casting of metal • C234 - Porcelain and ceramics • C27 - Electrical equipment • C30 - Other transport equipment • C201 - Basic chemicals • C231 - Glass • C206 - Man-made fibers • C172 - Articles of paper • C233 - Clay building materials • C241 - Iron and steel • C171 - Pulp and paper • D35 - Electricity, gas and steam • I - Accommodation and restaurants • E38 - Waste management	• C29 - Motor vehicles • C239 - Abrasive products • C103 - Fruit and vegetables • C28 - Machinery and equipment • C161 – Sawmills • H49 - Land transport • G - Wholesale and retail trade • F - Construction • **H52 – Air transport**

Box - Energy costs of data centres

Data centres consist of a very large number of server computers concentrated in one location, that provide on-line services over the Internet, with a high availability and reliability which are part of the contract offered to the customer. This concentration enables the sharing of a common infrastructure, such as electric power supply, cooling, high-bandwidth Internet access, security, redundancy, data storage. The servers themselves often are custom-designed and manufactured for the operator of the data centre, to achieve high performance and low energy consumption. The main energy consuming units are

- the servers, which contain the central processor (CPU) and the memory (RAM): 41.3% of total energy consumption of the sector in the EU27 in 2018 (in an upward trend since 2010, when they represented only 33.7% of the total);
- the cooling, which prevents the damaging of the servers by evacuating their excess heat: 28.9% of total energy consumption of the sector in the EU in 2018 (in an downward trend since 2010, when they represented only 32.8% of the total);
- the uninterrupted power supply – UPS – which ensure that the servers are permanently fed with electric power, including in case of micro-interruptions of the network supply: 11.3% of total energy consumption of the sector in the EU in 2018 (in a slow downward trend since 2010, when they represented only 15.0% of the total);
- the data storage (generally as hard disk drives): 12% of total energy consumption of the sector in the EU (constant over time);
- the connection to the network: 3.7% of total energy consumption of the sector in the EU (constant over time).

The evolution over time shows an increased technical efficiency of data centres, whereby a growing fraction of the energy consumption is used by the productive units (the servers, the storage and the communication network), and a decreasing part by the ancillary services that address the inefficiencies of the system, namely overheating and power interruptions (respectively: the cooling system and the UPS).

Electricity costs of the sector of Data Centres in the EU27 has been rising sharply over the years 2010 – 2015 (from 3,600 M€ in 2010 to 5,020 M€ in 2015), and has remained stable over the years 2015 to 2018. This evolution is essentially related to the evolution of the prices for electricity for large industrial users, which followed the same pattern. Electricity costs in the UK display similar evolutions.

The estimated **electricity costs** represent a significant **share of the overall production costs** of the EU27 sector of data centres, comparable to that of the other energy-intensive industries: between **10.8 and 14.7%** over the years 2010 – 2017. They also represent a small, but significant fraction of the production value of the sector: between 9.1 and 12.0%. These fractions have reached their peak in 2014 and decreased between then and 2018. The details of electricity costs and electricity costs as a share of production costs per Member State are presented in Annex D (4.1) of the Trinomics (2020).

Results on Gross Operating Surpluses shares

Profit margins add on production costs to make up final sales prices. Profits play an important role in the cost-competitiveness of firms in the short run (when setting prices). But they are also fundamental for the competitiveness in the long run as they attract and enable investment.

It is thus important to know the trends of Gross operating surplus[63] (GOS, a proxy for profits) for the sectors studied. **Figure 141** shows the average GOS as a share of production costs for the manufacturing sectors between 2010 and 2017. There has not been much changes in the overall picture over the last years. For most of the sectors, the share was between 5-15%, higher for sectors like *pharmaceuticals*; *cement, beverages, other manufacturing* and particularly lower for *refineries* and *steel* (although growing strongly at the end of the period up to 10% and recovering from negative numbers in 2009 and close to zero in 2011-2012, due to the crisis in Hungarian and Greek steel sectors).

The GOS as a share of production costs increased in most of the sectors, between 2010 and 2017. The relative higher increases were in *steel* (103%), *textiles* (52%), and *casting of metals (*41%), while the decreases were proportionally important is some sectors, including *man-made fibres* (-43%), *cement* (-23%), and *refineries* (-22%).

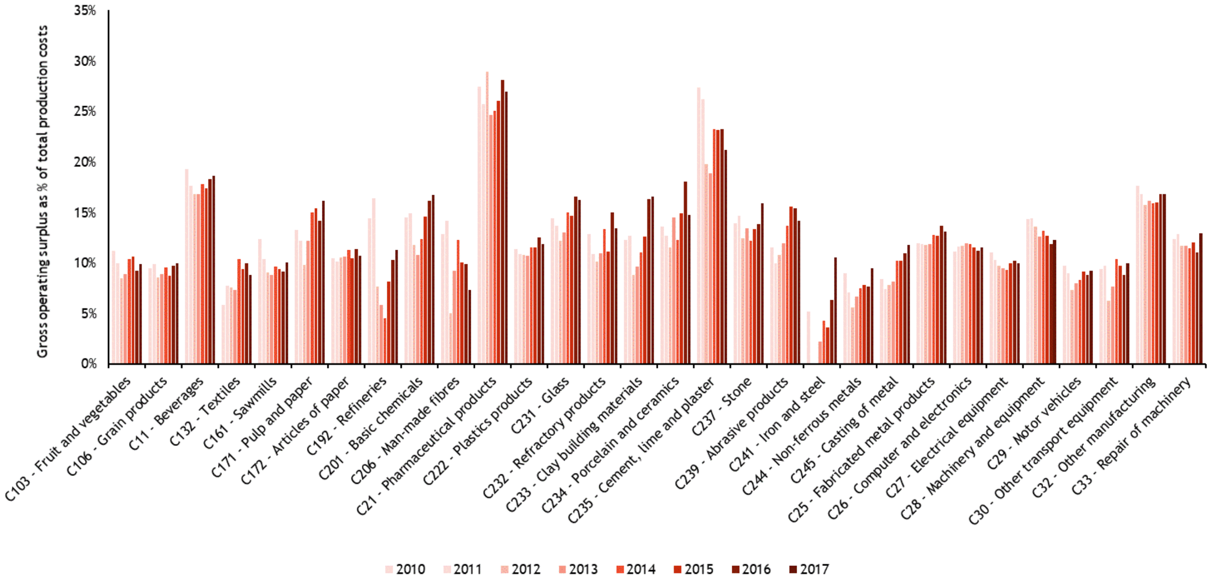

Figure 141 - Gross Operating Surplus in manufacturing sectors (average 2008-2015)

Source: Trinomics et altri study (2020)

Note: Average of for the sector based on the MS for which total production cost and GOS data available for all years

Across Member States (see **Figure 142**), GOS as a share of production costs were in most cases in the range of 10-14% between 2010 and 2017. Shares were over 14% in Ireland, Bulgaria, Cyprus, Denmark, Hungary, Latvia, Malta and Romania and close or slightly below 10% in Belgium, Germany, Italy and the lowest (6%) in France.

[63] Gross operating surplus presented are the result of subtracting personnel costs from value added using Eurostat SBS statistics

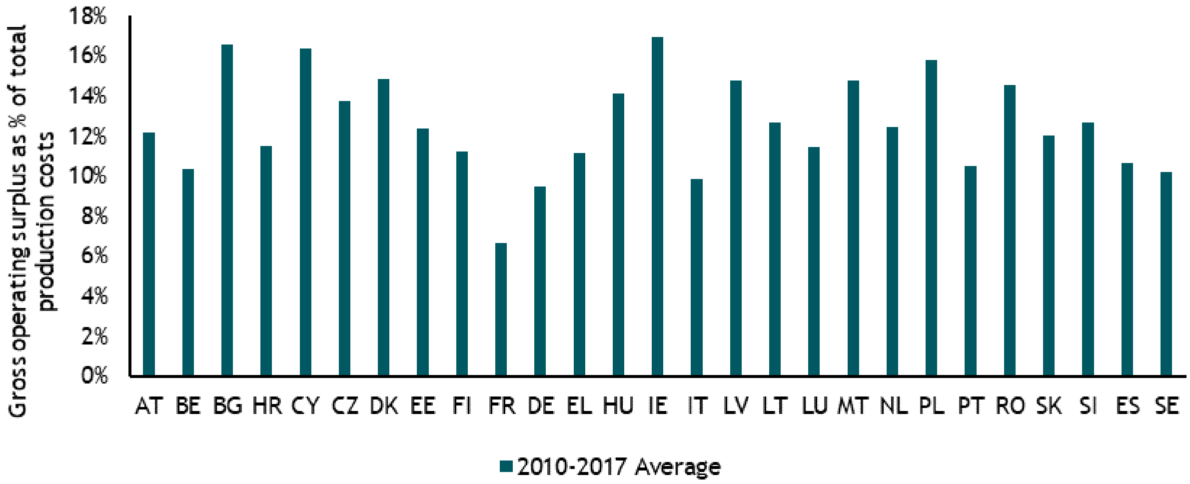

Figure 142 - Gross Operating Surplus in manufacturing in the EU and Member States, 2008-2015

Source: Trinomics et altri study (2020)

International comparisons of Gross Operating Surpluses

This section compares *Gross Operating Surpluses (GOS) shares in total production value* (proxy of profitability) across *manufacturing and non-manufacturing sectors* in the EU, its trade partners, and G20 countries (excluding Iceland for which data was insufficient).

Profitability of manufacturing sectors: EU vs G20

The results of the analysis shows that the EU displays average profitability of a similar magnitude that Japan, China, the US, Norway and Switzerland, higher than in Brazil but significantly lower than the rest of the G20 countries. The average profitability in the EU manufacturing sectors is however less volatile than in most of the G20 countries

When compared with its most important international trade partners, the EU manufacturing sectors show a similar profitability to those in China but lower levels than those in Japan and the United States. Between 2015 and 2017, the profitability increased in many countries, including in the EU. This rise in profitability was however not experienced in China (where it dropped in 2016), the US (where it dropped in 2016 and then rose slightly in 2017) or Japan (where it remained stable).

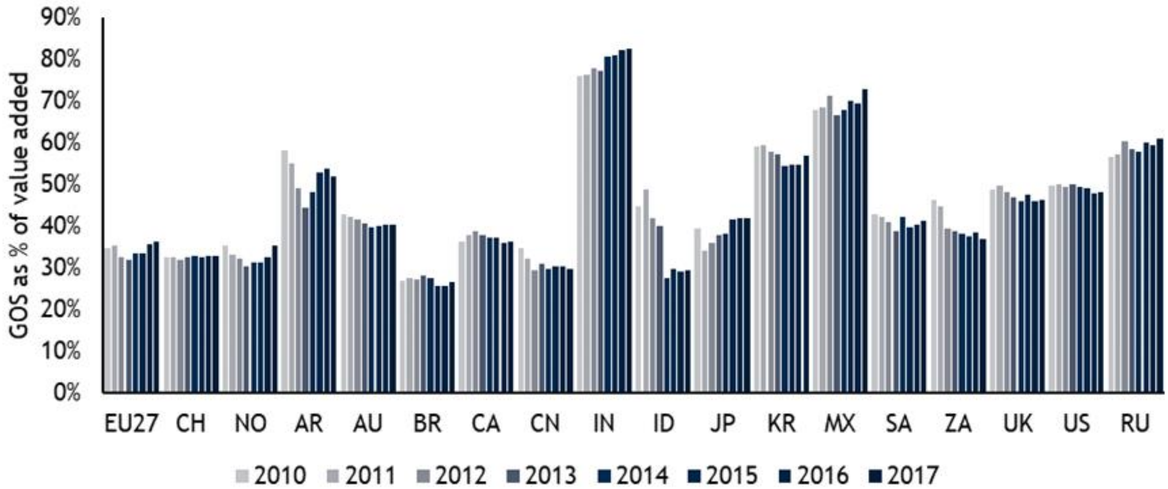

Figure 143 – Gross Operating Surplus shares of value added in manufacturing, EU vs G20

Source: Trinomics et altri study (2020)

Profitability of non- manufacturing sectors: EU vs G20

EU non-manufacturing displays on average a slightly lower profitability than in most of the G20 countries, yet comparable to the US and Japan and higher than in Switzerland and China. The highest average profitability of non-manufacturing sectors appears in Mexico, Saudi Arabia, and Russia

In the EU, the profitability of non-manufacturing sectors is slightly (2-3%) higher than that of manufacturing, while in Japan and in the US, the profitability in manufacturing sectors is higher than in non-manufacturing sectors.

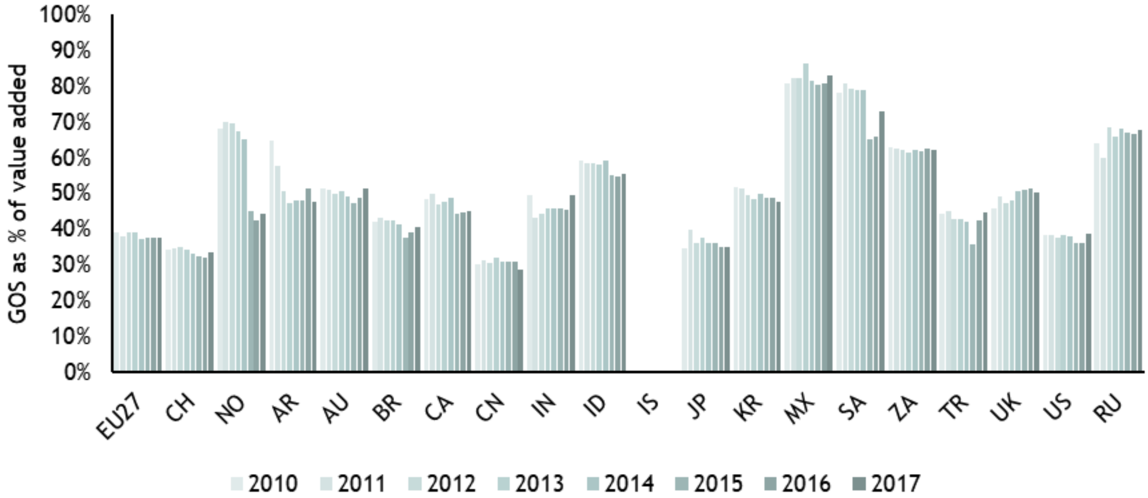

Figure 144 - Gross Operating Surplus shares of value added in non-manufacturing, EU vs G20

Source: Trinomics et altri study (2020)

6.3 Exploring energy intensities

Energy intensity is the result of dividing the energy consumption by the Gross Value Added (GVA). Although energy intensity is not a direct measure of energy efficiency of production (which could be measured by dividing the energy consumption by the volume of production), it is used as proxy of it. This is because comparable production volume data is not easily available.

When using energy intensity as proxy for energy efficiency it should be borne in mind that energy intensity is influenced by changes in the value added of the production, i.e. prices can change due to demand, exchange rates or other issues increasing or decreasing the value added in a way not necessarily proportional to changes in production volumes.

Figure 145 and **Figure 146** (see next page/s) display the energy intensity of selected sectors in the period 2010-2017 showing that:

- Energy intensity varies considerably across sectors in accordance to the various production processes. *Steel* and *cement* have the highest energy intensities (>2 toe/1000 Euro) followed by *refineries* and *paper* (> 1 toe/1000 thousand Euro) and *basic chemicals* (close to 1 toe/1000 Euro).
- Energy intensity varied widely during the period of study in the case of *refineries, steel, clay building materials* and *man-made fibres* probably reflecting price effects on the value added of production, with important spikes between 2014 and 2016
- Energy intensity decreased in absolute terms in most of the energy-intensive sectors like *non-ferrous metals* (-3.6%/year between 2011 and 2017), *steel* (-1,9%/y), *refineries* (-11%/y) and *paper* (-3.5%/y*)* and *glass* (-0.6%/y) although it increased in *cement* (by around 2%/year between 2011 and 2017), *clay building materials* (+1.1%/y), *sawmills* (+6%/y), *basic chemicals* (+0.5%/y) and *grain products* (+0.2%/y). In proportional terms the energy intensity indicator fell the most in *stone* (-60%), *man-made fibres* (-45%), *refineries* (-55%) and *paper* (-20%)
- Energy intensity decreased for the vast majority of the less energy-intensive manufacturing sectors in the EU between 2011 and 2017. The decrease were small in absolute numbers but important in relative terms for many of these sectors like were also proportionally significant decreases like in *textiles (-20% relative fall of energy intensity indicator)*, *articles of paper (-20%)*, *electrical equipment (-27%), computers (-23%)*, *machinery (-30%)* and *motor vehicles (-45%)* (although for the energy intensity of theses is very low and ranges between 0.2 and 0.01 toe/1000 euros)
- In non-manufacturing, energy intensity decreased in high energy intensity like *land transport* and *air transport*, but increased for *electricity-gas*. Amongst those with lower energy intensity, energy intensity increased in *agriculture*, *oil and gas*, *waste management*, decreased for *other mining* and *accommodation and restaurants* and remained relatively stable or with very small increases or decreases in absolute terms for the rest of sectors.

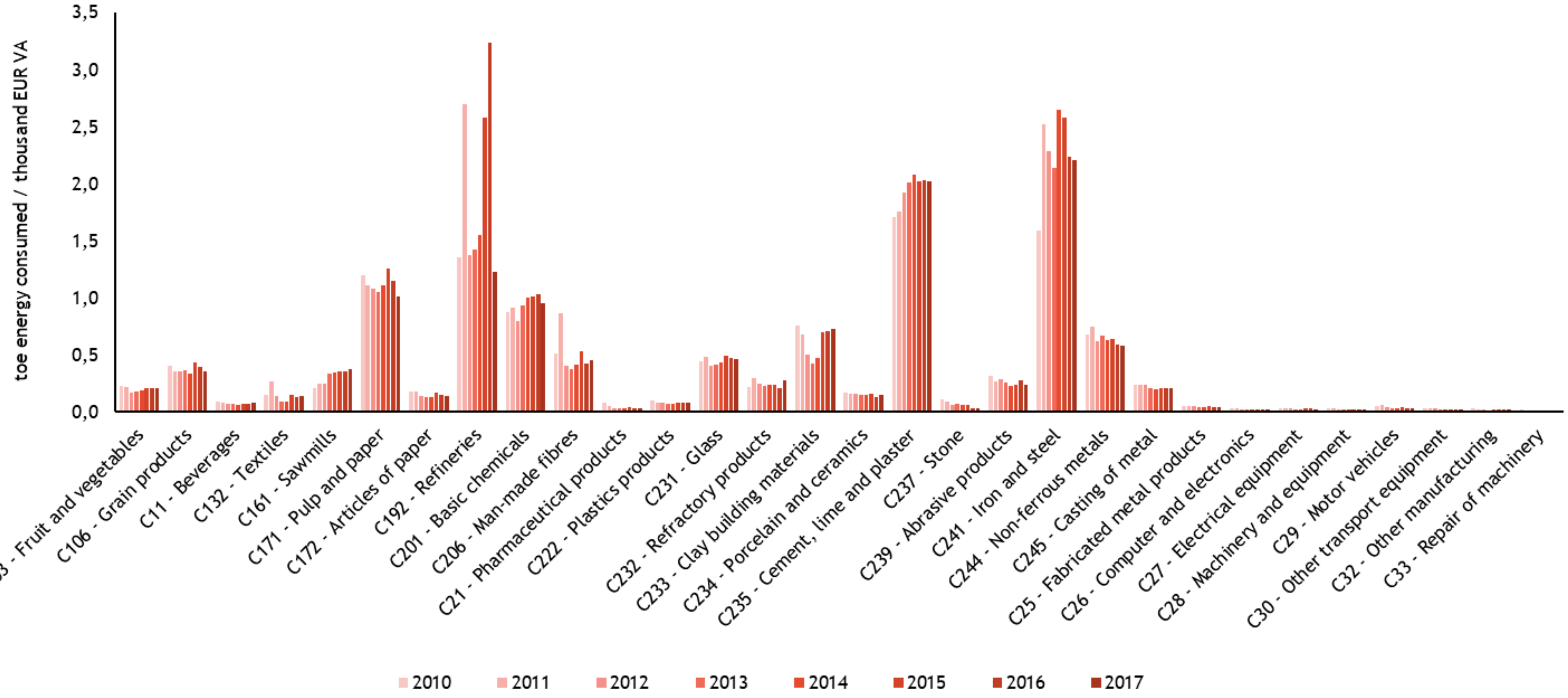

Figure 145 - Energy intensity (consumption/value added in nominal terms) for the most energy-intensive manufacturing sectors (average of available countries)[64]

Source: Trinomics et altri study (2020)

[64] The energy intensity change includes both change due to energy efficiency of production and change due to price effects

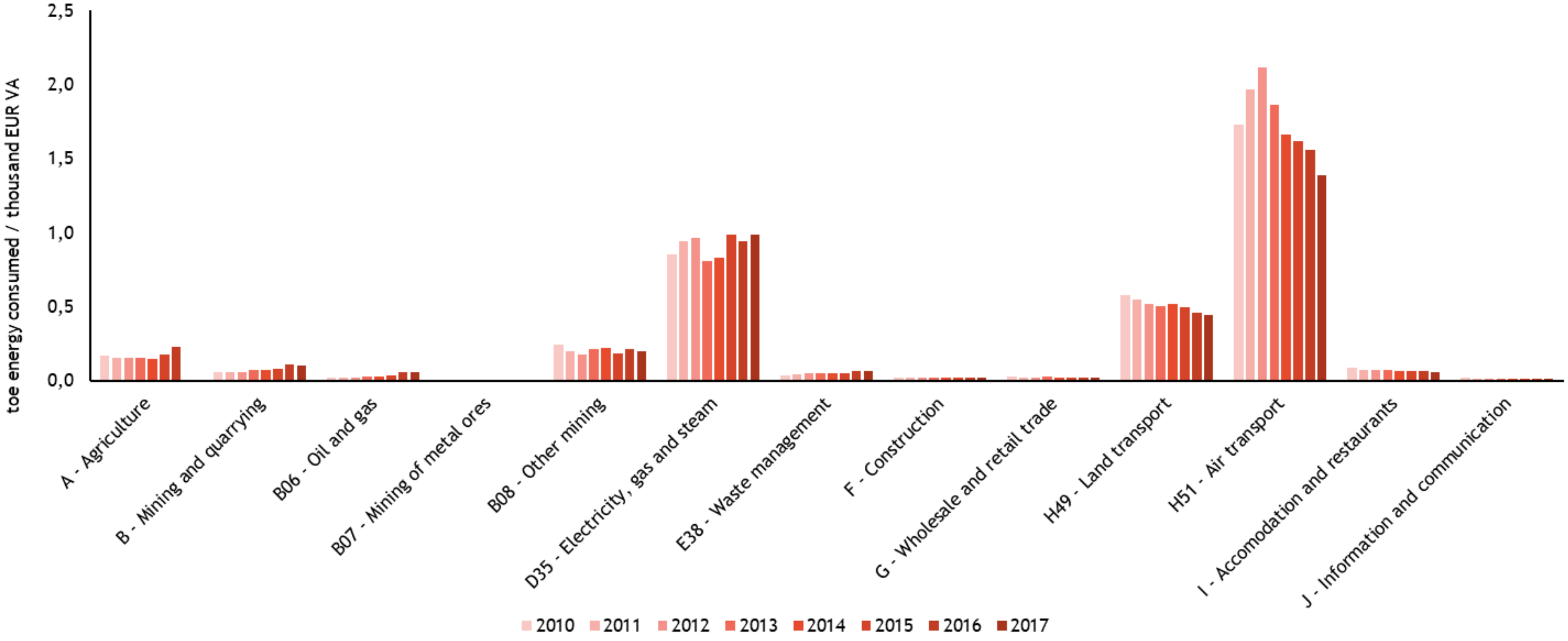

Figure 146 - Energy intensity (consumption/value added in nominal terms) for non- manufacturing sectors (average of available countries)[65]

Source: Trinomics et altri study (2020)

[65] The energy intensity change includes both change due to energy efficiency of production and change due to price effects

6.4 Energy costs drivers

In this section we estimate how changes on energy prices, output and energy intensity impact energy costs. It also looks at the drivers of changes in output (domestic demand vs external demand) and energy intensity (physical energy efficiency, structural changes or fuel switching) to have a more comprehensive picture of the ultimate drivers of energy costs changes.

The section relies on the decomposition analyses undertaken in the *Trinomics* (2020) which assesses the extent to which these three factors and the underlying drivers affected the energy costs of selected energy-intensive sectors in the EU and in G20 countries over 2010-2017. The specific sector scope of the decomposition analysis can be found below in **Table 16** and **Table 17.** The analysis of the decomposition analysis of sectors is undertaken at more aggregated (NACE 2) level in order to get more complete datasets. This makes that the results of the decomposition analysis are not directly comparable with the analysis of energy costs shares (section 6.2) which generally looks at a sectors with a more disaggregated (NACE 3) level.

The decomposition was carried out using the *Log Mean Divisia Index (LMDI)* which shows for a given percentage change in energy costs over the period, the extent to which this change is attributable to changes in each driver over the same period. To make that analysis it was necessary to estimate the prices and the consumption by sector. The purchases of energy resulting from multiplying the estimated prices and consumption were not always similar to the results from historical data coming from 'purchases of energy' collected in Eurostat. A residual (the difference between the two) was therefore introduced in the analysis to take into account for these data discrepancies and ensure a coherent approach in the analysis of the energy costs in this document[66]. As compared with the previous report, there were improved methodological efforts to reduce the residual and present information and analyses of the sectors where a high residual does not convey excessive uncertainty of the results. For the G20 countries there was no residual (since there is no a similar dataset as SBS).

[66] Energy price data was based on the prices from the consumption band from Eurostat relevant for each sector; energy consumption data came from the ODYSEE/MURE database and national data sources; gross output data from the Eurostat SBS. The difference between the estimated purchases of energy and the ‘Purchases of Energy Products’ data from the Eurostat SBS was attributed to a residual term, which captures data discrepancies which include *inter alia* the effect of fuel switching over the period (as the decomposition calculations assume fixed fuel shares over 2010-2015).

Table 16 - Sector scope of the EU27 decomposition analysis

Section	Code (NACE 2)	Description
C - Manufacturing	C10_C12	Manufacture of food products; beverages and tobacco products
	C13_C15	Manufacture of textiles, wearing apparel, leather and related products
	C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
	C17	Manufacture of paper and paper products
	C19	Manufacture of coke and refined petroleum products
	C20	Manufacture of chemicals and chemical products
	C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
	C22	Manufacture of rubber and plastic products
	C23	Manufacture of other non-metallic mineral products
	C24	Manufacture of basic 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
	C31_C32	Manufacture of furniture; other manufacturing
	C33	Repair and installation of machinery and equipment

Table 17 - Sector scope of the G20 decomposition analysis

Section	Code (NACE 2)	Sector Description
C - Manufacturing	C10_C12	Manufacture of food products; beverages and tobacco products
	C13_C15	Manufacture of textiles, wearing apparel, leather and related products
	C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
	C17	Manufacture of paper and paper products
	C19_C21	Manufacture of coke, refined petroleum products, chemicals and chemical products, basic pharmaceutical products, and pharmaceutical preparations
	C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
	C22_C23	Manufacture of rubber, plastic products, and other non-metallic mineral products
	C24	Manufacture of basic 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
	C29_C30	Manufacture of motor vehicles, trailers and semi-trailers, and other transport equipment
	C30	Manufacture of other transport equipment
	C33	Repair and installation of machinery and equipment

6.4.1 Drivers of energy costs

Using the LMDI decomposition, the key drivers of energy costs can be identified.

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

The analysis in this section aims to use LMDI decomposition to explain the behaviour of the energy costs observed as energy purchases of energy from SBS data. Thus, a residual is introduced in the analysis to account for the difference between estimated energy costs and the SBS data for energy *purchases of energy*. For the purposes of this analysis, the change in energy costs over time is defined as follows:

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

Where

- **Output effect:** the effect of changes in real production (GVA), this could be due to increases in domestic and/or external demand;
- **(Real) Energy intensity effect:** the effect of changes in energy per unit of real output (GVA) over time due to energy efficiency measures, behavioural changes and industry structural change;
- **Price effects:** the effect of changes in coal, gas and electricity prices.
- The **residual,** which includes the effect of unexplained data discrepancy with Eurostat SBS data on 'purchases of energy'.

Box – Interpretation of results

The interpretation of some of these effects is complex and requires additional explanations.

The unexplained **residual** likely arises from missing data, in particular, on energy consumption. In these cases, data gaps were filled using sectoral energy-intensity figures for those countries where data is available. In some cases, that meant relying on trends of very few countries (Germany and few others) to predict the wider sectoral trends at the EU27 level. Therefore it is possible that the residual is partly reflecting some energy intensity effects that were impossible to identify from the limited energy consumption data available. On the other hand, the residual was calculated as the difference from the Eurostat SBS data in order to ensure a coherent analysis in this section in line with the analysis on the previous sections of the chapter. However Eurostat SBS data could also present some inconsistencies as it is based on surveys which might also be partially incomplete.

The interpretation of the **price effect** is complex. The price effect captures the effect of changes in weighted-average energy prices on energy costs faced by firms. The prices used are nominal and exclude all recoverable tax and levies (such as VAT). The price effects are estimated by combining estimates of the energy mix at a sectoral level and estimates of energy prices (by fuel) over the period 2010-2017. Energy price for each sector and fuel is estimated by using the Eurostat price band in which most industrial production would fall into[67]. Therefore the price effect does not capture the behaviour of other fuel prices (price of biomass or heat) which are assumed to behave in line with the weighted average from coal, gas and electricity prices. Finally, price for each industry sector at the EU27 level, the Member State level prices are weighted by the total value of production (by Member State). Thus, the EU27 results for each industry sector reflect a double-weighting of price: (i) (relatively stable) fuel shares used to derive a representative weighted-average fuel price for each industry and each Member State (ii) (dynamic) Member State production shares used to weight the Member State -level price effects, to derive an EU average price effect for each industry sector. This means that prices changes can be due to changes on the production structure of the sector at EU level (shifts of production across Member States) which results on changes on the weights used for calculating the prices.

[67] Allocating industry sectors specified at the NACE 2 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. The decomposition analysis is interested in changes in energy prices (and costs) over time 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 usually reflect similar energy price trends over time.

A - Results of the analysis of energy cost drivers at EU level

The aggregate energy costs of all the manufacturing sectors fell by 13% between 2010 and 2017.

This was the result of the following combined effects:

- lower **energy-intensity** contributed to energy savings that reduced energy costs by 15%.
- **real output changes** contributed to an increase of 11% in energy costs;
- energy **price increases** contributed to an increase of 2% in energy costs;
- Still, the **residual** (unidentifiable factors) was responsible for driving the energy costs down by an additional 11%

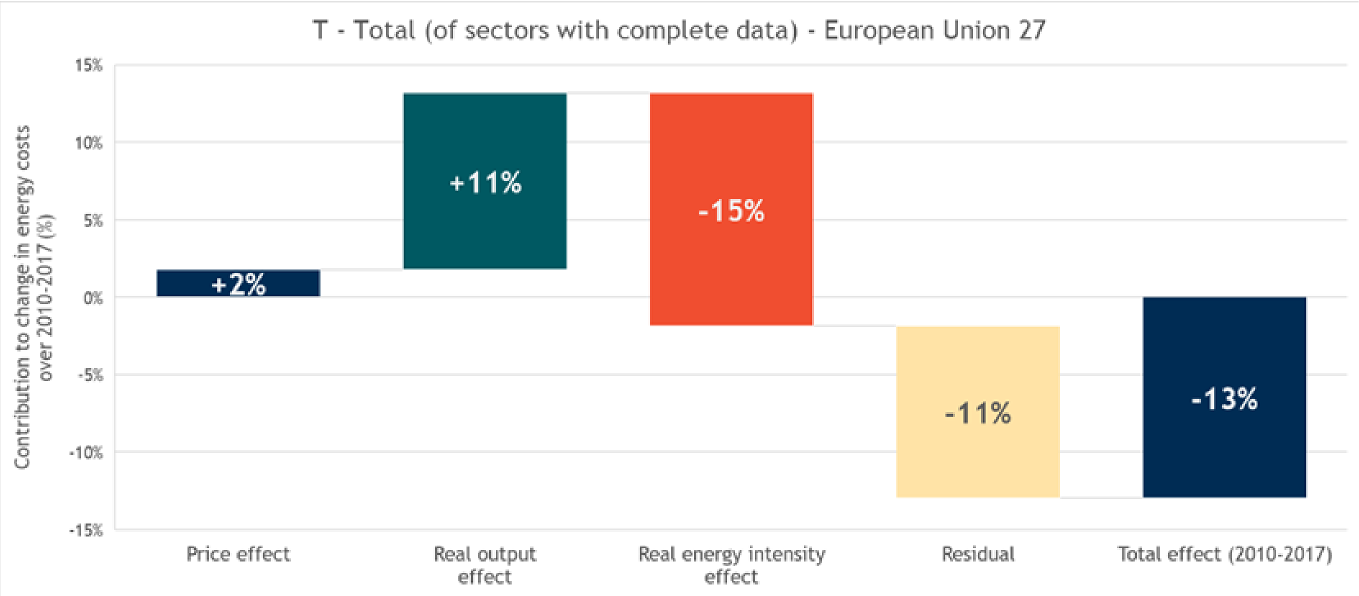

Figure 147 - Drivers of energy costs of the total of sectors

Source: Trinomics et altri (2020)

Real energy intensity effects (-15%)

For aggregated industrial sectors in the EU27, **an improvement in energy intensity contributed to a reduction in energy costs** between 2010 and 2017. This trend is reflected in all but two industry sectors (coke & petroleum and wood products**)**.

The **largest reduction in energy intensity was observed in the less energy-intensive sectors**. This reduction in energy intensity typically happened in sectors where output had increased. There are two plausible explanations for this. First, the reduction in energy intensity came through economies of scale. Second, fast output growth might have also led to investments in new, more efficient, industrial equipment and factories.

The **most energy-intensive industries** saw much smaller improvements in energy intensity over the period. This could be because these industries have already invested heavily in energy efficiency to maintain international competitiveness.

The energy intensity effect was analysed further to see the extent to which **industry structural change** or **fuel switching** contributed the improvements in energy intensity observed over the period. Overall, neither structural change nor fuel switch was found to be a substantial driver of the energy intensity effect. This suggests that **real energy efficiency improvements drove the reduction in energy intensity over the period.**

As in the EU27, industrial sectors in the US, and China have generally experienced improvements in energy intensity that have driven down energy costs over time.

Real output effect (+11%)

Output increased in most EU27 sectors contributing to increasing industrial energy use and costs (in absolute terms). Energy-intensive sectors had the lowest output growth, while sectors with lower energy intensity generally saw higher output growth.

For most industry sectors, output growth was driven by **growth in demand within the EU27 (domestic demand)**, implying that the EU's international competitiveness in manufacturing has remained relatively unchanged over the period.

A few industry sectors saw an improvement due to **external demand** that contributed to the increase in sector output i) *Pharmaceuticals*, where net exports grew substantially over the period and ii) *Motor vehicles and transport equipment*, where exports growth outweighed import growth. Conversely, a few sectors saw a reduction in the net external trade such as *computers and electronics* and *textiles* where imports grew faster than both exports and domestic demand, suggesting a loss of EU competitiveness despite increasing domestic demand and export growth.

Sectoral output has generally increased over time in the **EU's main trading partners**, driving up energy demand and therefore costs with the exception of the UK where industrial output has contracted since 2010

Fuel price effects (+2%)

In most EU27 industry sectors, **increases in average energy prices** have contributed to an increase in energy costs over the period 2010-2017. This is **largely driven by increases in industrial electricity prices**.

Sectors where oil, coal or gas make up a larger share of the energy mix have seen smaller impact of energy prices on energy costs, as prices have fallen for these fuels over the period.

Within the EU27, large relative increases in output are evident in countries where the average prices has decreased and large decrease in output are evident in countries where the average price has increased between 2010-2017. This suggests that energy prices impacted output growth for some industry sectors.

Average energy prices increased over the period for most country-sector combinations in the EU27's major trading partners (US, UK and China)

For most sectors, there is a positive price effect and a negative energy intensity effect. This suggests that **higher prices might have been an important element in driving down energy costs through improved real energy efficiency improvement**.

Residual effects (-15%)

Comparing the EU27 energy costs estimated from its components (price and energy consumption) with the Eurostat SBS purchase of energy products shows there is a residual effect contributing to the evolution of energy costs. The residual effect for most sectors shows a negative bias implying we are not capturing some factor reducing energy cost over the period.

This residual effect encapsulates some known limitations of the analysis:

- **Price trends of other fuels –** energy price data is only available for the four main fuels (coal, electricity, gas, oil). Some sectors have large shares of alternative fuels (biomass, waste & heat) in their fuel mix which we cannot capture in the price effect. Examples include *wood & paper* (high use of biomass and waste) and *chemicals* (High use of heat)
- **Addition exemptions from taxes & levies –** In the analysis we use average industry prices for each fuel (excluding VAT and recoverable taxes) however for some **energy-intensive industries**, there are specific exemptions from taxes and levies. These could include sectors such as the manufacture of *Chemicals* and *Basic Metals*.
- **Issues with the underlying data** – This includes missing data or inconsistencies in the Eurostat SBS data, which is based on a survey of businesses.

Regression analysis shows that across the whole manufacturing sector and EU27, the individual drivers of turnover, average energy prices and energy intensity do explain a reasonable proportion of the variance in SBS energy cost data.

Energy costs contribution to production costs

At the EU27-level, an increase in total industry production costs over the period is almost entirely explained by increases in other (non-energy) costs. **Energy costs have contributed to a very small, almost insignificant, reduction in total production costs**.
Furthermore, the share of energy costs as a proportion of total production costs is lower in 2017 when compared to the share in 2010 for most industrial sectors.
Estimated **energy costs in the EU's main trading partners (US, UK, and China) have generally increased** over the past years.

B- Results of the analysis energy costs drivers in the EU at sector level

Table 18 shows the effect of the various energy cost drivers (prices, real output, real energy intensity) vary widely across the EU sectors. The residual also varies significantly across sectors signalling which sectors have the most robust estimates. A detailed analysis of the effects by sector can be found in Annex F of the Trinomics (2020).

Table 18 - Decomposition of energy cost drivers by sectors in the EU between 2010 and 2017

Sector Code	Sector (Description)	Price effect	Real output effect	Real energy intensity effect	Residual	Total effect	2017 EU27 Energy Intensity (toe per million €)
High energy-intensive sectors							
C20*	Manufacture of chemicals and chemical products	-4.2%	2.0%	-6.8%	-5.6%	-14.6%	190.8
C17*	Manufacture of paper and paper products	0.7%	7.9%	-9.6%	-27.7%	-28.7%	182.3
C24*	Manufacture of basic metals	4.7%	12.7%	-12.8%	-24.2%	-19.6%	174.1
C19	Manufacture of coke and refined petroleum products	-6.3%	-34.4%	37.6%	-5.4%	-8.6%	158.8
C23	Manufacture of other non-metallic mineral products	1.3%	0.8%	-15.3%	-3.1%	-16.4%	158.2
C16*	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	10.2%	-2.2%	11.0%	-25.7%	-6.7%	75.5
Lower energy-intensive sectors							
C10_C12	Manufacture of food products; beverages and tobacco products	6.7%	10.2%	-6.0%	-13.0%	-2.1%	26.9
C22	Manufacture of rubber and plastic products	2.4%	10.4%	-37.1%	22.0%	-2.3%	22.4
C13_C15	Manufacture of textiles, wearing apparel, leather and related products	8.1%	-1.4%	-9.9%	-48.7%	-51.8%	21.5
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	11.6%	14.7%	-32.3%	-3.8%	-9.8%	19.3
C25	Manufacture of fabricated metal products, except machinery and equipment	10.1%	9.3%	-14.5%	-13.2%	-8.4%	17.5
C31_C32	Manufacture of furniture; other manufacturing	2.2%	4.4%	-10.9%	-4.0%	-8.3%	11.0
C33	Repair and installation of machinery and equipment	16.7%	-5.4%	-5.7%	0.3%	5.9%	10.1
C28	Manufacture of machinery and equipment n.e.c.	13.6%	16.6%	-26.0%	-2.0%	2.1%	9.5
C27	Manufacture of electrical equipment	10.1%	4.6%	-15.3%	-14.8%	-15.4%	8.3
C26	Manufacture of computer, electronic and optical products	11.4%	14.7%	-11.1%	-23.8%	-8.9%	6.5
C29	Manufacture of motor vehicles, trailers and semi-trailers	6.9%	40.4%	-36.7%	-3.5%	7.0%	6.1
C30	Manufacture of other transport equipment	12.3%	42.0%	-60.5%	-3.0%	-9.2%	4.3
T	**Total (Of sectors with complete data)**	**1.8%**	**11.4%**	**-15.0%**	**-11.1%**	**-13.0%**	**50.6**

Source: Own estimates based on the LMDI methodoloy and sorted according to energy intensity in 2017

The **energy intensity effects** contributed to a very significant reduction of the energy costs for the majority of manufacturing sectors analysed. The sectors that have seen the largest energy cost savings due to energy intensity improvements were *transport equipment* (-60%), *motor vehicles* (-37%) *plastics* (-37%), *pharmaceuticals* (-32%) and *machinery* (-26%) while the sectors where a positive energy intensity effect has contributed to an increase in energy costs were *refineries* (11%) and *wood* (10%).

Energy consumption has mostly decreased in industry sectors over the period whereas gross output has mostly increased, driving down energy intensity over time and reducing energy costs. Energy efficiency can improve due to a number of factors such as i) changes in the fuel mix ii) structural changes within each industry sector iii) and actual energy efficiency improvements (behavioural changes or investment in energy efficient equipment in response to higher prices or policies[68]). Further analysis shows that most of the energy efficiency observed is mainly due to real energy efficiency rather than structural change or fuel switching, which appeared to have a negligible effect on the changes of energy intensity of the sectors (Trinomics study section 4.4.5).

All the sectors with the highest decreases in energy intensity have registered an increase in gross output and a decrease in energy consumption between 2010 and 2017. Sectors *transport equipment* and *motor vehicles*, two low energy-intensity sectors, have had some of the highest relative increase in gross output over the period. Apart from the reasons mentioned above (recent investments in energy efficient processes), low energy-intensive sectors may be benefiting from economies of scale.

It is also interesting to see that reduction in (real) energy intensity was almost systematically higher among the ‘less energy-intensive’ sectors as compared with the 'most energy-intensive sectors'. **Figure 148** and **Figure 149** show examples that support this assessment. These results have however to be taken with certain precaution as, in many cases, they are reliant on consumption data (or estimations) from very few countries[69]. And structural changes within sectors are difficult to interpret (as there can be considerable heterogeneity at the level of aggregation studied, i.e. NACE 2-digit level[70]).

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[68] 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 can incentivise energy efficient investments and reduce energy cost pressures.

[69] From around five countries, where both energy consumption and gross output data is available, and used to proxy trends in energy-intensity at the EU level. In addition the unexplained residual component captures changes in energy intensity due to fuel switching and could also be partly capturing other energy intensity effects. See Table 4-12 of Trinomics et altri study (2020)

[70] Structural changes within sectors can be important and difficult to interpret as regards the most energy-intensive sectors that could be part of the aggregated and considerably heterogeneous NACE 2-digit level. There could also be different industrial process, with different energy consumption levels, combined in the same sector. For example, 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

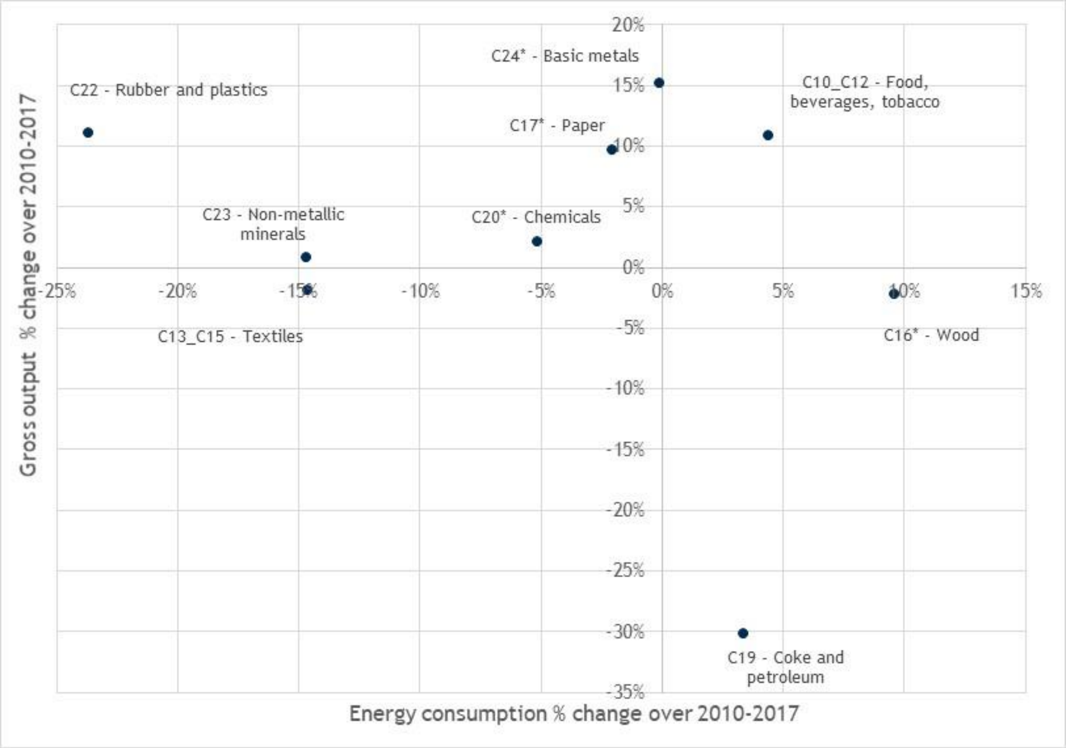

Figure 148 - Changes in gross output and energy consumption in high energy-intensity sectors, 2010-2017

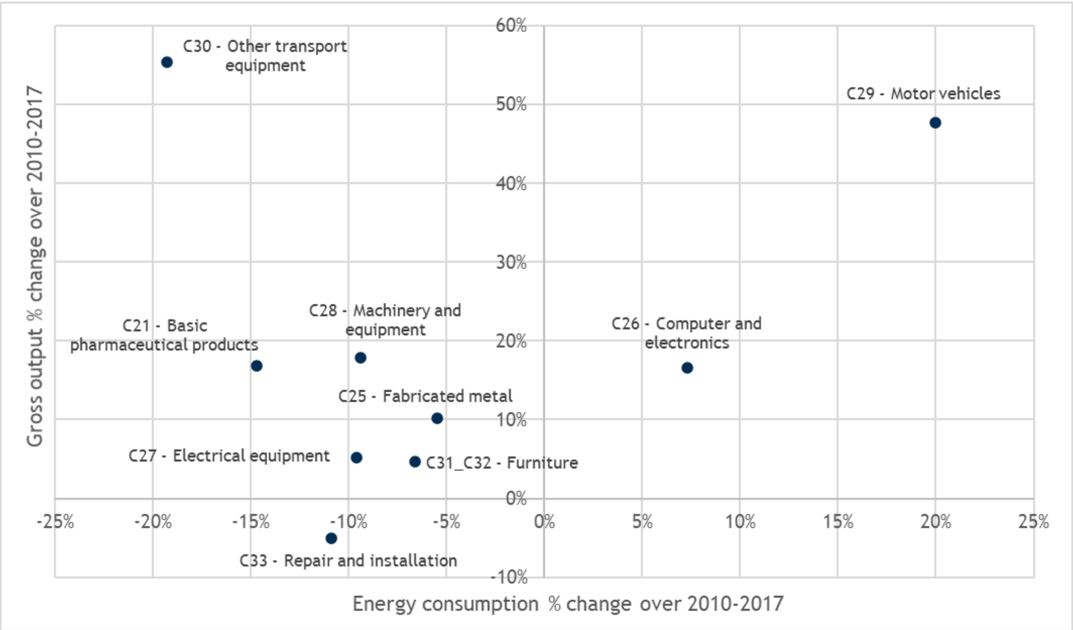

Figure 149 - Changes in gross output and energy consumption in low energy-intensity sectors, 2010-2017

The **price effect** was small although positive in most of the industry sectors analysed. The price change was driven by the combined effect of higher electricity prices and lower gas and oil prices over the period 2010-2017. Energy price increases also contributed to small changes in energy costs due to the fact that energy cost represent a rather small part of total production costs, especially in the less energy-intensive sectors.

The price effect was the highest in less energy-intensive sectors such as *repair of machinery (17%)*, *machinery (14%)*, *transport equipment (12%)* and *pharmaceuti*cals (12%). The price effects in the high energy-intensive industries were overall low or modest such as in the case of *paper* (+0.7%) and *non-metallic mineral products* (+1.3), *basic metals* (+5%) or even negative in the case of *chemicals (-4%)* and *refineries* (-7%). Low or negative price effects appeared in the sectors which importantly rely on oil and gas, the prices of which declined over the period.

The relatively small price effect in sectors in which electricity plays an important is largely because production took place in Member States where energy price rises were modest and/or because production shifted to Member States where energy prices are lower. For instance, for the highly energy-intensive of *paper*, production moved away from Italy (with a high sectoral average energy price in 2017) while increased in countries with lower average energy prices, such as Finland, Germany, the Netherland, and Poland. In the case of *non-metallic mineral products*, the growth in output was highest in France, Germany, and Poland in absolute terms. This was paired with a decrease in average energy prices decreased in both Germany and Poland over the time

The **real output effect** was positive for most sectors and contributed significantly to increase energy costs at EU level.

The growth in real output contribute to rise energy cost particularly in the manufacturing of *transport equipment* (+42%), *motor vehicles* (40%), *computers* and *pharmaceuticals* (+15%), *basic metals* (+12%), *plastics* and *beverages* (+10%). Few sectors, with sector specific economic dynamics, like *refineries* (-34%) and *textiles* (-1%) saw a reduction of real output over the period 2010-2017.

The increase in *transport equipment* and *motor vehicles* represented more than 40% of the contribution of output growth to the rise in total energy costs in the EU. The sectors' increase was due to large increase in activity in Germany, France, and Italy (in absolute terms). These sectors have experienced an increase in economic activity even though there is a positive price effect on energy costs. However, both sectors have experienced significant reduction in energy intensity, suggesting that international competitiveness has partially improved because of improved energy efficiency.

The **residual term** isolates the unexplained component of changes in energy costs (based on available price and energy consumption data). This residual arises because there are (sometimes large) discrepancies between the calculation of energy costs and the 'Purchases of Energy Products' data from Eurostat SBS.

The residual factor can be due to known data limitations: i) *Uncaptured fuel switching effects* as a result of other fuels not accounted for in the analysis. These include renewables, bioenergy, and heat which are very important in some of analysed sectors like wood and paper; ii) *Uncaptured industry specific price effects* such as tax and levy exemptions which are likely to affect the results of some of the analysed energy-intensive sectors such as chemical and basic metals iii) issues with the underlying data such as missing data leading to some country-sector combinations heavily relying on data filling techniques or inconsistencies in the Eurostat SBS data. This issue is not sector-specific and will be explored further in the regression-based analysis.

The results of the sectors with proportionally higher residual effects should be looked at with certain caution.

C- Results of the analysis of energy costs drivers at G20 countries

The analysis of the effects driving energy costs of industrial sectors in G20 countries covers the 2010-2016 period and focuses on China (CN), the United Kingdom (UK), Mexico (MX) and the United States (US). These were the G20 countries and time span for which available data was complete across industry sectors. For each of the sectors, the G20 results available are ranked based on each country's energy intensity, with the most energy-intensive G20 country ranked first for each sector. The analysis of the impact of the different effects on energy costs responds to very diverse international dynamics of sectors and countries. A detailed description of these can be found in the Trinomics et altri study (2020).

Table 19- Decomposition of energy cost drivers for G20 countries over the period (2010-2016)

Country	Sector Code	Sector (Description)	Price effect	Real output effect	Real energy intensity effect	Total effect	2016 Energy Intensity (toe per million €)
US*	C10_C12	Manufacture of food products; beverages and tobacco products	5.0%	33.6%	-22.5%	16.1%	34.5
TR			-36.1%	19.9%	23.4%	7.1%	31.6
CN			61.9%	112.6%	-121.2%	53.4%	23.4
UK			24.9%	6.7%	-11.8%	19.8%	21.0
UK	C13_C15	Manufacture of textiles, wearing apparel, leather and related products	24.1%	-11.9%	-2.6%	9.6%	48.5
TR			-52.9%	20.1%	42.3%	9.5%	37.4
US*			19.8%	45.6%	-41.6%	23.7%	31.9
CN			68.7%	96.8%	-100.8%	64.7%	29.2
MX*			-26.4%	-14.5%	31.9%	-9.0%	0.3
TR	C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	-41.0%	23.8%	68.6%	51.4%	82.1
US*			-2.0%	48.9%	-43.5%	3.4%	51.2
UK			39.8%	-42.0%	80.5%	78.3%	22.7
CN			73.3%	110.8%	-137.0%	47.0%	14.5
US*	C17	Manufacture of paper and paper products	20.0%	28.8%	-28.4%	20.4%	268.8
UK			44.7%	-12.3%	23.1%	55.5%	169.4
TR			-40.1%	22.8%	57.2%	39.9%	86.1
CN			74.4%	87.1%	-112.2%	49.3%	65.0
CN	C19_C21	Manufacture of coke, refined petroleum products, chemicals and chemical products, basic pharmaceutical products, and pharmaceutical preparations	31.7%	110.3%	-77.6%	64.5%	70.9
TR			-34.5%	19.4%	50.9%	35.7%	57.6
US*			-2.2%	31.3%	-28.3%	0.8%	52.5
UK			28.4%	-41.5%	15.2%	2.1%	33.0
CN	C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	-0.6%	129.2%	-74.1%	54.5%	33.5

D- Drivers of output effect in the EU and G20

The EU, the US, and China have experienced increases in total industrial gross output over time driven by increased domestic demand. Although higher exports in all three areas have contributed moderately to gross output although this was generally compensated by increasing imports.

The UK experienced a negative output effect driven by a strong growth of imports that were bigger than exports and the small growth in domestic demand. A detailed account of the varied sectorial developments can be found in the Trinomics (2020)

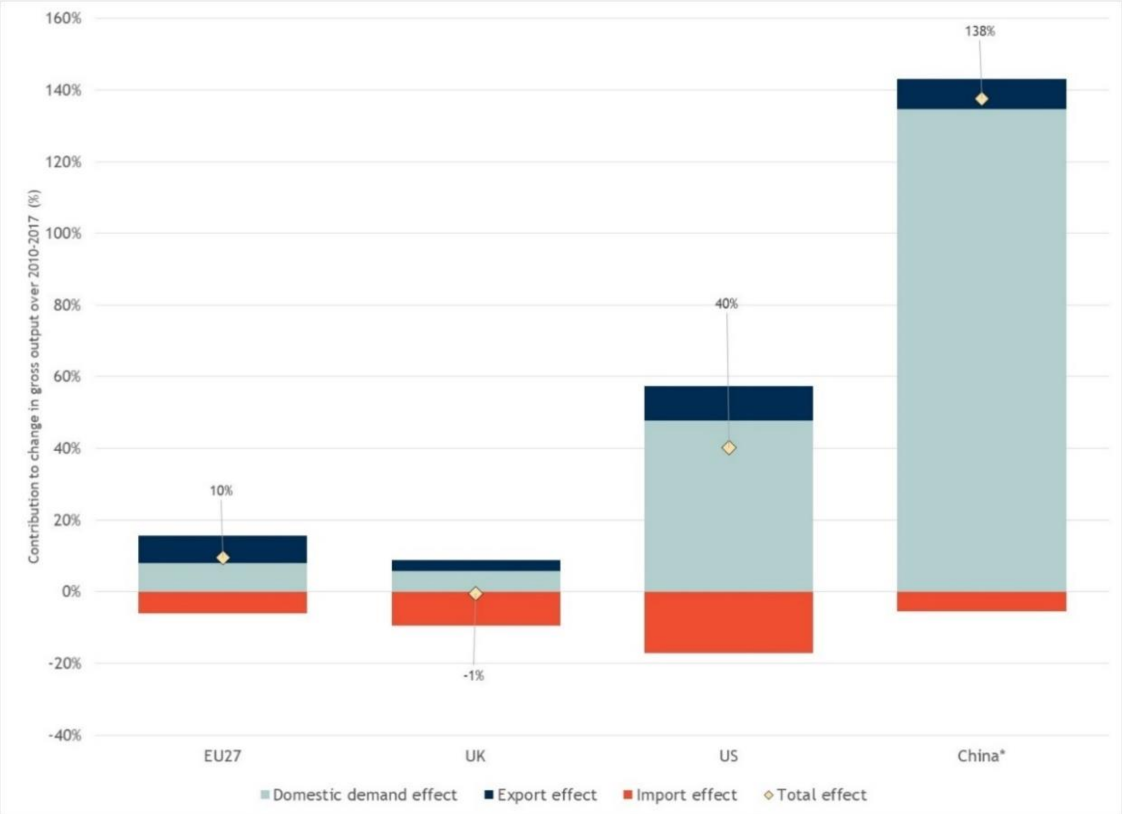

Figure 150- Decomposition of output effect in EU, UK, US and China

Table 20 - Decomposition of output drivers for the EU27 and main G20 trade partners, 2010-2017

Area	Sector Code	Sector Description	Domestic demand effect	Export effect	Import effect	Total effect (2010-2017)
EU27	C10_C12	Manufacture of food products; beverages and tobacco products	3.3%	4.3%	-1.7%	5.9%
UK			13.9%	4.2%	-6.6%	11.5%
US			34.6%	2.8%	-5.1%	32.3%
CN			171.8%	2.9%	-4.0%	170.7%
EU27	C13_C15	Manufacture of textiles, wearing apparel, leather and related products	6.9%	14.5%	-20.9%	0.4%
UK			-36.4%	12.3%	8.8%	-15.3%
US			98.6%	6.8%	-48.2%	57.1%
CN			118.7%	14.8%	-1.8%	131.7%
EU27	C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	-2.5%	3.0%	-0.4%	0.0%
UK			-28.3%	-1.7%	6.4%	-23.5%
US			67.7%	5.6%	-13.8%	59.5%
CN			175.2%	2.7%	-5.6%	172.3%
EU27	C17	Manufacture of paper and paper products	1.3%	0.7%	0.4%	2.3%
UK			-7.6%	-5.6%	15.2%	2.1%
US			26.5%	1.9%	-1.4%	26.9%
CN			122.6%	6.1%	-5.7%	123.0%
EU27	C19	Manufacture of coke and refined petroleum products	-29.9%	-6.6%	7.6%	-28.9%
UK			-33.7%	-22.7%	7.1%	-49.3%
US			17.0%	19.5%	-3.5%	33.0%
CN			123.1%	2.4%	-0.4%	125.1%
EU27	C20	Manufacture of chemicals and chemical products	1.1%	4.8%	-5.1%	0.9%
UK			-23.5%	-25.8%	24.9%	-24.5%
US			25.4%	6.0%	-5.6%	25.7%
CN			164.3%	7.0%	-7.4%	164.0%
EU27	C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	-8.4%	47.4%	-18.2%	20.8%
UK			16.4%	-8.0%	-21.6%	-13.2%
US			84.1%	5.7%	-23.8%	66.0%
CN			227.3%	2.8%	-11.2%	218.8%
EU27	C22	Manufacture of rubber and plastic products	15.0%	5.8%	-5.0%	15.8%
UK			8.6%	0.7%	-5.3%	4.0%
US			50.8%	6.4%	-13.1%	44.1%
CN			115.0%	14.3%	-1.0%	128.3%
EU27	C23	Manufacture of other non-metallic mineral products	1.2%	3.5%	-1.9%	2.8%
UK			12.0%	0.4%	-4.5%	7.9%
US			51.4%	2.9%	-9.1%	45.2%
CN			168.1%	5.5%	-1.5%	172.1%

Source: Trinomics (2020)

E- Drivers of energy intensity effect in the EU

Table 21 shows the key drivers of the structural change, the range of changes in shares of turnover and the range of energy cost shares for subsectors.

The analysis shows that the **structural change in subsectors at a NACE 3 level, had a relatively small impact on overall energy cost share of the aggregate sector relative to other factors**. This reflects that **despite substantial variation in energy intensity between subsectors** for some industries, there is no indication that there was a **sufficient shift in production between subsectors to drive the changes in energy costs shares observed.**

The **differences in energy cost shares can be quite large for subsectors within a NACE 2 level sector**. For example, in Non-metallic minerals, the least intensive sub sector is a fifth as intensive as most intensive sub sector. However, over the period, the change in turnover shares was only between -1.8% and 1% so the *net structural change* effect is only 2%. For other sectors, where the difference in energy cost share in subsectors is very small, and this limits the scope of structural change to impact energy intensity (for instance *leather* and *printing,* in which there *was a* shift in shares of 4.9% and 3.2% respectively, the structural intensity effect was only 1% and 0%). The largest structural change effect is observed for *other transport equipment* which shows a particularly large structural change effect in turnover between sectors to a lower energy-intensive sector.

Table 21- Structure intensity effect for EU27 for Manufacturing sub sectors at 2 digit level

Sector code	Sector	Structural intensity effect	Other energy intensity effects	Total energy intensity effect	Minimum change in turnover share	Maximum change in turnover share	Minimum Energy cost share	Maximum Energy cost share
C10	Food products	-1%	-21%	-22%	-1.2%	0.8%	1.1%	2.5%
C13	Textiles	-3%	-31%	-34%	-2.3%	3.8%	1.7%	4.9%
C14	Wearing apparel	-1%	-65%	-66%	-0.8%	0.9%	0.5%	1.0%
C15	Leather and related products	1%	-83%	-82%	-4.9%	4.9%	0.4%	0.5%
C16	Wood and wood products	0%	-15%	-14%	-1.9%	1.9%	2.3%	2.7%
C17	Paper and paper products	-1%	-37%	-38%	-1.4%	1.4%	2.0%	6.1%
C18	Printing and reproduction of recorded media	0%	-5%	-5%	-3.2%	3.2%	1.6%	1.8%
C19	Coke and refined petroleum products	0%	49%	49%	-0.1%	0.1%	0.0%	1.8%
C20	Chemicals and chemical products	0%	-27%	-28%	-0.4%	1.1%	0.7%	4.7%
C21	Pharmaceuticals	-1%	-24%	-26%	-0.8%	0.8%	0.6%	1.8%
C22	Rubber and plastic products	0%	-19%	-19%	-0.1%	0.1%	1.5%	2.0%
C23	Other non-metallic mineral products	2%	-22%	-20%	-1.8%	1.1%	2.6%	11.4%
C24	Basic metals	-1%	-25%	-26%	-1.7%	3.7%	1.6%	6.0%
C25	Metal products	2%	-24%	-22%	-2.4%	2.5%	0.7%	2.0%
C26	Computer, electronic and optical products	4%	-11%	-7%	-12.4%	8.6%	0.3%	1.0%
C27	Electrical	1%	-29%	-28%	-2.5%	0.9%	0.5%	1.3%

	equipment							
C28	Machinery and equipment n.e.c.	-1%	-23%	-24%	-2.3%	1.0%	0.5%	0.9%
C29	Motor vehicles etc	0%	-30%	-30%	-0.3%	0.5%	0.3%	1.0%
C30	Other transport equipment	-14%	-36%	-49%	-7.8%	19.5%	0.3%	0.6%
C32	Other manufacturing	-1%	-25%	-26%	-1.7%	4.4%	0.4%	1.2%
C33	Repair and installation	1%	-7%	-6%	-2.4%	2.4%	0.5%	0.8%

Source: Trinomics (2020)

6.4.2 Impact of energy costs on total production costs

This section assesses the results of the decomposition of total production costs in order to understand the extent to which total production costs were driven by changes in energy costs.

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

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

The result of the analysis by *Trinomics et altri* (2020) estimates that, at aggregated level, energy costs continue to have an almost negligible impact (-0.3%) on reducing total production costs over the period of study (2010-2017). Total production costs increased by 22% driven by non-energy energy production costs.

At sector level, the impact of energy costs changes on total production costs was not very diverse (See **Table 22**), ranging from -2% to 0%. The most important negative impacts on energy costs took place in *paper* (-2%) *basic metals* (-1%) and *non-metallic* minerals (-1%).

Table 22- Drivers of total production costs in manufacturing sectors, EU27, 2010-2017

Sector Code	Sector	Energy cost effect	Non-energy costs effect	Total effect (2010-2017)	2017 EU27 Energy Intensity (toe per million €)
C20	Manufacture of chemicals and chemical products	-0.7%	14.8%	14.1%	190.8
C17	Manufacture of paper and paper products	-2.0%	15.8%	13.8%	182.3
C24	Manufacture of basic metals	-1.2%	7.7%	6.5%	174.1
C19	Manufacture of coke and refined petroleum products	-0.2%	-20.6%	-20.8%	158.8
C23	Manufacture of other non-metallic mineral products	-1.1%	4.0%	2.9%	158.2
C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	-0.2%	7.2%	7.0%	75.5
C10_C12	Manufacture of food products; beverages and tobacco products	0.0%	27.3%	27.3%	26.9
C22	Manufacture of rubber and plastic products	-0.1%	18.8%	18.8%	22.4
C13_C15	Manufacture of textiles, wearing apparel, leather and related products	-1.3%	4.2%	2.9%	21.5
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	-0.1%	13.5%	13.4%	19.3
C25	Manufacture of fabricated metal products, except machinery and equipment	-0.2%	15.6%	15.4%	17.5
C31_C32	Manufacture of furniture; other manufacturing	-0.1%	16.5%	16.4%	11.0
C33	Repair and installation of machinery and equipment	0.0%	12.5%	12.5%	10.1
C28	Manufacture of machinery and equipment n.e.c.	0.0%	34.2%	34.2%	9.5
C27	Manufacture of electrical equipment	-0.2%	18.9%	18.7%	8.3
C26	Manufacture of computer, electronic and optical products	-0.1%	2.7%	2.6%	6.5
C29	Manufacture of motor vehicles, trailers and semi-trailers	0.1%	52.6%	52.6%	6.1
C30	Manufacture of other transport equipment	-0.1%	83.6%	83.5%	4.3
T	**Total (Of sectors with complete data)**	**-0.3%**	**22.2%**	**21.9%**	**50.6**

Source: Trinomics et altri study (2020), 2017 data

6.5 International comparisons

In this section we compare indicators which can influence the international competitiveness in terms of costs of the EU sectors with regard to its trading partners. We directly compare the international energy costs shares in production costs and production value of sectors. We also look at the underlying reasons for these energy costs differentials. First, we compare differences in energy efficiency indicators, which can influence the relative differences in energy consumption and therefore be one of the reasons explaining differences in energy costs. Second, we also look at the international differences in the prices of energy products, as they usually are the main drivers of the energy costs in the short term and thereby of costs differentials. Data on international prices is relatively robust while data on energy costs and energy efficiency is rather limited and the results of the latter should be taken with caution.

The section compares retail industrial prices for electricity and gas between sectors in the EU and in non-EU G20 countries as these two energy carriers tend to be the most relevant for industrial energy costs. The section relies on the results of the *Trinomics et altri* study (2020).

International comparisons on oil products prices can be found in **section 3.3.7** as they are relevant for the energy costs in some specific manufacturing sectors and non-manufacturing sectors.

6.5.1 Energy costs vs other G20 countries

In this section energy costs of EU sectors are compared with those in main EU trading partners. These comparisons could give indications of the international competitiveness of EU industries in terms of costs. Specific data on energy cost shares of non-EU G20 partners is scarce and limited the scope of comparisons that could be made. In addition, the aggregated sectors compared are made of various sub-sectors, the importance of which within the aggregated sectors may vary across countries.

Figure 151 shows a comparison of energy costs shares in production costs for highly energy-intensive sectors and countries for which equivalent energy cost and production cost data were found.

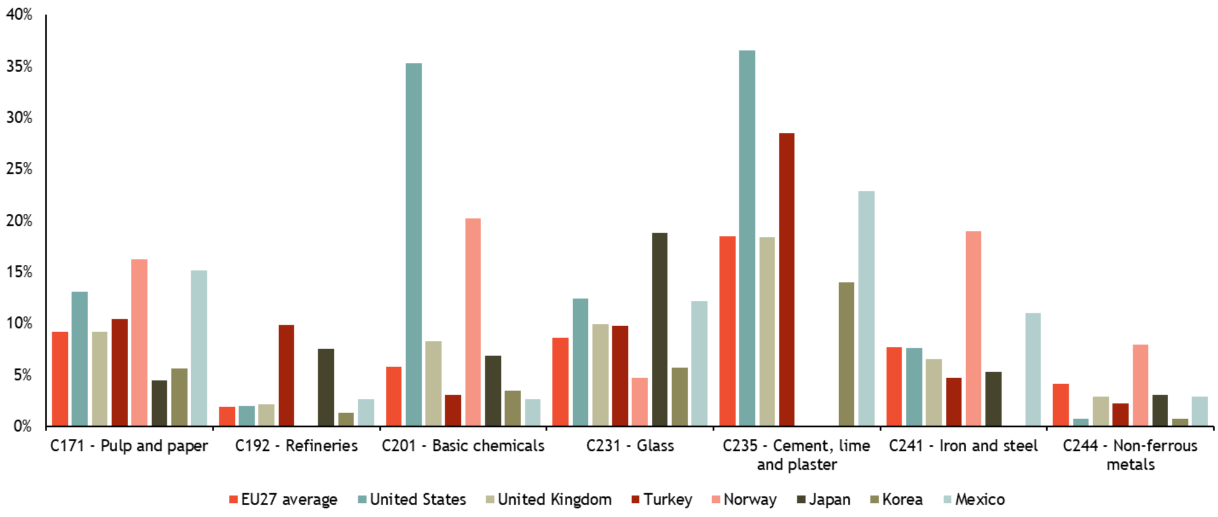

Figure 151 - International comparision of energy costs shares for selected highly energy-intensive sectors

Source: Trinomics et altri study (2020)

The available data for the highly energy-intensive sectors show that shares of energy costs in production costs in the EU are lower than in the US for *paper*, *basic chemicals*, *glass* and *cement*, comparable for *refineries* and *steel* but higher for *non-ferrous metals*. This would point to overall comparable or lower energy costs shares in production costs in the EU than in the US for the highly energy-intensive sectors studied. As compared to Japan, EU's energy costs shares in production costs are lower in *refineries*, *glass* and *basic chemicals* but higher in *steel*, *non-ferrous metals* and *paper*. The results, in comparison to what was found in the two previous (2016 and 2018) editions of the energy prices and costs report, show an overall more mixed picture, no longer pointing to EU costs shares being generally higher than in Japan (it depends on the sector).

That said, from the point of view of the sectors subjected to highest international competitive pressures (*refineries*, *steel*, *non-ferrous metals*), the share of energy costs in production costs for these industries in the EU are comparable or higher in the US and Japan (with the exception of refineries).

For the other highly energy-intensive sectors, the energy cost shares in production costs in the EU were lower than those in the US and Japan for *basic chemicals* and *glass*. For *paper*, they were also lower in the EU than in the US but higher than in Japan. The situation is similar for *cement*, for which the EU energy costs shares in production costs are lower than in the US but higher than in Korea (there is no data for Japan for this sector)

Korea displays lower energy costs shares in production costs than the EU, the US and Japan, in almost all the highly energy-intensive sectors studied for which data was available (*paper*[71], *basic chemicals*, *glass*, *cement* and *non-ferrous metals*)

From the point of view of the main fuels used by the studied highly energy-intensive sectors, the numbers suggest that, as compared to US and Japan, the energy costs shares in production costs in the EU tend to be higher in electro-intensive sectors (*non-ferrous metals*) and

[71] *Paper* is the only exception for which Korea does not show the lowest energy costs shares in production costs in highly energy-intensive industries when compared with the EU, Japan, and the US. For paper, Japan displays the lowest energy costs share, followed by Korea, the EU and the US.

comparable or lower in fossil-fuel intensive sectors (*refineries*, *basic chemicals*, *glass*). The picture is mixed for *paper* (which relies importantly in biomass energy in addition to gas and electricity) and *cement.*

When looking at a broader picture of energy-intensive sectors (See **Figure 152**) the pattern changes. The energy cost shares in production value of less energy-intensive sectors in the EU tend to be lower than those in the US and Japan. They are lower in the case of *machinery, casting of metals* and *computers* and significantly lower in *other manufacturing* and *electrical equipment.* Energy cost shares for *motor vehicles* are lower than in Japan, but higher than in the US.   They are also lower than in the US and Japan for a bit more energy-intensive sectors like *grain* and *pharmaceuticals* and for the very energy-intensive sector of *cement, lime and plaster.*

The energy cost shares in production value in the EU are similar to those in the US for *beverages* and *stone.* They are lower than in the US (but higher than in Japan) for *abrasive products* and *ceramics.*

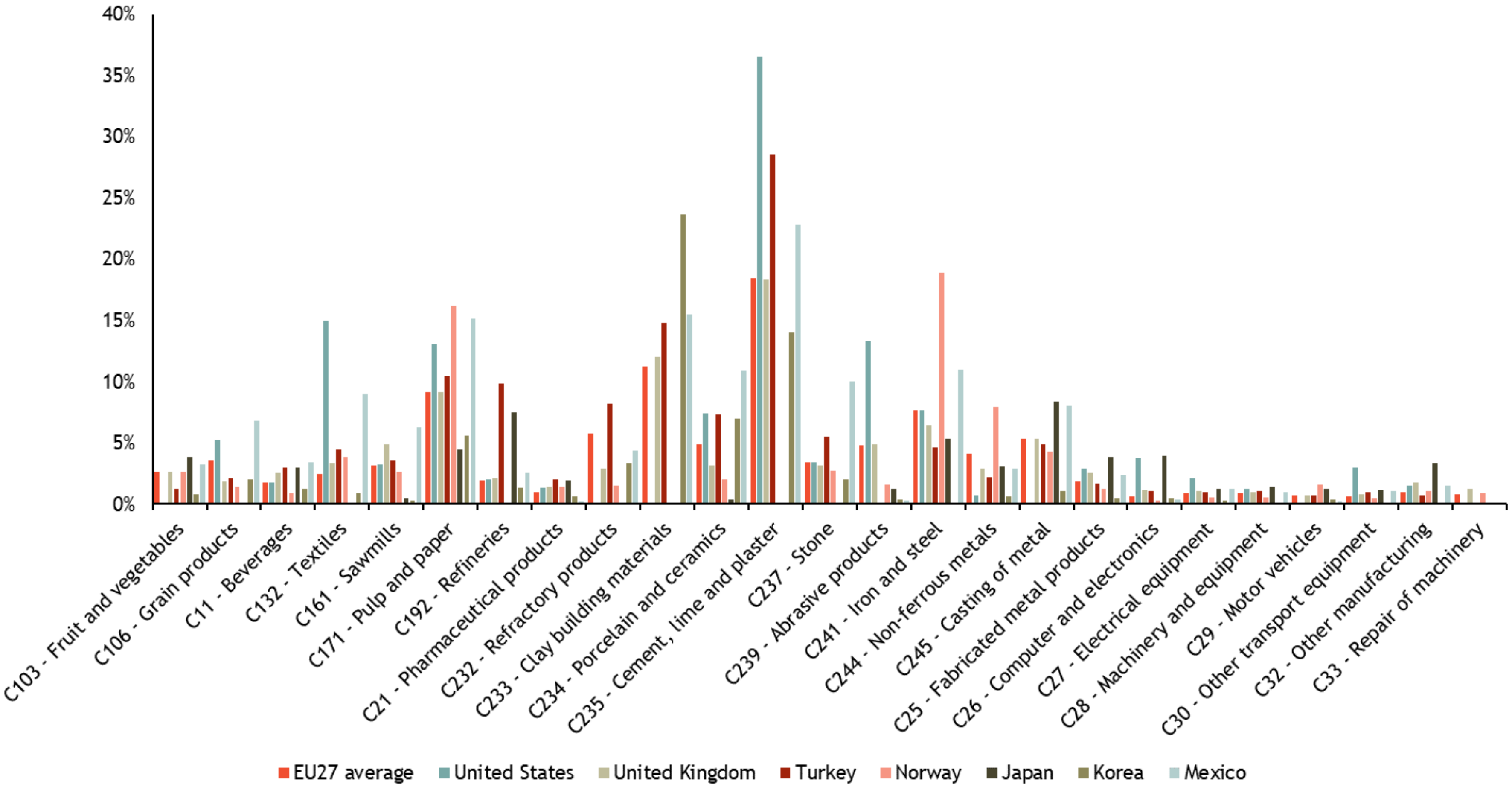

Figure 152 - Energy costs shares in production value for manufacturing sectors, 2008-2017

Source: Trinomics et altri study (2020)

As to Norway, the result of the comparison with the EU is mixed. For highly energy-intensive sectors, the energy cost shares in the EU are lower than in Norway in *steel*, *non-ferrous metals*, *chemicals* and *paper* but higher in gas intensive sectors like *grain*, *glass*, *refractory products* and *ceramics*. As to the less energy-intensive products the results are also mixed, with the energy costs shares in the EU being higher in sectors like *stone*, *abrasive products* and *metals products*, *machinery, computers* and *electric equipment*, comparable in *other manufacturing* and lower in *motor vehicles* and *pharmaceutical* products.

With regard to Turkey, as regards the most energy-intensive sectors, the EU's energy cost shares were significantly higher in *basic chemicals*, *non-ferrous metals* and *steel*, slightly lower in *paper* and *glass*, and much lower in *cement*. In most of the other less energy-intensive sectors, the EU's energy shares were lower than in Turkey, with the exception of *motor vehicles, metal products* (in which they were comparable or slightly higher) and *grain, fruit* and *other manufacturing* (in which they were higher).

Some additional general observations can be drawn across sectors:

- Norway displays the highest energy cost shares in the *paper* and *non-ferrous metals* in spite of lower electricity and natural gas prices than the EU's, due to their relatively higher energy consumption
- Turkey has the highest energy cost share in the refineries, followed by Japan
- Japan has the highest energy cost share in *glass*
- The US has the highest energy cost shares in *basic chemicals* and *cement.*
- On average, the EU has energy cost shares comparable to those of most international trade partners, with relatively high energy cost shares in *steel* and *non-ferrous metals,* and comparable or lower shares for the less energy-intensive sectors. The EU has a relatively low energy cost shares in refineries.

6.5.2 Energy intensity of EU sectors vs other G20

Energy efficiency can also be factor for international competitiveness (the more energy efficient a firm is, the lower its relative consumption and energy costs). By comparing energy intensities across sectors one can have an indication of the different energy efficiency in these sectors and countries (bearing in mind that other factors, such as countries with specialisation in products of high added value, will also have an impact on decreasing the carbon intensity of a particular sector). This complements the understanding of the role of energy cost shares. One should also be aware that the international data on energy intensity is rather limited (with often only one or two other international comparators available) and that these results should be taken with caution.

Figure 153 and **Figure 154** display the trends in energy intensity on the available sectors and countries. Although it is difficult to draw any general conclusions it can be observed that that:

- Energy intensities in the EU compared to those in the US show considerable variation per sector for which data is available, with the EU being less energy-intensive in *glass*, *fabricated metal products*, *abrasive products and electrical equipment;* and the US being less energy-intensive in *refineries*, *beverages*, *basic chemicals*, *pharmaceutical products* and *computers and electronics*.

— The EU continues to be less energy-intensive than China in every sector for which data is available (but for *refineries* for which the EU have the highest energy intensity of the countries for which data was available). The EU is however more energy-intensive than Japan for the most energy-intensive sectors and comparable or lower for the less energy-intensive sectors.

By sector, the EU's energy intensity relative position to other countries varies importantly. In *paper*, the EU's energy intensity is higher (double) than in Japan and Korea. In *refineries*, it is the highest in particular as compared with Switzerland, Brazil, China and Japan. In *basic chemicals*, the EU27 has a lower than average energy intensity, lower than China, Japan and Brazil. In *steel* and *non-ferrous metals*, the EU27 has higher intensity levels than Switzerland and Japan but lower levels than Norway. In *glass*, it is lower than in Mexico and the United States, but higher than Norway and Canada. In *abrasive products*, it is the lowest across all international counterparts, though intensity in Japan and the US are only slightly higher than in the EU. For other less intensive energy sectors, the EU27 has generally lower than average intensity and, as compared with the US, lower in sectors like *metal products*, *electrical equipment*, *machinery and equipment*, and *motor vehicles*, comparable in *computers* and higher in *beverages*, *pharmaceuticals*. China has consistently the highest comparative energy intensities in these sectors.

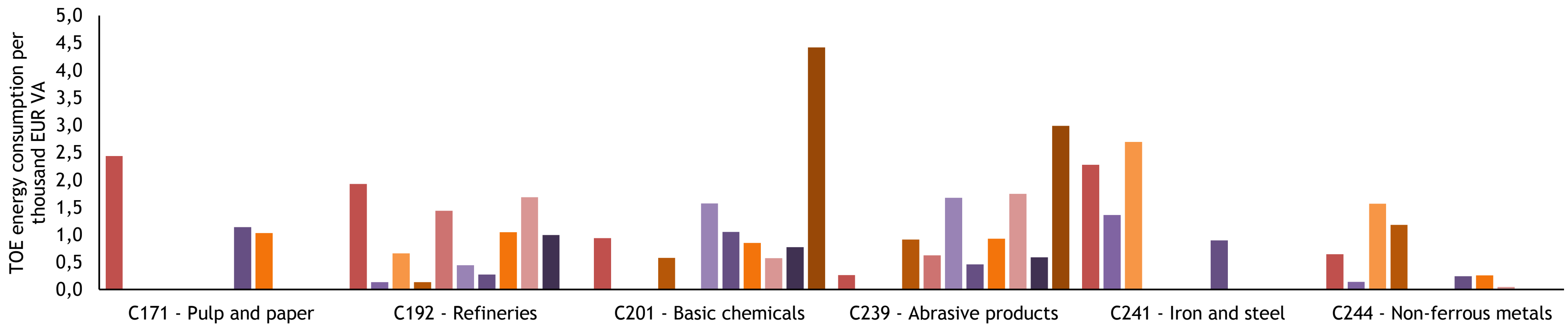

Figure 153 - Energy intensity international comparisons for the most energy-intensive manufacturing sectors

Source: Trinomics et altri study (2020)
Note: data limited for available sectors and countries

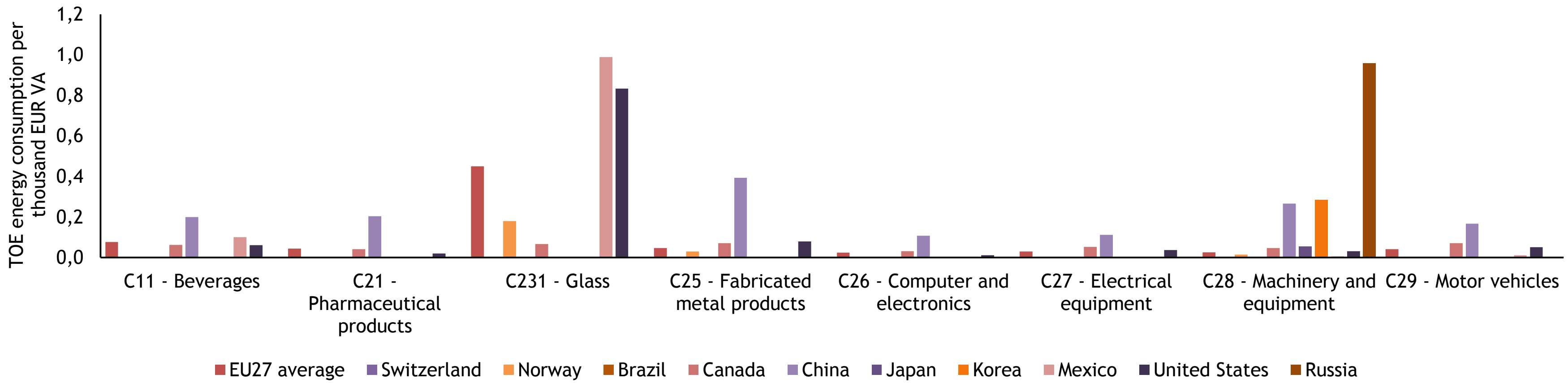

Figure 154 - Energy intensity international comparisons for other manufacturing sectors

Source: Trinomics et altri study (2020)
Note: data limited for available sectors and countries

6.5.3 Industrial electricity prices: EU vs G20 countries

In this section retail electricity industrial prices in the EU industry and in G20 Members are compared. The comparisons are mainly based on the results of the *Trinomics et altri* study. Electricity prices gaps between international trade partners can be relevant for an assessment of cost competitiveness of sectors. Electricity is in many cases the energy carrier with most potential to impact the energy costs differential between energy-intensive sectors in manufacturing.

Retail electricity prices for industry have relatively complete datasets. The price data covers EU27 and G20 countries from 2008-2019. EU27 prices are based on consumption band assumptions (mainly Eurostat consumption band ID) while data for non-EU G20 countries is usually relying on the average of the countries (not based on consumption bands). The price data is however widely comparable (i.e. comparability checks were undertaken can be found in the study by *Trinomics et altri*). Finally, prices are exclusive of VAT and recoverable taxes and levies but include (non-recoverable) excise taxes and levies.

The main conclusions that can be drawn from this data are:

— EU27 average real electricity prices rose from around 110 EUR/MWh in 2008 to 125 EUR/MWh by 2013-2014; they declined until 2018 to 110 EUR/MWh and rose until 2019 to 115 EUR/MWh.

— US prices are around half the EU average levels and have not changed significantly between 2008 and 2019.(See **Figure 155)**

— Prices in Japan are higher than the EU27 average, they converged between 2012-2015 but the differential remained broadly stable since.(See **Figure 155**)

— Prices in China began at a comparable level to EU prices but declined in 2011 to levels below the EU price levels. They have declined further since 2018 increasing the divergence with the EU prices. (See **Figure 155**)

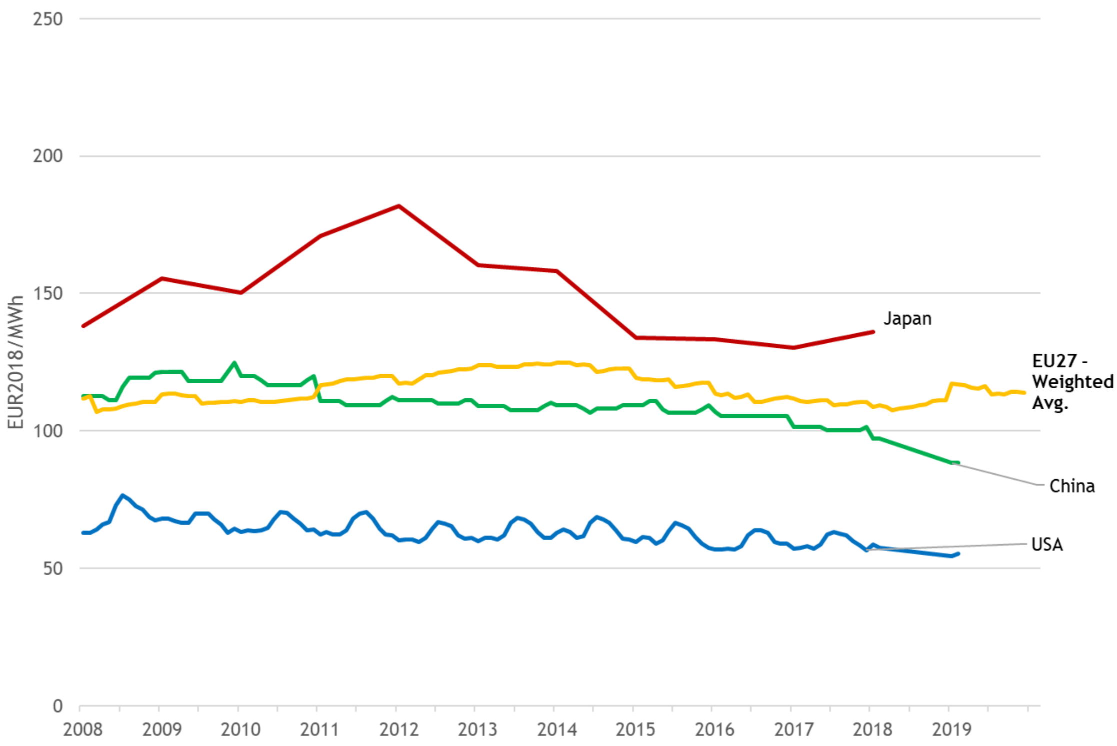

Figure 155 – Retail electricity prices for industry: EU vs China, Japan & US, 2008-2019

Sources: Eurostat, CEIC and IEA

— Most other non-EU G20 countries (Canada, India, Russia, Mexico, South Korea, Saudi Arabia, and Turkey) also have lower prices than the EU average. Only Brazil has higher prices. Prices in Turkey fluctuate importantly but they were rapidly converging in the last years. Prices in South Korea also show a converging trend to EU levels (as prices do in Saudi Arabia and South Africa but from much lower levels). Mexico significantly decreased since 2014 and continue diverging from the EU prices. (See **Figure 156**)

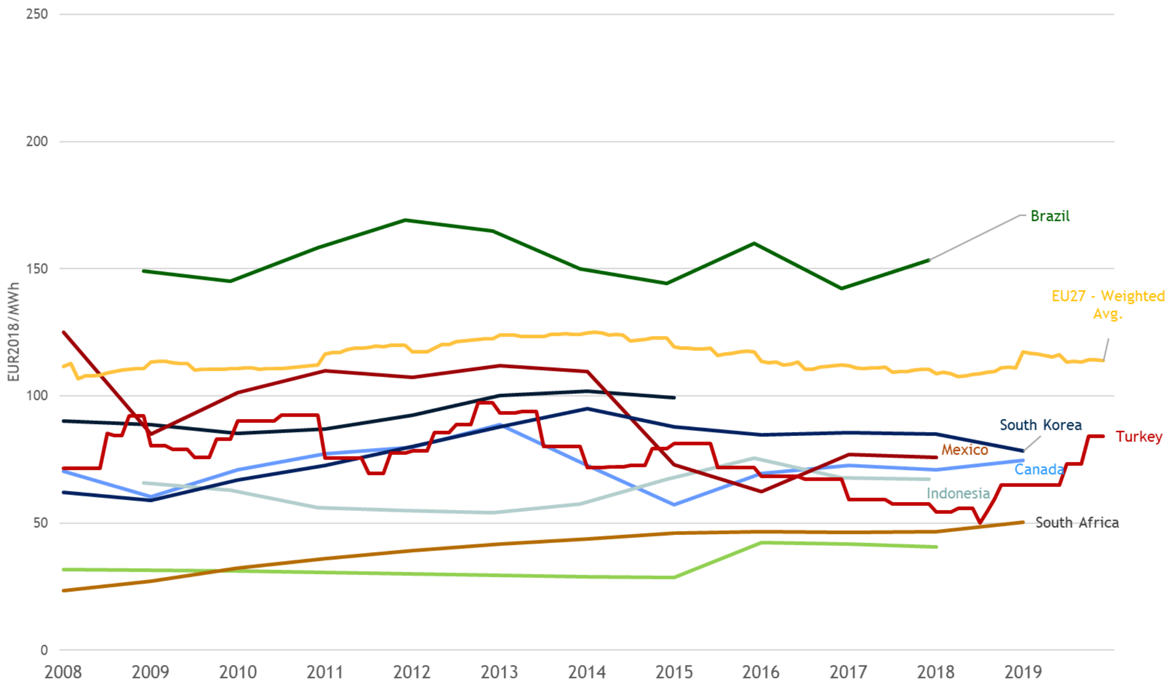

Figure 156 - Retail electricity prices for industry: EU vs other G20, 2007-2019

Sources: Eurostat, CEIC, IEA, ERRA

For Argentina, Australia, India there is only information from price indices (and not absolute price data). The indices' evolution show that average prices have rose by 20% since 2008 (+1.1%/year) while real price indices fell in Argentina and, to a lesser extent, in India. The Australian price index rose in real terms by more than 60%, moving in a similar way as wholesale prices in that country. – See **Figure 157**

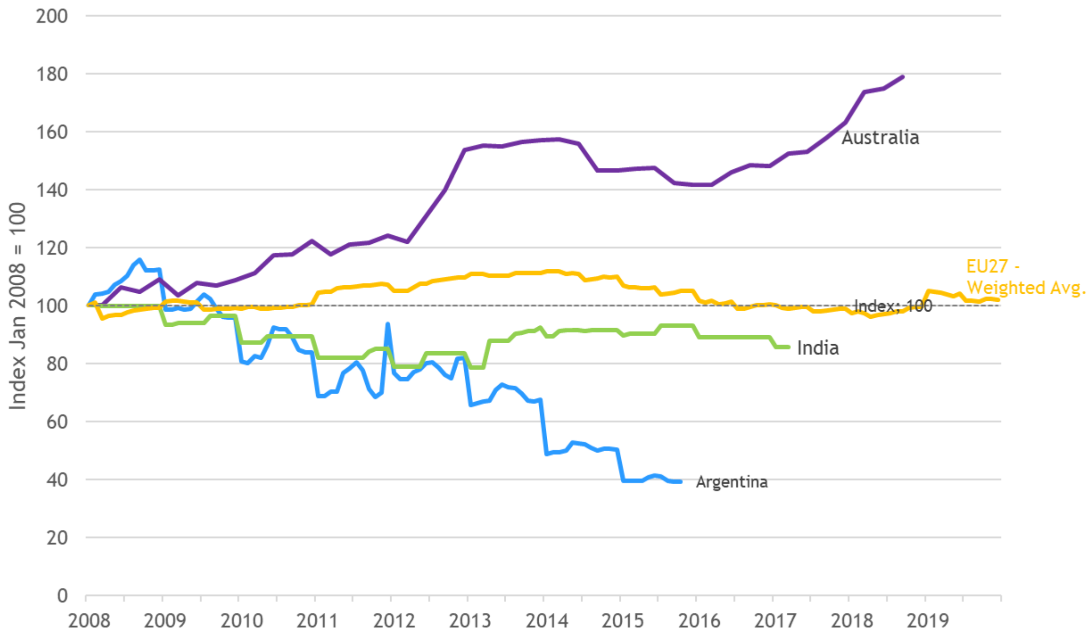

Figure 157 – Retail electricity indexes prices for industry: EU vs Argentina, Australia & India, 2008-2019

Sources: Eurostat, CEIC and IEA

— In 2008, the EU weighted average price was higher than prices in 11 countries, while in 2019 it was higher than 13 countries. Price gaps (in constant real prices 2018) did not evolve favourably for the EU with its most important trade partners as EU prices increased (by around 20%) while prices decreased in many non-EU G-20 countries. The price gap with the US and China (which was favourable for these two countries at the start of the period analysed) has widened slightly while the gap with Japan (which was favourable for the EU) has decreased. Over the whole period (2008-2019), the evolution of the price gap with non-EU G-20 countries was mixed, it was favourable (positive) with Argentina, Australia, Saudi Arabia, South Korea, South Africa and Turkey. It was not favourable (negative) with Brazil, Canada, Indonesia, India and Mexico– See **Table 23**

Table 23 - Changes in retail industrial electricity prices compared to EU prices, constant 2018 EUR/MWh

Country	Start price [EUR2018]	End price [EUR2018]	Change EUR	Change %	Start Gap [EUR]	End Gap [EUR]	Difference [EUR]	Relative for EU
EU27	111.72	116.25	4.53	4.1%				
Argentina	15.86	37.96	22.11	139.4%	-95.87	-78.28	17.58	Positive
Australia	74.66	142.14	67.48	90.4%	-37.06	25.89	62.96	Positive
Brazil	149.09	153.38	4.29	2.9%	37.37	37.14	-0.23	Negative
Canada	70.39	74.74	4.35	6.2%	-41.33	-41.51	-0.17	Negative
China	112.73	88.35	-24.38	-21.6%	1.01	-27.90	-28.90	Negative
India	90.19	99.20	9.01	10.0%	-21.53	-17.05	4.48	Positive
Indonesia	65.76	67.29	1.53	2.3%	-45.96	-48.96	-3.00	Negative
Japan	138.27	135.98	-2.28	-1.7%	26.54	19.74	-6.81	Negative
Mexico	125.07	75.78	-49.29	-39.4%	13.35	-40.47	-53.82	Negative
Russia								
Saudi Arabia	31.76	40.63	8.86	27.9%	-79.96	-75.62	4.34	Positive
South Africa	23.36	50.35	26.98	115.5%	-88.36	-65.90	22.46	Positive
South Korea	61.94	78.35	16.41	26.5%	-49.78	-37.89	11.89	Positive
Turkey	71.43	84.19	12.77	17.9%	-40.29	-32.05	8.24	Positive
USA	62.83	55.28	-7.56	-12.0%	-48.89	-60.97	-12.08	Negative

Source: Trinomics et altri study.

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 and 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.

- The analysis of the drivers of international prices (see **Table 24**) shows that beyond the evolution of domestic prices, monetary effects (inflation and exchange rate changes) also played a significant role in the evolution of nominal prices.

- High inflation played a key role in pushing up prices in countries like Brazil (+75%) and Turkey (+65%) as well as Indonesia and Mexico (>= +30%). In Turkey the effects of high inflation and rises in domestic prices were significantly mitigated by the exchange rates depreciations. In China and US domestic prices fell and inflation and in particular exchange appreciations of the domestic currencies against the Euro, pushed prices up.

Table 24 - Factors in observed industrial 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 [%]
EU27	2008-1	2019-12	**100.55**	12.39	2.90	0.00	**15.29**	**115.84**	12.3%	2.9%	0.0%	**15.2%**
Argentina	2008-1	2019-1	**10.85**	34.91	320.44	-325.95	**29.40**	**40.25**	321.7%	2952.5%	-3003.3%	**270.9%**
Australia	2008-1	2019-1	**57.99**	12.80	66.27	6.17	**85.24**	**143.24**	22.1%	114.3%	10.6%	**147.0%**
Brazil	2008-12	2017-12	**111.68**	74.25	-5.54	-30.92	**37.79**	**149.47**	66.5%	-5.0%	-27.7%	**33.8%**
Canada	2008-1	2019-1	**48.18**	7.23	25.61	-1.78	**31.06**	**79.24**	15.0%	53.2%	-3.7%	**64.5%**
China	2008-1	2019-2	**62.87**	19.44	-15.69	26.20	**29.95**	**92.83**	30.9%	-25.0%	41.7%	**47.6%**
India	2008-1	2015-1	**72.52**	33.38	18.38	-24.81	**26.95**	**99.47**	46.0%	25.3%	-34.2%	**37.2%**
Indonesia	2008-12	2017-12	**40.72**	22.75	7.81	-3.43	**27.13**	**67.84**	55.9%	19.2%	-8.4%	**66.6%**
Japan	2008-1	2018-1	**94.64**	-1.35	18.95	19.44	**37.04**	**131.69**	-1.4%	20.0%	20.5%	**39.1%**
Mexico	2008-1	2018-1	**85.61**	37.79	-17.91	-32.10	**-12.22**	**73.38**	44.1%	-20.9%	-37.5%	**-14.3%**
Russia	No data											
Saudi Arabia	2008-1	2018-1	**21.74**	3.62	7.56	6.42	**17.60**	**39.34**	16.6%	34.8%	29.5%	**80.9%**
South Africa	2008-1	2019-1	**19.97**	12.55	46.72	-27.58	**31.69**	**51.64**	62.9%	234.0%	-138.1%	**158.7%**
South Korea	2008-1	2019-1	**42.40**	7.66	26.65	6.36	**40.67**	**83.07**	18.1%	62.9%	15.0%	**95.9%**
Turkey	2008-1	2019-12	**64.29**	65.24	192.00	-235.87	**21.37**	**85.66**	101.5%	298.7%	-366.9%	**33.2%**
USA	2008-1	2019-2	**43.01**	7.96	-5.52	13.48	**15.92**	**58.94**	18.5%	-12.8%	31.3%	**37.0%**

Source: Trinomics et altri.study

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.

Note: 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 due to small differences in the conversions used in the two calculations, this latter difference is typically less than +/- 5% of the price.

Note on the range and dispersion of electricity prices for industry in the EU

The industrial electricity prices in the EU Member States have spanned a range of 50-230 EUR/MWh between 2008 and 2019 (see figure below looking at the maximum and minimum prices registered in MS between 2008–2018)

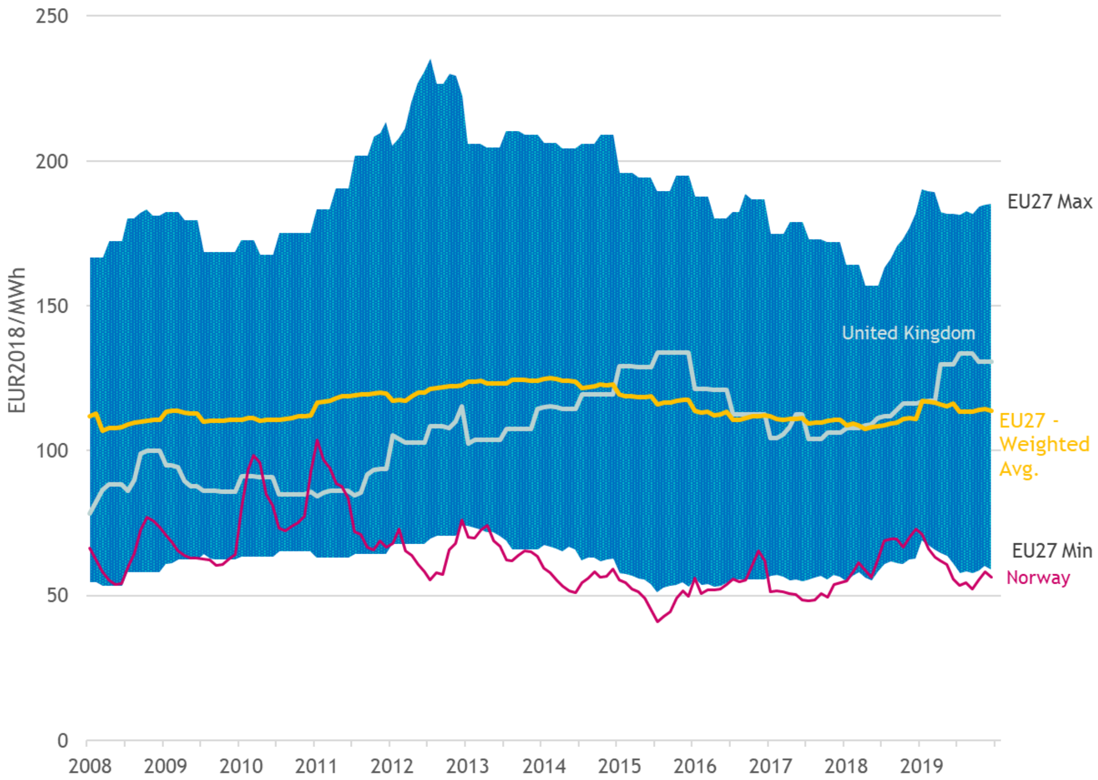

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Figure 158 - Range of retail electricity prices for industry in the EU

Source: Eurostat, Trinomics et altri (2020)

The wide range in prices does not necessarily mean that there is big dispersion in Member States prices. It reflects steady price differentials between Member States/regions (i.e. Members with consistently higher or lower prices than the EU average) but also short lived or temporary price divergences (e.g. price spikes) in some countries. The dispersion of EU prices can be better assessed by the Box plot figure below (in which the square shows the range of the prices of the 25% of the Member States being above the average and 25% of the Member States being below the average price (i.e. 50 of the sample))

Figure 159 - Box plot of EU27 industrial retail electricity prices 2008-2019

Source: Trinomics et altri (2020)

The figure below helps to identify the Member States with prices close to the maximum and minimum range and those showing significant steady deviations from the average.

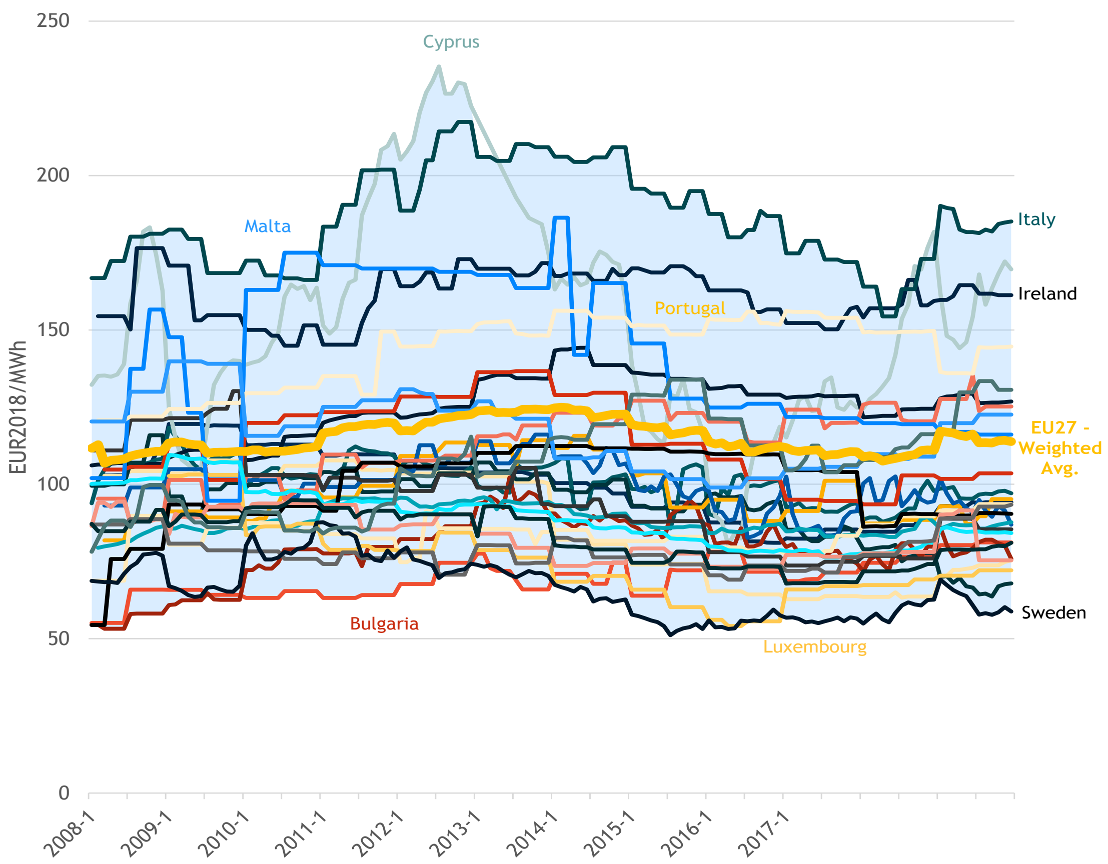

Figure 160 - EU27 industrial retail electricity prices 2008-2019, individual Member States lines visible, outliers named

Source Trinomics et altri (2020)

6.5.4 Industrial gas prices: EU vs G20 countries

In this section the retail gas prices for industries of the EU27 are compared with G20 countries over the period 2008-2019. Retail gas prices for industries also have relatively complete datasets until 2019. Prices exclude VAT and all recoverable taxes and levies. The main highlights of the period are:

- EU prices were in the range of 25-40 EUR/MWh until 2019. Since 2016 they have declined to a level below 25 EUR/MWh (marking a fall of around 20-25% over the 2008-2017). In 2020, amid the crisis triggered by COVID, prices fell to historical lows (e.g. 3 EUR/MWh in the Dutch gas price hub)

- Industry gas prices in the **US** (and **Canada**) are considerably lower than the EU average. They were similar to those of the EU in 2008 (around 30 EUR/MWh), but then declined to 10 EUR/MWh in 2016 and remained around that level until 2019. Prices in **China** have declining since 2015 reaching 35 EUR/MWh at the end of 2019. Prices in **Japan** prices increased between 2009 and 2014 (diverging from the EU average), declined strongly between 2014-2016 (to just above EU levels) but have been increasing during the last two year for which data is available (until 2018). – See **Figure 161**

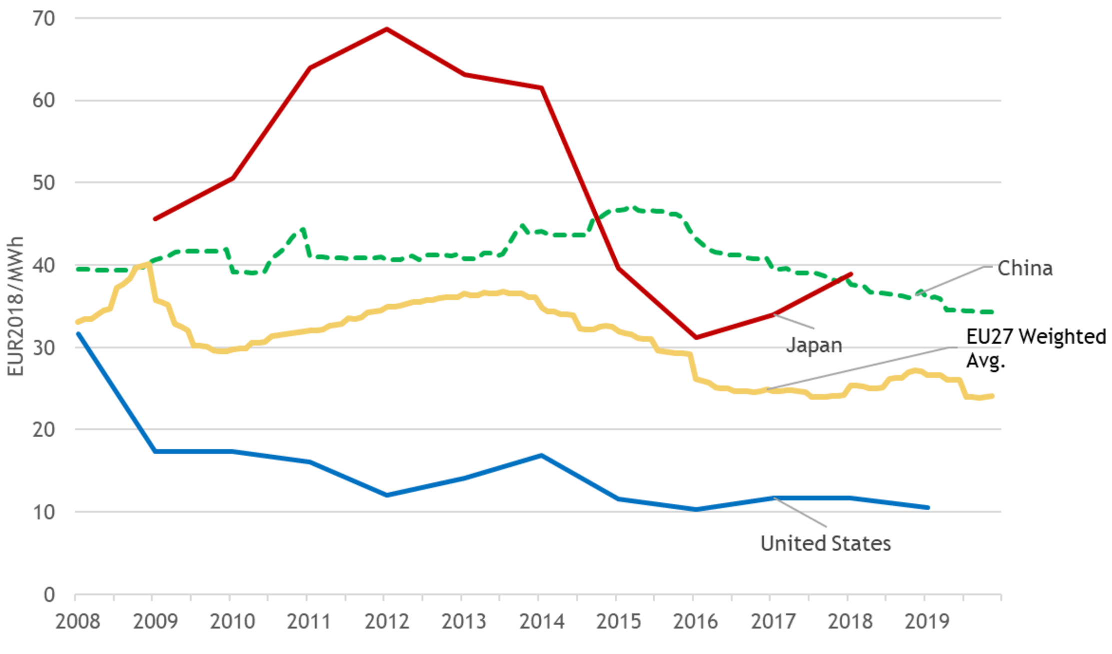

Figure 161 - Retail gas prices for industry: EU vs China, Japan and the US, 2008-2019

Sources: Trinomics (2020) based on Eurostat, CEIC

Note: the Chinese wholesale price is an assumed proxy price based on Usage Price: 36 City Avg: gas for Industrial users. Actual wholesale prices, to the extent they exist in China, are likely to be lower

— Prices in **Turkey** fluctuate while overall displaying a similar trend to the EU average, to which they have been converging since 2018. **South Korean** prices followed similar evolution of other Asian countries but they were relatively stable since 2016. Prices in **Brazil, Mexico** continue to be around half the EU levels, comparable to those in the US (and Canada). Prices in **Saudi Arabia** and **Argentina** are the lowest of all (below 5 EUR/MWh), possibly kept at those low levels by policy regulation (although they have been increasing since 2015-2016). – See **Figure 162**

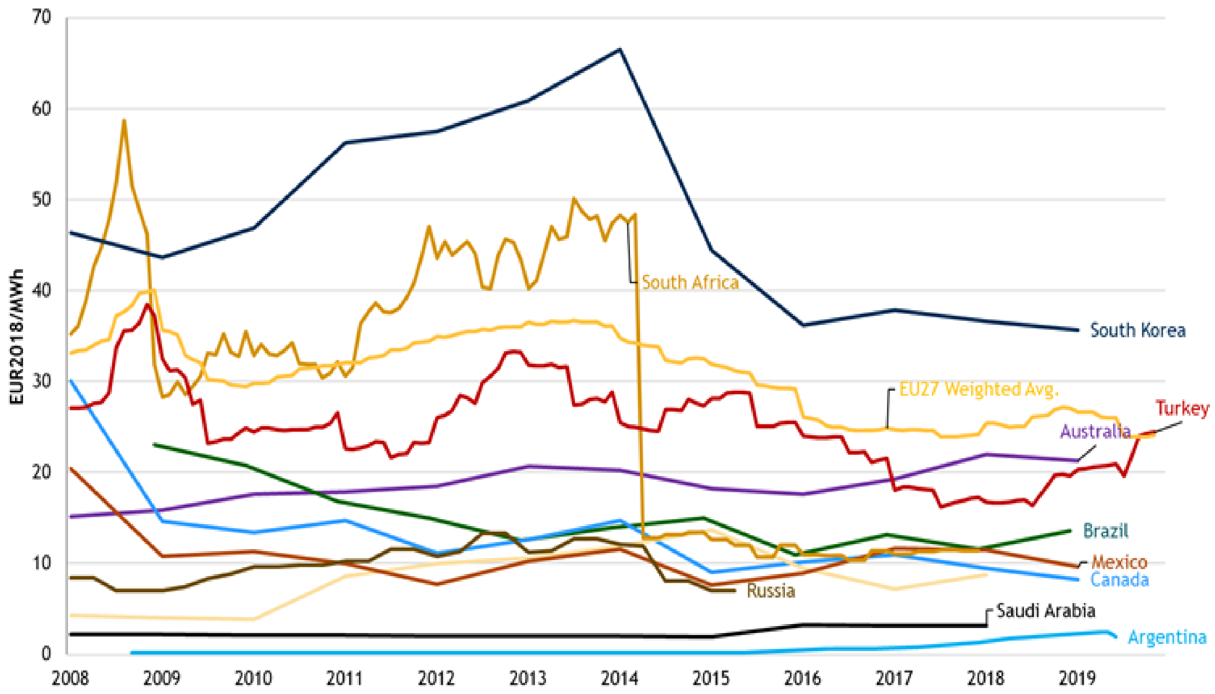

Figure 162 - Retail gas prices for industry: EU vs other non-EU G20 countries, 2008-2019

Sources: Trinomics (2020) based on Eurostat, CEIC, ERRA, IEA

— Price differential (in 2018 euros) did evolve favourably for the EU with regard to more than half of the countries including important trade partners such as China, Turkey, Japan and Russia (and also India, Australia and Saudi Arabia). The price gap evolved unfavourably with the US and Canada (in which prices fell more than the EU average). The price gap with, China, Turkey, Japan and Russia evolved positively for the EU as the prices in these countries fell less than in the EU. (see **Table 25**)

Table 25 - Changes in the industry retail natural gas price differential compared to EU prices between 2008-2019 (constant 2018 euros per MWh)

Country	Start price [EUR2018]	End price [EUR2018]	Change EUR	Change %	Start Gap [EUR]	End Gap [EUR]	Difference [EUR]	Relative for EU
EU27	**33.14**	**24.07**	-9.07	-27.4%				
Argentina	**0.20**	**1.94**	1.75	891.1%	-32.94	-22.13	10.81	Positive
Australia	**15.18**	**21.35**	6.17	40.6%	-17.95	-2.72	15.23	Positive
Brazil	**23.06**	**13.60**	-9.46	-41.0%	-10.07	-10.47	-0.40	Negative
Canada	**30.07**	**8.24**	-21.83	-72.6%	-3.07	-15.83	-12.77	Negative
China	**39.52**	**34.27**	-5.25	-13.3%	6.39	10.20	3.81	Positive
India	**4.33**	**8.80**	4.47	103.4%	-28.81	-15.27	13.54	Positive
Indonesia								
Japan	**45.61**	**38.93**	-6.68	-14.7%	12.47	14.85	2.38	Positive
Mexico	**20.44**	**9.61**	-10.84	-53.0%	-12.69	-14.46	-1.77	Negative
Russia	**8.44**	**7.00**	-1.44	-17.1%	-24.69	-17.07	7.62	Positive
Saudi Arabia	**2.17**	**3.12**	0.95	43.9%	-30.96	-20.95	10.02	Positive
South Africa	**35.27**	**11.39**	-23.88	-67.7%	2.13	-12.68	-14.81	Negative
South Korea	**46.38**	**35.68**	-10.71	-23.1%	13.25	11.61	-1.64	Negative
Turkey	**27.07**	**24.43**	-2.64	-9.8%	-6.06	0.36	6.42	Positive
USA	**31.69**	**10.58**	-21.11	-66.6%	-1.44	-13.49	-12.04	Negative

Source: Trinomics et altri study (2020)

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 and 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.

Between 2008 and 2019, the analysis of the factors driving price differential (see **Table 26**) shows that:

— EU nominal prices in Euros decreased by 9% over the period. Nominal prices in national currency decreased very significantly in South Africa (-30%), significantly in the US, Canada and Mexico (around -15%), similarly to the EU in Brazil (-8%) and technically in China and South Korea (- 3%). Prices, increased in all other non-EU G20 countries, especially in Turkey (+40%).

— Inflation pushed prices up especially in Turkey (+25%), South Africa (17%), Brazil (+11%) and Mexico (10%), moderately in China (7%), South Korea (6%) and mildly in the US (4%) and Canada (3%). Prices decreased in Japan (only technically, -0.3%)

— Exchange rate played important role in pushing prices downwards in Turkey (-66%), Argentina (-15%) and moderately in countries like South Africa, Brazil, Mexico, Japan, Russia and India (- 3-6%). Exchange rates appreciations against the Euro were important as regards China (+10%) and moderately as regards the US and South Korea (+3%).

Table 26 - 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 [%]
EU27	2008-1	2019-11	**29.82**	3.68	-9.01	0.00	**-5.34**	**24.49**	12.3%	-30.2%	0.0%	**-17.9%**
Argentina	2008-9	2019-6	**1.49**	4.30	10.23	-14.55	**-0.02**	**1.48**	288.4%	686.2%	-975.9%	**-1.3%**
Australia	2008-1	2019-1	**11.79**	2.60	6.19	0.93	**9.72**	**21.51**	22.0%	52.5%	7.9%	**82.4%**
Brazil	2008-12	2018-12	**17.55**	10.95	-8.54	-5.05	**-2.64**	**13.64**	62.4%	-48.7%	-28.8%	**-15.0%**
Canada	2008-1	2019-1	**20.58**	3.09	-14.74	-0.20	**-11.85**	**8.73**	15.0%	-71.6%	-1.0%	**-57.6%**
China	2008-1	2019-11	**22.04**	6.82	-3.02	9.66	**13.46**	**35.50**	30.9%	-13.7%	43.8%	**61.1%**
India	2008-1	2018-1	**4.98**	2.85	4.47	-3.14	**4.18**	**9.15**	57.2%	89.7%	-63.0%	**83.9%**
Indonesia	No data											
Japan	2009-1	2018-1	**34.97**	-0.29	7.90	-4.89	**2.72**	**37.70**	-0.8%	22.6%	-14.0%	**7.8%**
Mexico	2008-1	2019-1	**18.78**	9.23	-13.75	-3.80	**-8.32**	**10.46**	49.1%	-73.2%	-20.2%	**-44.3%**
Russia	2008-1	2015-4	**5.78**	4.07	1.61	-4.18	**1.50**	**7.27**	70.4%	27.9%	-72.3%	**26.0%**
Saudi Arabia	2008-1	2018-1	**1.49**	0.25	0.80	0.49	**1.54**	**3.02**	16.8%	53.8%	33.0%	**103.7%**
South Africa	2008-1	2017-12	**30.14**	16.58	-30.12	-5.62	**-19.16**	**10.98**	55.0%	-99.9%	-18.6%	**-63.6%**
South Korea	2008-1	2019-1	**31.75**	5.74	-2.83	3.17	**6.08**	**37.82**	18.1%	-8.9%	10.0%	**19.2%**
Turkey	2008-1	2019-11	**24.37**	24.73	41.90	-66.14	**0.49**	**24.85**	101.5%	171.9%	-271.4%	**2.0%**
USA	2008-1	2019-1	**21.69**	4.02	-17.01	2.52	**-10.47**	**11.22**	18.5%	-78.4%	11.6%	**-48.3%**

Source: Trinomics et altri (2020)

Note on the range and dispersion of retail gas prices for industry in the EU

The max-min range of gas prices in the EU Member States was roughly between slightly less than 15 EUR/MWh to close to 60 EUR/MWh. The dispersion in gas is thus much lower than for electricity with most of the countries being much closer to the average price.

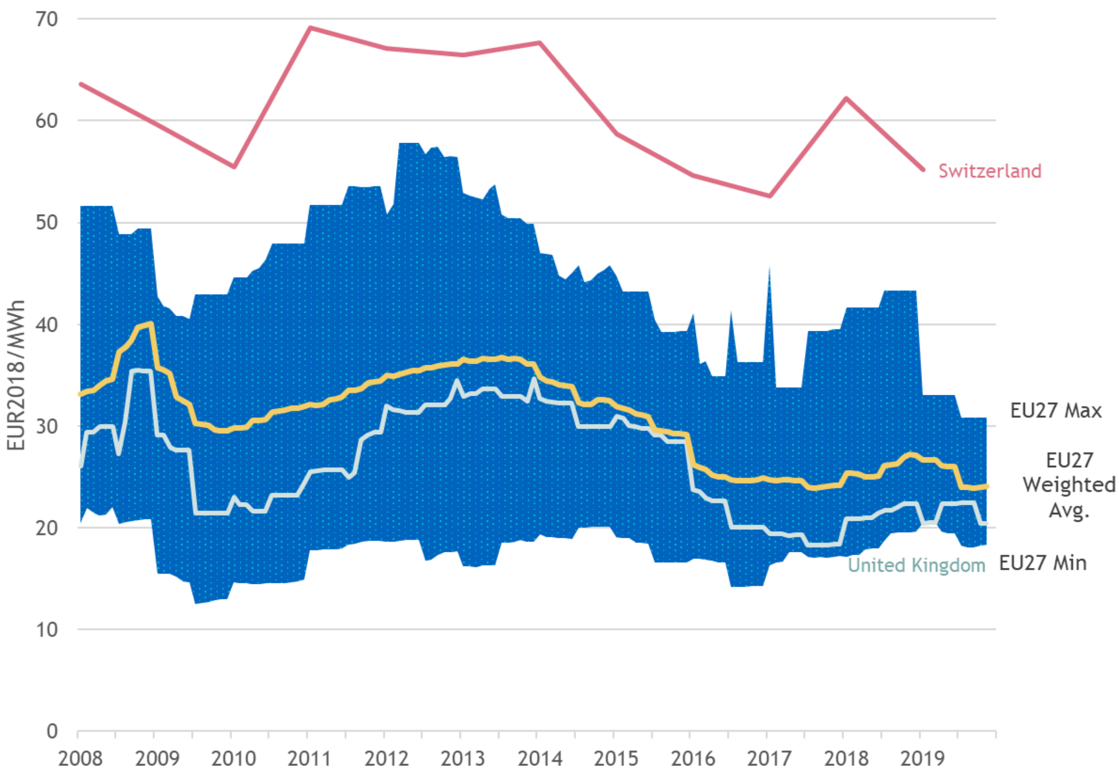

Figure 163 - Max-min range of retail gas prices for industry in the EU, 2008-2019

Sources: Eurostat

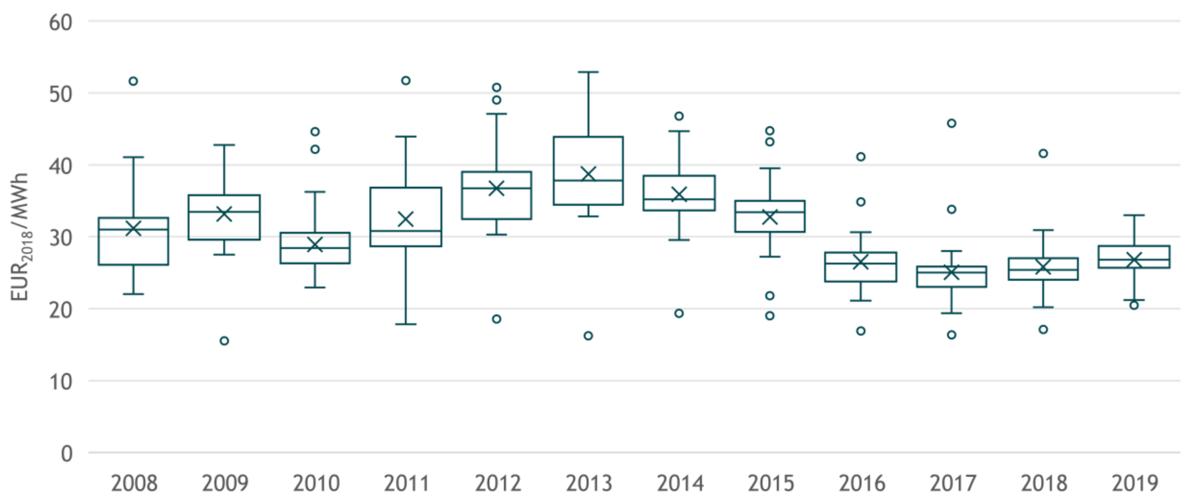

Figure 164 - Box plot of industrial gas prices, 2008-2019

Source: Trinomics et altri study

Note: the square represents the range of the prices for the 25% of countries above and below the average (50% of the sample)

The figure below identifies the Member States which are close to the maximum and minimum price levels in the range of EU price as well as those with significant deviations from the EU27 average.

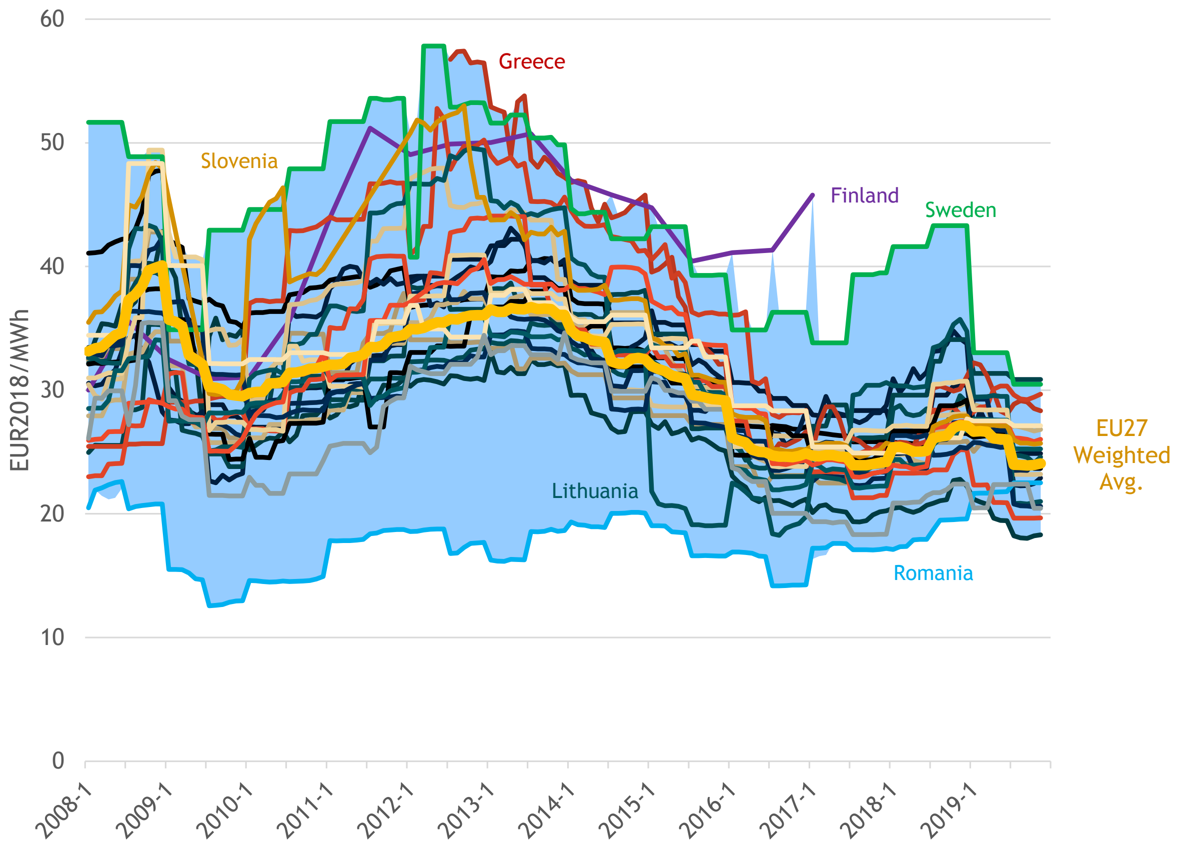

Figure 165 - EU27 industrial retail natural gas prices 2008-2019, Member States lines visible, outliers named

Source: Trinomics et altri (2020)

6.6 Overview of selected Energy-intensive Industries

In the previous sections and chapters we have analysed energy prices and costs for industry from highly aggregated statistical information (top-down approach). In this section, based on data collected from production plants (bottom-up approach), we analyse the evolution of energy prices and costs and the impact on the competitiveness of selected energy-intensive industries. This analysis at a more disaggregated level, aims at capturing the specificities of (sub-)sectors which are not reflected by the aggregated sectorial data. The results presented are based on the study commissioned by the European Commission to Trinomics et altri (2020). Primary data were collected at plant level via dedicated questionnaires.

Scope and samples

The bottom-up analysis covers the entire EU over from 2010 to 2017. It focusses on the following five sectors: *flat glass*, *zinc*, *ferro-alloys and silicon*, *refineries* and *fertilisers*.

The selection of these sectors covers various features of EU energy-intensive industries:

- Natural gas-intensive sectors (e.g. *fertilisers*, *flat glass*, *refineries*) and electricity-intensive sectors (e.g. *zinc*);
- Sectors purchasing additional energy carriers, including crude oil (e.g. *refineries*);
- Sectors concentrated in European regions (e.g. *zinc* is mainly located in Central Eastern and South Europe) and sectors geographically dispersed in Europe (e.g. *flat glass*);
- Sectors dominated by large companies (e.g. *refineries*) and sectors including many SMEs (e.g. *flat glass*);
- Net importer sectors (e.g. *ferro-alloys and silicon*) and net exporter sectors (e.g. *flat glass*) with different levels of exposure to international competition.

Table 27 shows the representativeness at EU level (share of the sample in the EU turnover or production capacity) and geographical scope of the sample over four European regions.[72] The EU representativeness of the surveyed plants samples ranges from 12% (refineries) to 97% (*zinc*) of their sector's turnover or production capacity. The results of the bottom-up analysis are based on data collected from 96 plants across six industrial sectors; participating plants reflected the average features of EU installations.

[72] Sectorial results had to be aggregated at a regional level to respect confidentiality.

Table 27 - Plants participating in the study

Sector	Number of plants by geographical region (1)					Representativeness in 2018 (2)
	Central Eastern Europe	North Western Europe	Southern Europe	Non-EU North Western Europe	Total	Share of turnover (T) or production capacity (C)
Flat glass	7	19	10	4	40	74% C
Zinc	5	1	2	-	8	97% T
Ferro-alloys and silicon	2	3	2	-	7	*NA*
Refineries	4	8	8	3	23	12% T
Fertilisers	7	3	3	-	13	90% C

Source: Trinomics (2020)

(1) **Central-Eastern Europe:** Bulgaria, Croatia, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovak Republic, Slovenia; **North-Western Europe:** Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Luxembourg, the Netherlands, Sweden, the UK; **Southern Europe:** Cyprus, Greece, Italy, Malta, Portugal, Spain. Non-EU; **Non-EU North Western Europe**: UK, Norway, Iceland

(2) For illustrative purpose, figures are shown for 2018. Estimates of the representativeness may vary from year to year although with a similar order of magnitude.

Cross-sectorial findings

The straightforward relationship between high electricity consumption levels and low average prices is well established and had been already confirmed by CEPS-Ecofys[73] study (2018) which fed into the previous (2018) Report on energy prices and costs report[74]. The relation is explained by various factors: i) larger consumers of electricity are directly connected to the grids and thus do not have to pay the distribution fees ii) larger consumer have more bargaining power to negotiate their prices iii) larger consumers of electricity are sometimes exempted from specific taxes and levies on electricity prices iv) larger consumers of some industries can adapt their manufacturing processes to better exploit cheaper, baseload electricity (e.g. produce at night when prices are lower).

The new data collected by Trinomics (2020) is in line with those previous findings. It shows that the above mentioned inverse relation between prices and consumption also holds (and is possibly grounded) when the sectors' energy intensities are compared with electricity and gas prices they pay. **Figure 166** and **Figure 167** display this inverse relation.

[73] CEPS and Ecofys (2018), Composition and Drivers of Energy Prices and Costs: Case Studies in Selected Energy-intensive industries – 2018.

[74] COM(2019) 1

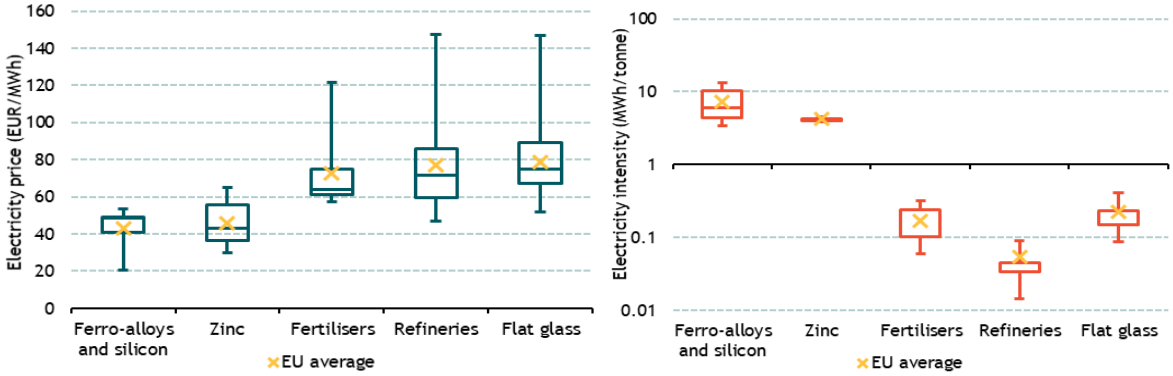

Figure 166 - Electricity prices vs energy intensity by sector (based on plant's data)

Source: Trinomics (2020)

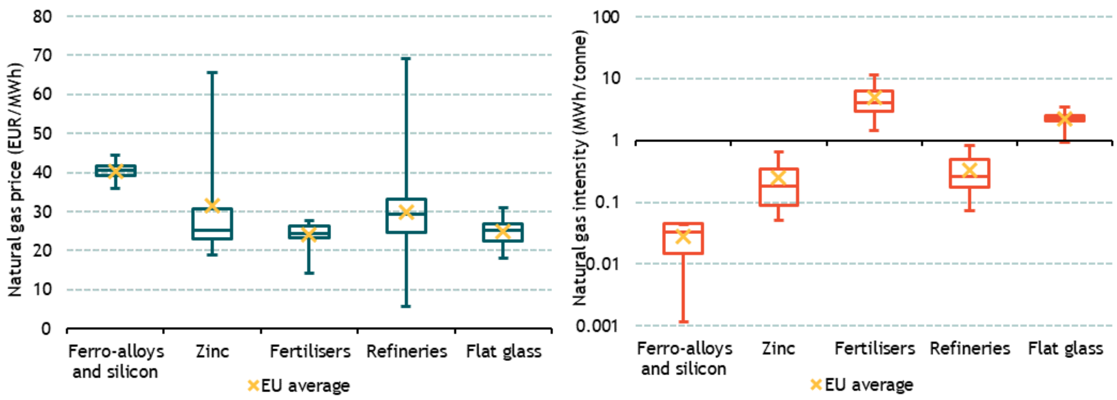

Figure 167 – Gas prices vs energy intensity by sector (based on plant's data)

Source: Trinomics (2020)

Overview of the results of selected EU energy-intensive sectors

Table 28 shows average energy prices and costs as well as energy costs shares in production costs of the selected Energy-intensive industries in Europe. Figures are presented for 2018 only, the latest year for which data was collected from all sectors. Note that natural gas costs in particular reached higher levels in 2018 than in previous years.

Electricity prices range from 40-45 EUR/MWh in the sectors with plants consuming very large amounts of electricity (*ferro-alloys and silicon*, *zinc*) to 70-80 EUR/MWh in sectors with plants with relatively smaller electricity consumption (*flat glass*, *refineries*, *fertilisers*). Similarly, sectors with large gas consuming plants (*fertilisers*, *flat glass*) appear paying much less for their gas (around 25 EUR/MWh) than the other sectors.

The energy costs shares in production costs vary widely across sectors. The highest energy costs share amongst the sectors studied was found in the very gas intensive sector of *fertilisers* (71%), followed by electro intensive sectors such as *zinc* (31%) and *ferro-alloys and silicon* (28%) and the gas intensive sector of *flat glass* (25%). Refineries, for which the sample is rather small, displayed lower energy costs shares (estimated at ~15%).

To better understand the potential impact of energy costs on the financial balances and competitiveness of the sectors studied, it is important to know about the sector's external exposure to international trade. The higher the exposure (because of exports or imports), the more relevant that the effect of the changes of the energy costs (and any other relevant production costs) could be. **Table 29** indicates the exposure of most of the sectors studied is *medium* or *high* highlighting the potential significance of energy costs for affecting the competiveness and profitability of these sectors.

Having said that, the actual impact of energy costs on the competiveness and trade balances of industrial sectors will depend on many factors, in particular the existence of divergences with competitors as regards the evolution of other relevant production costs (e.g. labour costs, non-energy raw material related costs, etc.). Indeed, competiveness is relative and depends on the developments of competitors (e.g. energy costs could fall for a sector but they would not increase its competiveness if the energy costs of the competitors fall more). A detailed analysis of energy costs and the sectors' market and trade developments can be found in the Annex of the Trinomics et altri study (2020). The analyses by sector show that overall, energy costs developments, despite being important part of production costs, did not play a decisive role in increasing or decreasing the trade balances (i.e. an indicator that 'reveals' the actual competitiveness) of the sectors studied. In recent years (2014-2016), decreases in gas costs in *fertilisers* and *flat glass* helped to increase or restore these sectors' profitability but had a limited impact on their trade balances and competiveness. In fertilisers' plants, when the share of energy costs out of total production costs plants rose again in 2018, the export/import amounts remained roughly steady. Similarly, for *ferro-alloys and silicon*, the steady increase in electricity prices and costs for the sector between 2016 and 2019 reduced its profitability but did not meaningfully impact the sector's trade balance or competitiveness. For other sectors, the impact of energy costs on profitability and competiveness is difficult to assess (*zinc*) or other factors are identified as the key factor for sector's profitability and competiveness (e.g. for *refineries* profitability is closely linked to crude oil prices; high when crude oil prices are high and low or negative with low crude oil prices)

COVID pandemic and its impact on industrial energy costs

Finally, through interaction and discussion with industry representatives during the data collection and analyses for producing the Trinomics et altri (2020) study, informal feedback has been gathered on the possible impact of COVID's pandemic on energy costs and their economic consequences for industry. COVID's pandemic has curbed significantly demand for products, reducing the sales revenues of industrial sectors and triggering reductions of production output in plants. That said, in this context of low production and sales, energy costs are not expected to play an important role in aggravating the economic situation of most energy-intensive industries. This is because COVID's induced economic crisis and mobility restrictions have also prompted a very significant fall in energy prices during the first half of 2020 (as signalled in the first chapters of this document). This sudden and notable fall in energy prices is very likely not being followed by equivalent declines in the prices of other non-energy production inputs (salaries, fees for services or prices for manufactured goods) which tend to be more stable. Moreover, while energy consumption usually declines with lower output, the use or consumption of other non-energy inputs and services (e.g. labour force, renting of offices, plants, payments of interests) tends to be more stable and difficult to reduce despite lower output of the firms. All this implies that that the purchases of energy (the energy costs) should be falling much faster than the expenditure related to other non-energy production costs, resulting in lower shares of energy costs in production costs.

That said, in certain cases, energy costs might still have a role in eroding profits in certain energy-intensive sectors. This is the case for sectors which have an important amount of their energy consumption that is fixed or cannot be reduced along with the decline in output. In these cases, the firm could be suffering a disproportionate increase in the share of their energy costs in production costs. This would apply, for instance, to sectors that have to run their furnaces 24/h despite the level of output. This information has to be taken with caution given that the sector's actual data on the recent consumption of energy and other production inputs will only be fully accounted in the coming months[75].

Table 28 Energy prices & costs in selected EU energy-intensive sectors – simple average EU, 2018.

Sector	Electricity prices (€/MWh)	Electricity costs per production quantity (€/tonne)	Electricity costs as a share of production costs	Electricity intensity (MWh/tonne)	Natural gas price (€/MWh)	Natural gas costs per production quantity (€/tonne)	Natural gas costs as a share of production costs	Natural gas intensity (MWh/tonne)
Flat glass	79	18	6%	0.23	25	54	19%	2.19
Zinc	46	191	31%	4.18	32	6.5	0.3%	0.25
Ferro-alloys and silicon	43	304	28%	7.38	40	1.1	0.1%	0.03
Refineries	77	3.7	5%	0.05	30	7	9%	0.33
Fertilisers	73	11	7%	0.17	24	114	64%	5.01

Source: Trinomics (2020).

Table 29 - Exposure of EU selected energy-intensive industris to international trade – 2017/2018

Sector	Gross exports (M€)	Gross imports (M€)	Production value (M€)	Internal consumption (M€)	IMPORT EXPOSURE (1)	EXPORT EXPOSURE (2)	EXPOSURE TO INTERNATIONAL TRADE
Flat glass[3,4]	466	270	2828	2632	10%	17%	**Medium**
Zinc[5]	1030	1152	5136	5258	22%	20%	**High**
Ferro-alloys[3,4]	657	2950	4471	6763	44%	15%	**High**
Silicon[3,4]	55	500	1456	1902	26%	4%	**Low**
Refineries[3,4]	76667	94228	123947	141509	67%	62%	**Very high**
Fertilisers[3,4]	1376	2364	18061	19050	12%	7%	**Medium**

Source Trinomics 2020

(1) Share of internal consumption served by extra-EU imports
(2) Share of production dedicated to extra-EU exports
(3) COMEXT
(4) PRODCOM
(5) Eurostat SBS

[75] Statistical data on industry consumption and other indicators becomes available with much important lag than energy price data. For instance, the latest available data in this report on industry indicators goes back to 2017 while energy price data is complete for 2019 and available for some prices for the first months of 2020.

PART III

Government revenues from energy products and taxes and levies on energy products

7 The role of energy for government revenues and inflation

7.1 Government revenues from the energy sector[76]

Main findings

- In 2018, energy taxes collected by EU Member States amounted to EUR 294 billion, equivalent to 1.85% of EU GDP. As a percentage of GDP and total tax revenue, energy tax revenue has been rather stable since the 2008 economic crisis.

- In individual Member States, the role of energy taxes in government revenues and GDP shows a significant variety: Member States with a lower GDP/capita typically have a higher share of energy taxes in both total tax revenue and from GDP.

- The energy tax revenue per 1 tonne of oil equivalent of gross inland energy consumption was EUR 177 in 2018. In real terms, this average calculated tax rate increased by 21.1% between 2010 and 2018.

- Excise duties constitute the largest part of energy taxes, amounting to around EUR 247.7 billion in 2018. When adjusted for inflation, excise duty revenues have been rather stable in 2011-2014 but increased by 2-3%/year in 2015-2018.

- Oil products (mineral oils) continue to dominate excise duty revenues, with a share consistently above 80%, although this share has slightly decreased over the last decade, at the benefit of gas and electricity. In 2018, the share of petroleum products was more than 50% in all Member States and more than 90% in 19 Member States.

- For the main oil products, the nominal excise duty revenue is gradually growing, driven by increasing excise duty rates and, in the last few years, rising consumption. In 2013-2015, growing excise duty revenues were offset by lower VAT revenue driven by falling oil and oil product prices. As a result, the nominal tax revenue from petroleum products has been relatively stable and increasing in the last couple of years.

7.1.1 Energy taxes

Taxes and duties imposed on energy products are becoming an important source of government revenue in EU Member States. In 2018, energy taxes[77] collected by EU Member States amounted to EUR 294 billion. This was equivalent to 1.85% of EU GDP and 4.59% of total revenues from taxes and social contributions (including imputed social contributions).

[76] This chapter analyses EU-28.

[77] Energy-related environmental taxes as defined in "Environmental taxes – A statistical guide" (http://ec.europa.eu/eurostat/documents/3859598/5936129/KS-GQ-13-005-EN.PDF/706eda9f-93a8-44ab-900c-ba8c2557ddb0?version=1.0); this category includes taxes imposed on energy production and on energy products used for both transport and stationary purposes, as well as on greenhouse gases but does not include VAT imposed on energy products

While nominal energy tax revenues increased by 27% between 2009 and 2016 (on average by 3.5%/year), as a percentage of GDP and tax revenue they remained relatively stable, showing only a marginal increase in this period.

According to the estimations of the Commission's Taxation and Customs Union Directorate-General, around 70% of energy tax revenues come from transport fuels.[78]

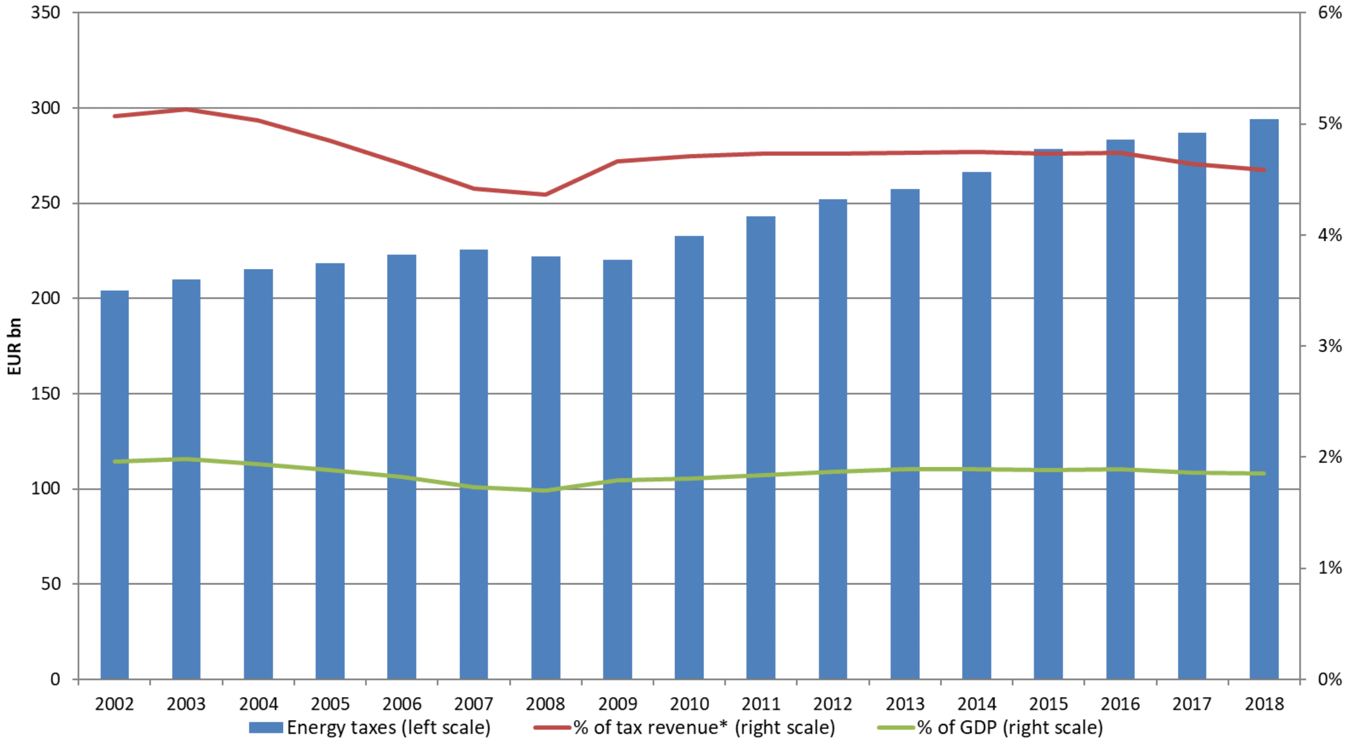

Figure 168 - Energy taxes in the EU-28

Source: Eurostat (data series env_ac_tax)

*percentage of total revenues from taxes and social contributions (including imputed social contributions)

Looking at individual Member States, the role of energy taxes in government revenues shows a significant variety: in 2018, energy taxes in Latvia made up 9.1% of total revenues from taxes and social contributions (including imputed social contributions) while this share was only 3.3% in Austria. When compared to the GDP, energy tax revenue was highest in Slovenia (3.0%) and lowest in Ireland (1.0%). Typically, Member States with a lower GDP/capita have a higher share of energy taxes from both total tax revenue and from GDP.

[78] Taxation Trends in the European Union (2018); https://ec.europa.eu/taxation_customs/sites/taxation/files/taxation_trends_report_2018.pdf

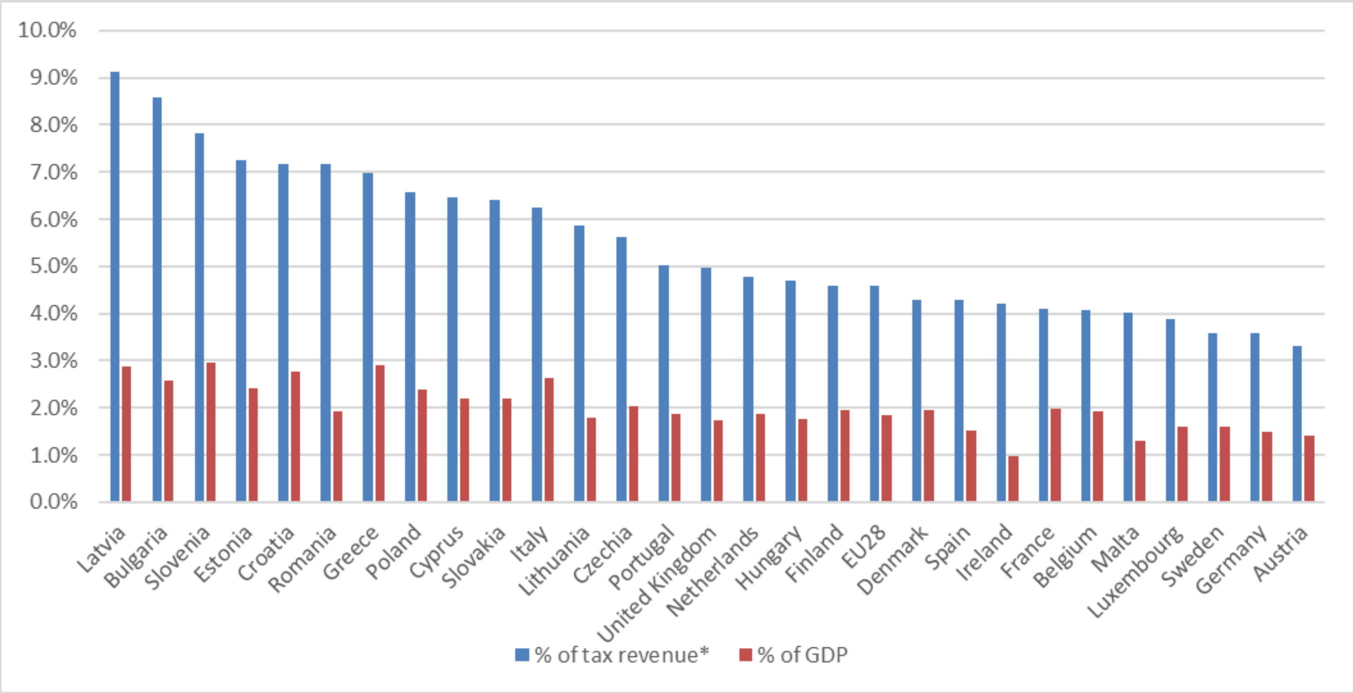

Figure 169 - Energy taxes as a percentage of tax revenue and of GDP in 2018

Source: Eurostat (data series env_ac_tax)

*percentage of total revenues from taxes and social contributions (including imputed social contributions)

Households are the main contributors to energy tax revenues: in 2018, they payed 51% of total energy taxes. This represents a small decrease compared to 2008/2009 when this share reached 53%/54%. From other economic activities, transportation, manufacturing and other services are only second in paying energy taxes with their share 10%, 11% and 11% of total energy taxes, respectively.

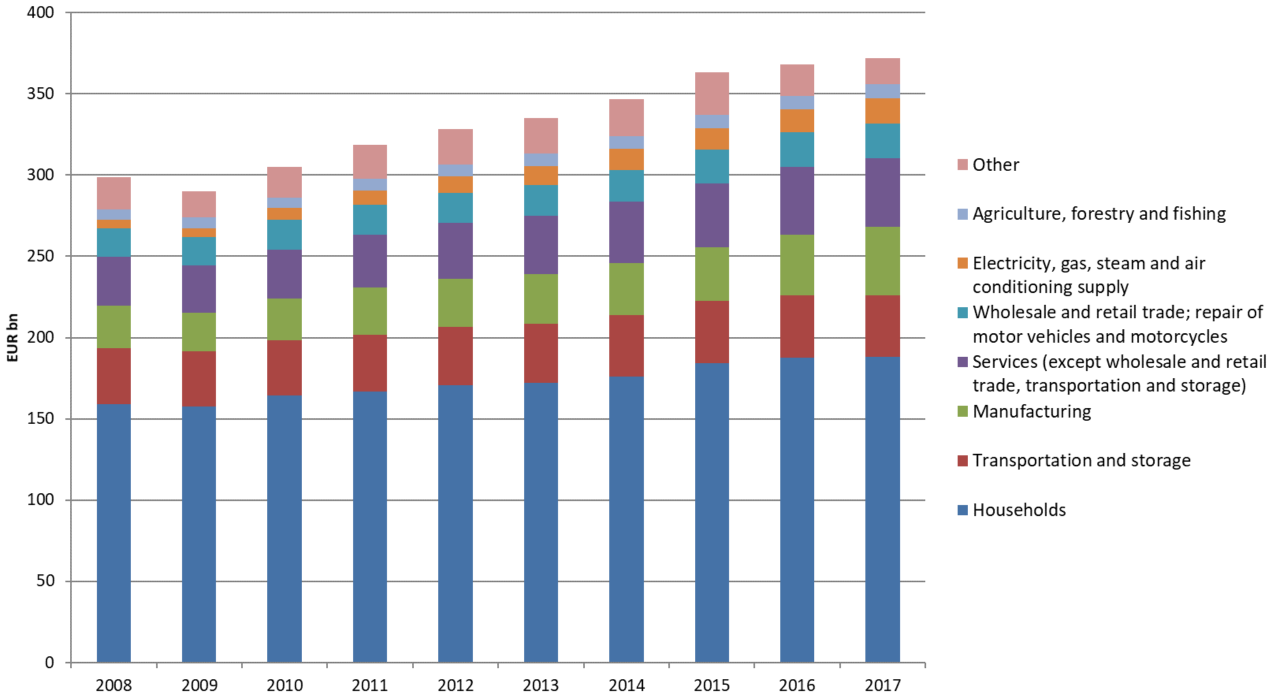

Figure 170 - Energy taxes by economic activity

Source: Eurostat (data series env_ac_taxind2)

The underlying tax base of energy taxes declined in the last decade: the EU's gross inland energy consumption decreased by 12.6% between 2006 and 2014, followed by a slight increase between 2015 and 2018 (+3.0%). This decline was more than offset by the increase of the average calculated tax rate which increased from EUR 121 per 1 tonne of oil equivalent (toe) of gross inland energy consumption in 2006 to EUR 177/toe in 2018.

When allowing for inflation, the average calculated ‘real’ tax rate decreased between 2002 and 2010 (with a dip in 2008) but increased afterwards. Between 2010 and 2018, the ‘real’ tax burden increased by 21% (by 3%/year), from EUR 142/toe to EUR 171/toe (both measured in 2015 euros).

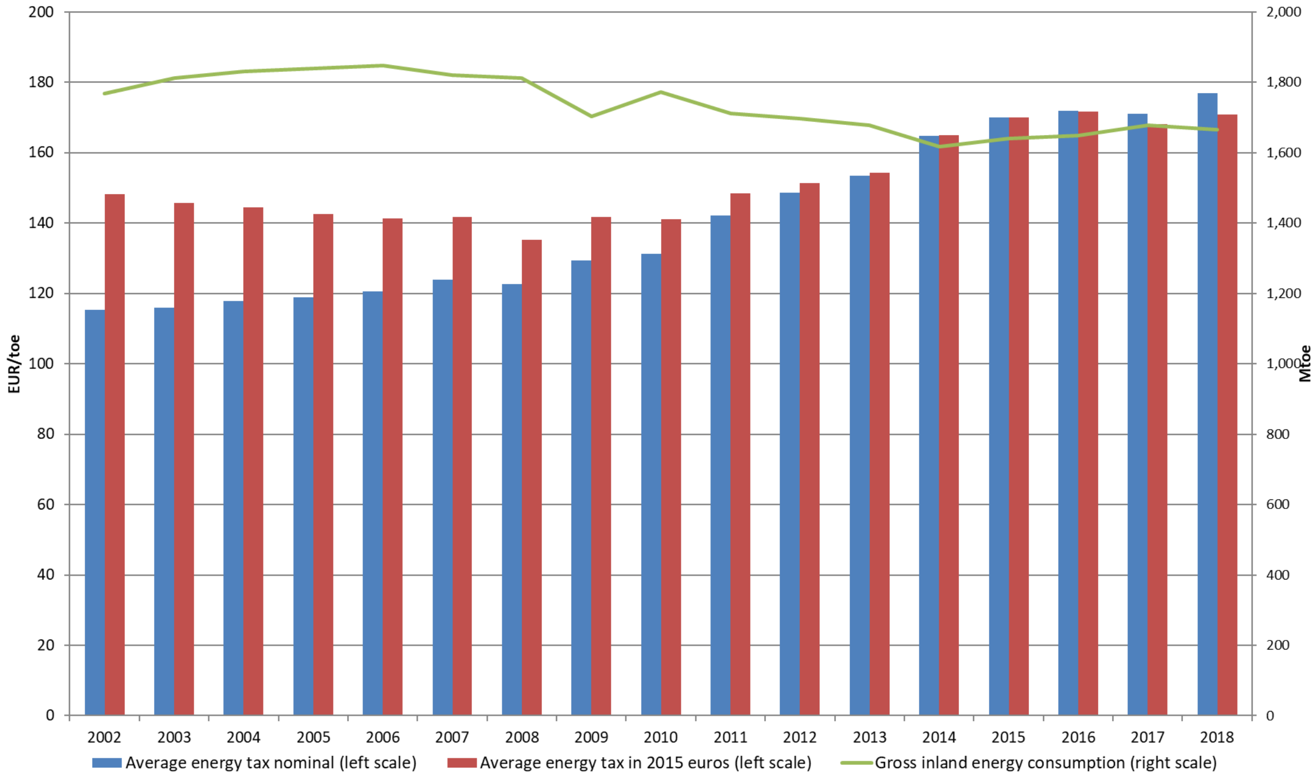

Figure 171 – Average energy tax for 1 toe of gross inland energy consumption in the EU-28

Source: DG Energy calculation based on Eurostat data (data series env_ac_tax, nrg_100a and prc_hicp_aind)

On average, the energy tax revenue per 1 toe of gross inland energy consumption was EUR 171 in 2018, but there was a huge variation across Member States, from EUR 76 in Bulgaria to EUR 322 in Denmark. Member States with higher GDP and a higher share of oil in the energy mix tend to have higher energy taxes per 1 toe of gross inland energy consumption.

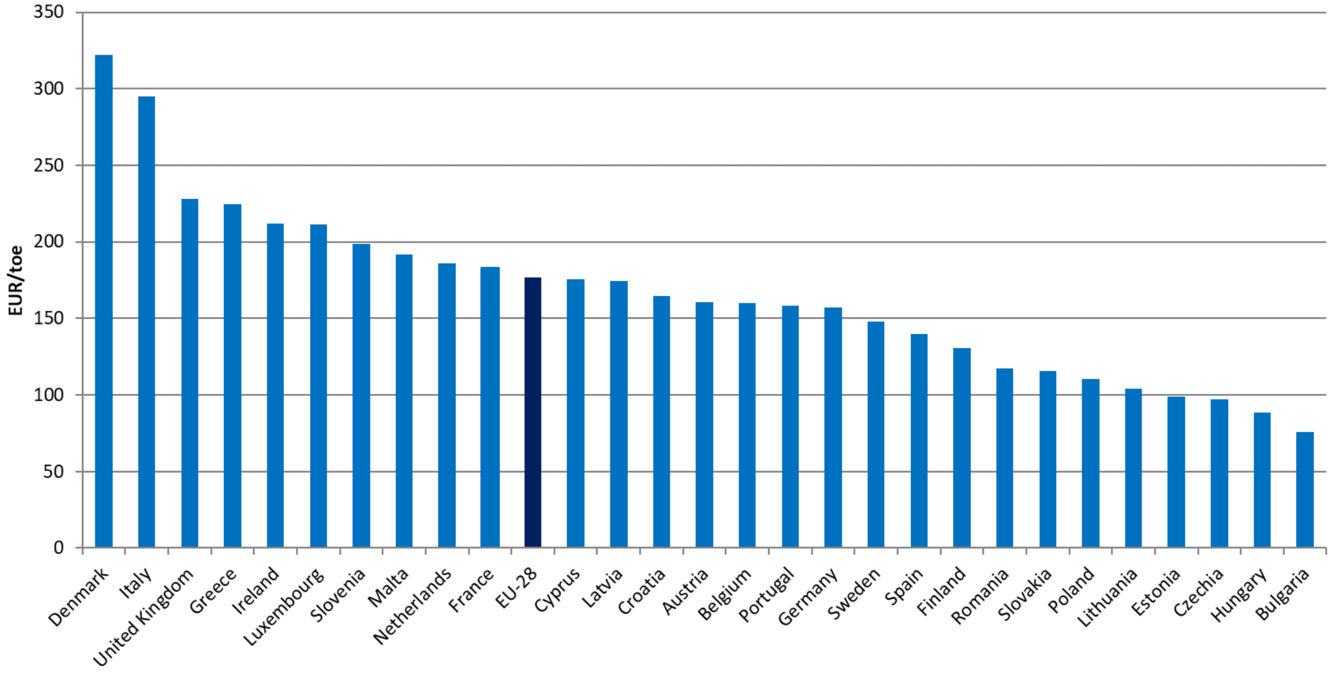

Figure 172 – Average energy tax for 1 toe of gross inland energy consumption in 2018

Source: DG Energy calculation based on Eurostat data (data series env_ac_tax and nrg_100a)

7.1.2 Excise duties

Excise duties constitute the largest part of energy taxes.

Excise duties are indirect taxes imposed on the sale or use of specific products, typically alcohol, tobacco and energy products. All revenue from excise duties goes to the budgets of Member States. Excise duties are set in absolute values, i.e. as a fixed amount per quantity of the product (e.g. per litre/kg/GJ/MWh). Accordingly, assuming that the rates do not change, the revenue will depend on the consumption of the specific product. In contrast, price changes should not impact revenues (at least not directly).

Current EU rules for taxing energy products are laid down in Council Directive 2003/96/EC174[79] (the Energy Tax Directive), which entered into force on 1 January 2004. The Directive covers petroleum products (gasoline, gasoil, kerosene, LPG, heavy fuel oil), natural gas, coal, coke and electricity. In addition to establishing a common EU framework for taxing energy products, the Directive sets minimum excise duty rates.

The Commission's Taxation and Customs Union Directorate-General (TAXUD) regularly publishes the excise duty rates applicable in EU Member States[80] and the revenue from excise duties[81].

[79] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2003:283:0051:0070:EN:PDF

[80] https://ec.europa.eu/taxation_customs/sites/taxation/files/resources/documents/taxation/excise_duties/energy_products/rates/excise_duties-part_ii_energy_products_en.pdf

[81] https://ec.europa.eu/taxation_customs/sites/taxation/files/resources/documents/taxation/excise_duties/energy_pro

As far as revenues are concerned, the latest available data relate to 2018. According to these data, excise duty revenues amounted to EUR 247.7 billion in 2018. From 2009, total revenue shows an increasing trend.

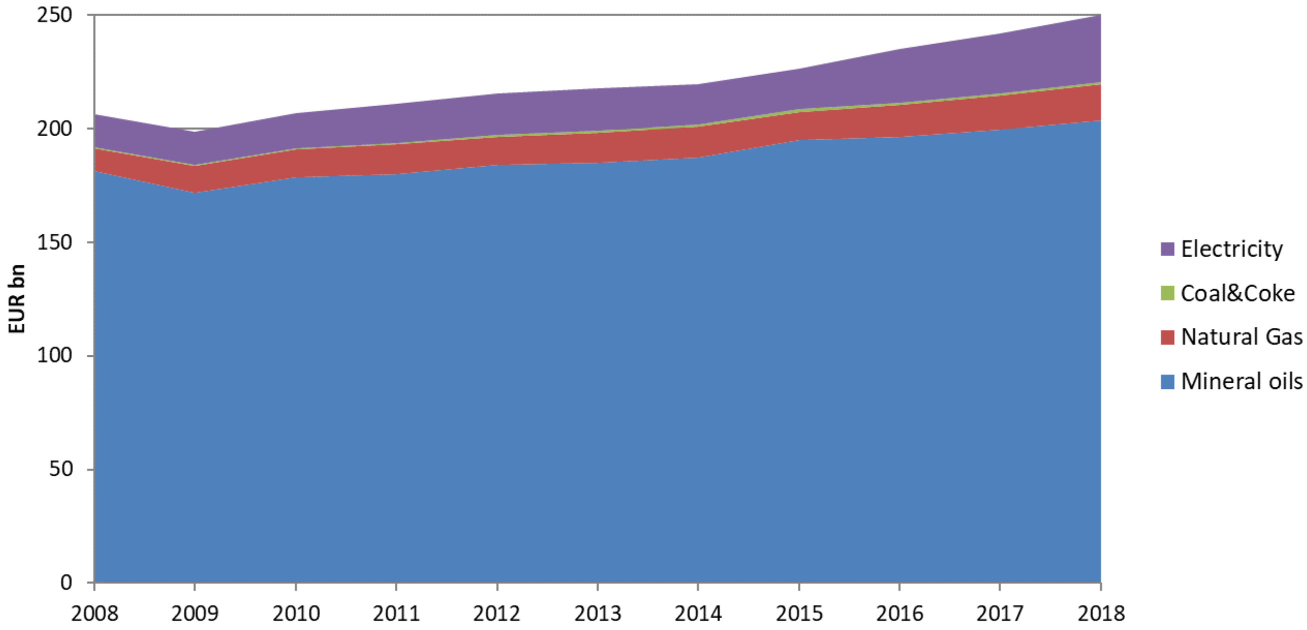

Figure 173 - Excise duty revenues from energy consumption

Source: DG Taxation and Customs Union

If adjusted for inflation, excise duty revenues have slightly decreased between 2008 and 2014: measured in 2015 euros, they amounted to EUR 230 billion in 2008 and EUR 220 billion in 2014. In the last here years (2015-2018), however, real revenues increased by 3.4%, 3.5%, 1.2% and 0.5%, respectively, reaching EUR 239 billion.

ducts/rates/excise_duties_energy_products_en.pdf (at the time of writing the report, this document included revenue data for the period 2008-2018)

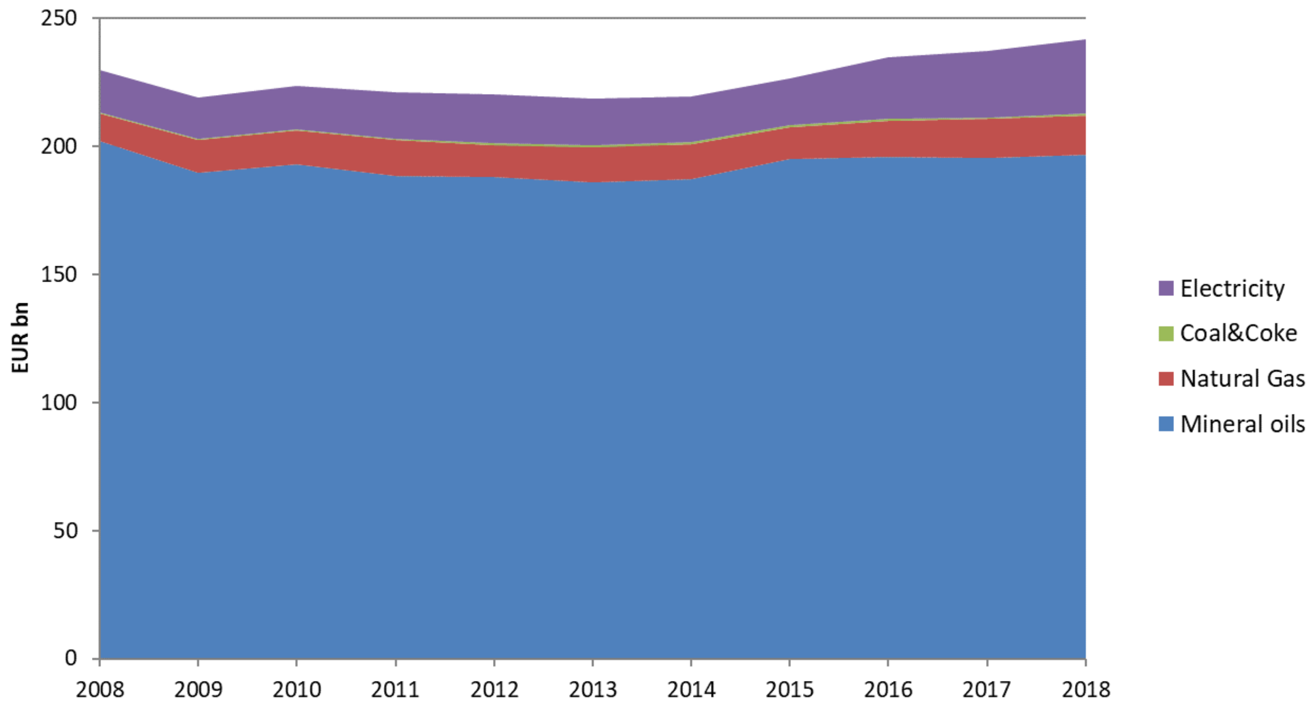

Figure 174 - Exercise duty revenues from energy consumption, adjusted for inflation (in 2015 euros)

Source: DG Taxation and Customs Union, adjusted by HICP

In 2018, oil products were the main source of excise duty revenue, covering 81.4% of all excise duty revenue from energy products. The rest was shared by electricity (11.9%), gas (6.4%) and coal (0.3%).

The share of oil products from total revenues decreased from 87.8% in 2008 to 81.4% in 2018 mainly at the benefit of gas and electricity.

Between 2008 and 2018, revenues from taxes on oil products increased by 12.3%, on gas by 62.4%, on electricity by 79.5% and on coal by 101%. In this 11-year period, inflation measured by the Harmonised Index of Consumer Prices (HICP) was 15.3%.

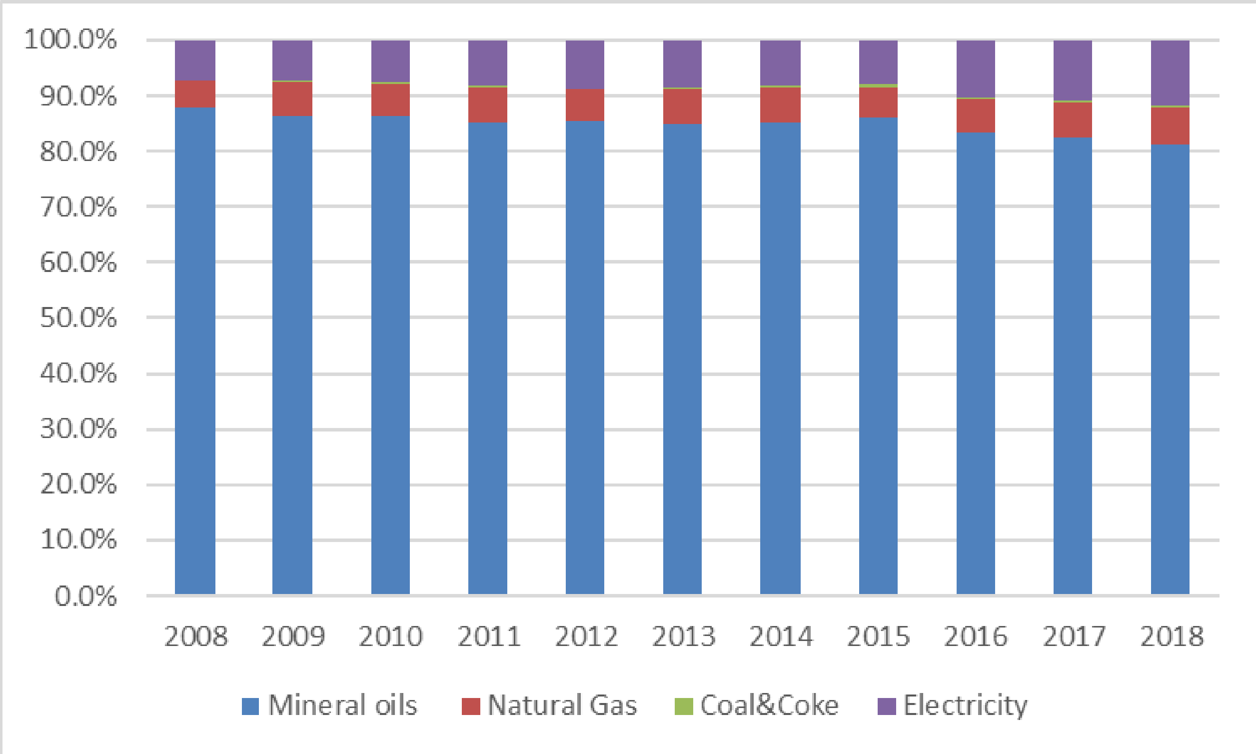

Figure 175 - The share of excise duty revenues by energy product

Source: DG Taxation and Customs Union

Oil products make up majority of the excise duty revenue in all Member States except Malta. In 17 Member States they make up more than 90%.

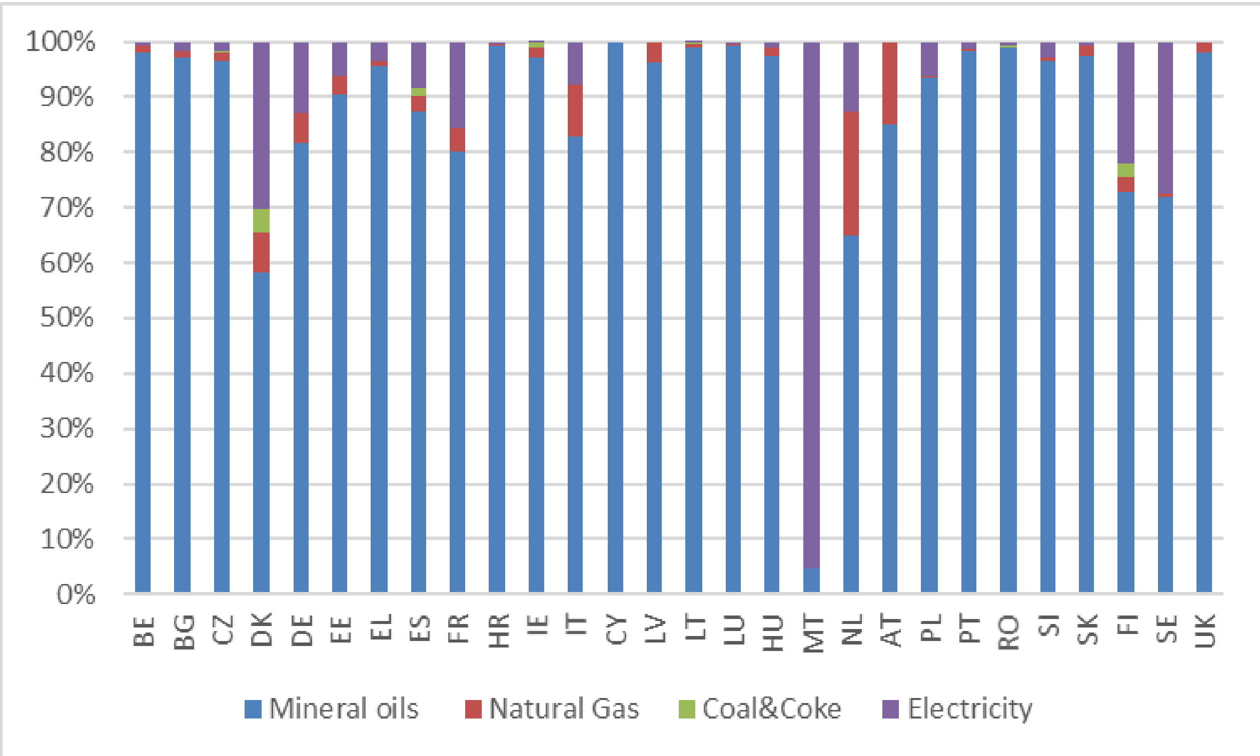

Figure 176 - The share of excise duty revenues by energy product, 2018

Source: DG Taxation and Customs Union

7.1.3 Value added tax (VAT)

VAT imposed on energy products is another important source of government revenue. However, unlike for excise duties, there is no publicly available data for VAT revenues from energy products.

The VAT is a general consumption tax assessed on the value added to goods and services. It applies to practically all goods and services (including energy products) that are bought and sold for use or consumption in the EU. The VAT is borne ultimately by the final consumer; companies can reclaim the VAT they pay on the products and services they use as an input. VAT is charged as a percentage of the price which means that an increase of the price will entail an increase in the tax revenue and vice versa.

The VAT Directive (2006/112/EC)[82] requires that the standard VAT rate must be at least 15% and Member States can apply one or two reduced rates of at least 5% but only to goods or services listed in Annex III of the Directive (energy products are not in the list). In addition, there are multiple exceptions to the basic rules (usually with conditions/deadlines), including

- possibility of reduced rates for goods and services other than those listed in the directive (e.g. Article 102 allows the use of reduced rate to the supply of natural gas, electricity and district heating, "provided that no risk of distortion of competition thereby arises");
- several country-specific exceptions, including the permission to use "super reduced" rates under 5% (including zero rates) for certain (including energy) products.

The EU-28 average standard VAT rate increased by 2 percentage points between 2008 and 2015 but has been rather stable since then: it was 21.5% in 2016 and 2017 and also at the start of 2018. Hungary has the highest VAT standard rate (27 %), followed by Croatia, Denmark and Sweden (all 25%). Luxembourg (17%) and Malta (18%) apply the lowest standard rate.

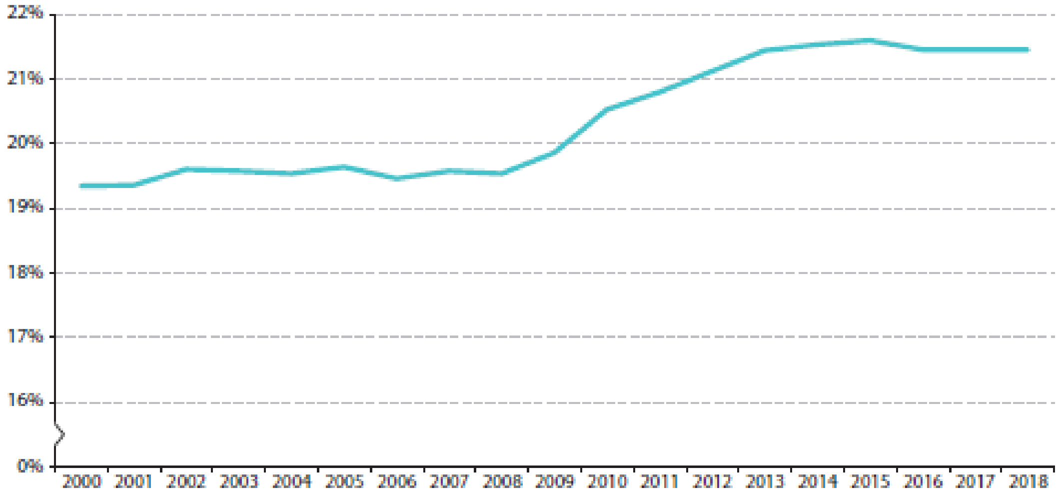

Figure 177 - The average standard VAT rate in the EU

Source: DG Taxation and Customs Union

[82] https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:347:0001:0118:en:PDF

About half of the Member States use reduced VAT rates for certain energy products, mainly gas, electricity, district heating, firewood and heating oil. Of course, this has an impact on household retail prices and partly explains the price differences across Member States. For example, the applicable VAT rate for gas and electricity ranges from 5% to 27%. DG TAXUD regularly publishes the VAT rates applied by Member States for different product groups/services.[83]

As a follow-up of the Action Plan on VAT[84], the Commission adopted a number of legislative proposals related to the VAT system with the objective of working towards the completion of a single EU VAT area. On 18 January 2018, a proposal was adopted to introduce more flexibility for Member States to change the VAT rates they apply to different products. According to the proposal, the current list of goods and services to which reduced rates can be applied would be abolished and replaced by a new "negative" list to which the standard rate of 15% or above would always be applied. The proposed "negative list" contains most oil products, requiring the application of the standard rate. On the other hand, Member States would continue to be able to apply a reduced rate for electricity, gas, LPG, district heating and firewood.[85]

7.1.4 Tax revenues from oil products

Oil products, especially motor fuels, are the main source of tax revenue from the energy sector for government budgets. Data from the Weekly Oil Bulletin[86] allows a more detailed analysis of tax revenues from petroleum products, including an estimation of VAT revenues (assuming that no VAT is reclaimed).

Our analysis covers the three main petroleum products sold in the retail sector: gasoline (Euro-super 95), diesel (automotive gas oil) and heating oil (heating gas oil). For most Member States, the analysis covers the years 2005-2019.

For each year and each Member State, an average price was calculated as an arithmetic average of the weekly prices. The EU average price was then calculated as the weighted average of these, weighted by consumption. For last year (2019), we used the same consumption as the previous one (2018) as the weight since the figures on 2019 consumption were not ready at the time of this study.

Based on the development of consumption, consumer prices and their components, we estimated the tax revenues collected by Member States by multiplying average yearly prices with consumption of each fuel converted to litres[87]. It is important to underline that most enterprises can reclaim the VAT they pay, so the calculated VAT revenue is a theoretical maximum; the actual VAT revenue collected by Member States must be significantly lower.

[83] https://ec.europa.eu/taxation_customs/sites/taxation/files/resources/documents/taxation/vat/how_vat_works/rates/vat_rates_en.pdf
https://ec.europa.eu/taxation_customs/sites/taxation/files/resources/documents/taxation/vat/how_vat_works/rates/vat_rates_en.xlsx

[84] https://ec.europa.eu/taxation_customs/sites/taxation/files/com_2016_148_en.pdf

[85] http://europa.eu/rapid/press-release_IP-18-185_en.htm

[86] https://ec.europa.eu/energy/en/statistics/weekly-oil-bulletin

[87] Since consumption is in kt (kilotons), we were using a factor 1135.07 to convert 1 ton of Gasoline into litre of Gasoline and 1129.94 to convert 1 ton of Diesel and Heating oil into litres.

The estimated revenue from excise duties shows an increasing trend between 2005 and 2018. Although the combined consumption of the three product groups decreased between 2008 and 2014, this was largely offset by the increase of the average excise duty rates. If adjusted for inflation, however, excise duty revenues slightly decreased in this period. Supported by the low oil prices and the economic recovery, fuel consumption increased in 2015-2018, giving a boost to excise duty revenues.

As the VAT is an ad valorem tax, the estimated (theoretical) VAT revenue is fluctuating in line with the net price. Accordingly, it decreased from 95.2 billion euros in 2012 to 73.8 billion euros in 2016 (a decrease of 22%). In the same period, the estimated excise duty revenue increased from EUR 188.2 billion to EUR 191 billion (an increase of 7%). In line with rising fuel prices, estimated VAT revenues increased in period 2017-2019 and estimated excise duty revenue was picking up but not as much as VAT compared to 2016.

Assuming that roughly half of the VAT is reclaimed (i.e. the actual VAT revenue is half of the theoretical value depicted on the below graph), the increase of excise duty more or less offset the decrease of the VAT revenue in 2012-2018, resulting in a relatively stable tax revenue from petroleum products. When adjusted for inflation, this means the value of the tax revenue has slightly decreased.

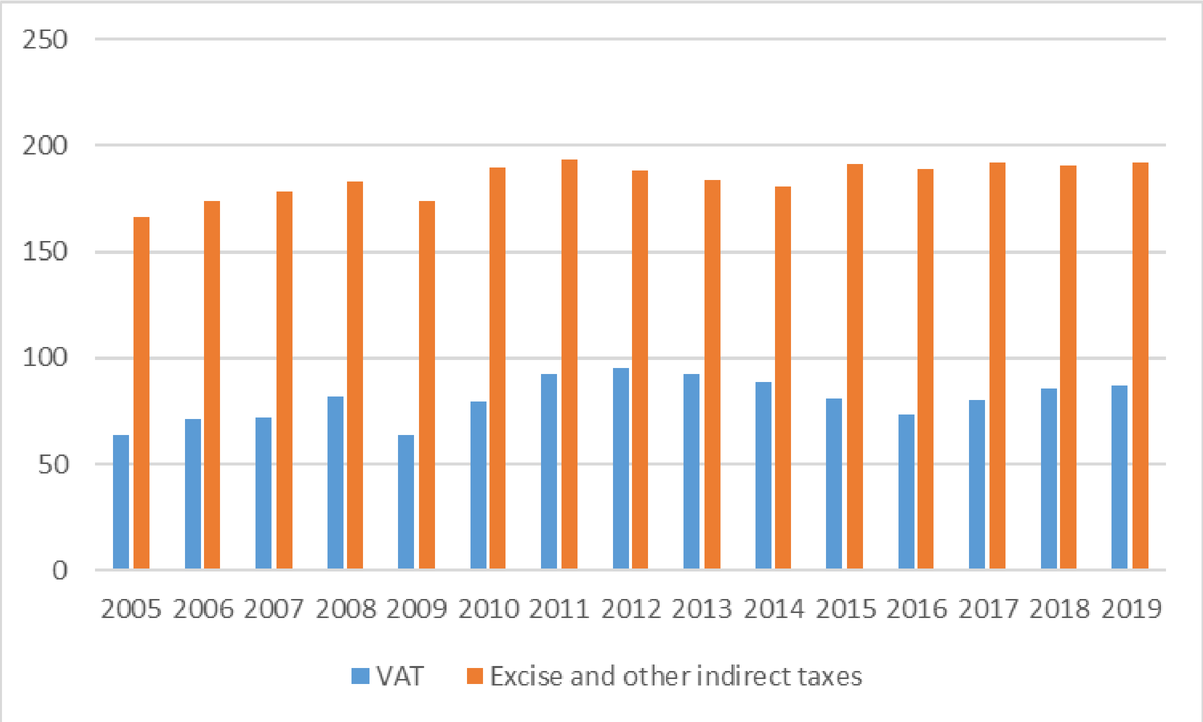

Figure 178 - Estimated tax revenue from gasoline, diesel and heating oil, EUR bn

Source: DG Energy calculation

7.1.5 Energy taxes, prices and incentives

In a recent study (Trinomics 2020b[88]), analysis of taxes, subsidies and other levies on energy were considered. Key findings are the following[89]:

Reported tax rates on energy consumption in the EU27

- Tax rates on energy use increased by 29% between 2008 and 2018, in real terms. The total reported tax rate on energy consumption in the EU27 was EUR 25/MWh in 2018. Member states total tax rates ranged from EUR 9/MWh (Hungary) to EUR 34/MWh in 2018 (Germany), with a median of EUR 19/MWh;
- There is now more differential tax treatment by sector than there was in 2008. Rates increased the most, in absolute terms, in the non-energy-intensive industry ('non-EII'), services and construction sectors, while rate changes in the passenger road and water transport sectors were small;
- Tax rates on EIIs are three times less than on non-EIIs. And the median tax rate on EIIs is half that of non-EIIs;
- Tax rates on liquid fuels used for road transport are the highest and rates on petroleum coke and coal are the lowest. The median tax rate levied by EU MS on gasoline is EUR 60/MWh and EUR 37/MWh on diesel, while the median tax rate on solid fossil fuels (i.e. coal) is EUR 1/MWh, EUR 2/MWh on natural gas, and EUR 4/MWh on electricity.

Estimated tax revenues from taxes on energy consumption in the EU27

- Total revenues from taxes on energy consumption increased 23% between 2008 and 2018 (from EUR 219 billion in 2008 to EUR 263 billion in 2018). 47% of the revenue in 2018 was accounted for by Germany and France, and another 28% by Italy, Spain and the Netherlands. Road transport accounts for 60% of tax revenue, followed by residential (15%), then services (12%);
- Three-quarters of revenues in the EU27 were from excise taxes in 2018, and 20% were for renewables support. Between 2008 and 2018 revenues increased by EUR 50 billion, out of which EUR 40 billion were for renewable support;
- Energy-intensive industries and agriculture paid the least taxes relative to the amount of energy they consumed in 2018, whereas the road transport sectors paid the most. EIIs account for 18% of energy consumption and 2% of tax revenue, and agriculture accounts for 3% of energy use and 0.5% of tax revenue while road transport accounts for 29% of energy consumption and 60% of tax revenue;
- Revenues from taxes on electricity rose while those on gasoline fell. Taxes on diesel account for the largest share of tax revenues in 2018 (41%), as they did in 2008. Electricity accounted for 30% of tax revenues in 2018, up 15 percentage points from 2008, while the gasoline share decreased from 30% to 20%, corresponding to a drop of a fifth in gasoline consumption between 2008 and 2018.

[88] Trinomics et.al., (2020), ENER/2018-A4/2018-471, "Final Report: Energy Taxes: Energy costs, taxes and the impact of government interventions on investments".
[89] Some numbers can differ from Eurostat as data gathering methods and methodology is different.

Taxes on energy production and infrastructure in the EU27

- Revenues from taxes on energy production fell from EUR 21 billion in 2008 to EUR 5 billion in 2018, while taxes on infrastructure doubled to EUR 5 billion.

Taxes on energy consumption in G20 countries

- Total tax rates on passenger road transport within 11 G20 countries (including the United Kingdom, but excluding Germany, France and Italy) are, on average, half that in the EU27. The US tax rate is 40% that of the lowest EU MS tax rate (Bulgaria) and a quarter of the total EU27 rate. The rate in Japan is 20% lower than the EU27 total and equivalent to the rates in Austria, Romania, and Latvia;
- Tax rates on energy-intensive industries in Japan are twice that of the EU27 (EUR 12/MWh versus EUR 6/MWh), but tax rates on non-energy-intensive industries are a third lower (EUR 12/MWh versus EUR 18/MWh).

It could be interesting to compare the EU average prices of MWh of electricity, gas, and three main oil fuel types (gasoline, diesel and heating oil) available to the consumer on retail level[90] to get a glimpse into the rationale of the consumer choices between different energy carriers in the everyday pursue to satisfy their energy needs. The most expensive is the MWh of electricity compared to gas and fuel, which is discouraging electrification in the household sector. Relatively cheaper gas is providing incentive to heat with gas as opposed to heating oil. Of course, mobility needs are most frequently addressed by transport means fuelled by gasoline and diesel, although gas and electricity (EV) are becoming increasingly used in transport. Across the energy carriers available to households, in MWh terms, gas is the cheapest fuel, followed by oil fuels and electricity[91]. This ranking of prices applies both to nominal net prices and price with taxes included – oil fuels have the highest share of taxes (VAT, excise taxes, other indirect taxes) in the retail price compared to electricity and gas, even when we add in network fee for electricity and gas (which is 27 and 23%, respectively).

[90] Electricity price is retail price for Household DC band from Chapter 1. Gas price is retail price for Household D2 band from Chapter 2. Fuel prices for gasoline, diesel and heating oil are retail prices from Chapter 3.
[91] These are by no means perfect substitutes for number of reasons.

Table 30 – Comparison of retail prices and taxes of different energy carriers (2019)

	Electricity		Gas		Gasoline		Diesel		Heating oil	
Consumer type	Household (DC)		Household (D2)							
Component	Price 2019 per MWh	Share 2019	Price 2019 per MWh	Share 2019	Price 2019 per MWh	Share 2019	Price 2019 per MWh	Share 2019	Price 2019 per MWh	Share 2019
Energy/Gas/Fuel net price	68.5	32%	30.2	45%	60.9	40%	58.4	44%	55.8	49%
Network	57.8	27%	15.4	23%						
Taxes	87.7	41%	21.4	32%	92.2	60%	75.6	56%	57.3	51%
Total	214.0		67.0		153.1	100%	133.9	100%	113.1	100%

Source: DG ENER in-house data collection. Eurostat data. DG ENER calculation

PART IV

Prices and Costs
and
Future Investments

8 Realised prices and profitability in the power market

Main Messages

- Realised electricity prices have fluctuated for all technologies in the time period considered (2012-2018). Revenues obtained on European electricity markets were the highest in 2018.
- PV generated electricity was selling for a higher price than baseload power in earlier years. This price premium has been almost completely eroded over time. However, the rise in electricity prices between 2016 and 2018 has also increased the relative value of PV generated electricity. Falling prices for PV generators have led to PV reaching small but positive IRRs in some markets
- Wind power traded at a lower price than baseload power for most of the years and in most of the EU markets considered. The price discount is higher for wind onshore than for wind offshore. Investments in both wind onshore and wind offshore, in general, require support payments for reaching economic viability.
- Investments in gas-fired power generation and in coal-fired power generation face difficulties, if the plants' running hours are further eroded, as suggested by the electricity system projections used in the study.

8.1 Introduction

The significant variation of electricity prices within one day and on longer time scales is reflected in the structure of the European generation portfolio. Power stations are technically designed and economically optimised to run a given number of hours per year, during which the margin obtained needs to allow paying back the investment. This plants' margins will be largely determined by the power prices "realised"[92] at the moment of dispatch. The impact on 'realised' prices for the various generation technologies of increasing penetration of wind and solar electricity generation requires to be carefully assessed for a number of reasons.

Firstly, as PV and wind power generation is determined by meteorology and correlated over larger regions, an increasing penetration of these sources might lead to falling electricity prices at the moment of production. This can affect either the generator's profitability, if remunerated based on electricity market or the costs of the support scheme if the renewable energy resource is benefitting from a guaranteed selling price.

Secondly, conventional sources of power generation such as gas, coal, nuclear or hydropower dams will be confronted with different hourly price patterns, changing the economically optimal dispatch of these technologies. Conventional power plants may run fewer hours per year and realise lower prices as a result of an increasing penetration of wind and PV generation, eventually losing profitability.

8.2 Methodology

This report assesses the realised prices and the resulting profitability for wind, PV and conventional electricity generation technologies. It looks at both the time period 2008 -2018 and extrapolates into the future based on projections. The analysis is based on the Trinomics et altri study (2020), in which more details, and results for non-EU regions can be found.

This study determines realised prices as the annual average of hourly electricity prices weighted over the hourly generation of the respective technology within a given market (generally a country or a price zone within a country). It also collects information on payments through support schemes.

The primary metric used for measuring the economic viability of an asset is the internal rate of return (IRR), which is defined as the discount rate at which the net present value (NPV) of all cash flows related to the asset equals zero. The internal rate of return needs to exceed an investor's weighted average costs of capital (WACC) for an investment to become profitable.

[92] Annual "captured" or "realised" price means: sum over all hours of the total production level for a technology at every hour *multiplied* by the price at every hour divided by the total annual production for this technology.

$$p_c = \frac{\sum_{i=1}^{8760} p_i q_i}{\sum_{i=1}^{8760} q_i}$$

With p_c = annual captured electricity price; p_i = electricity price for hour i; q_i = electricity produced during hour i

This study determines the profitability of investments based on market based remuneration and on support schemes.

Hourly electricity prices and generation profiles for the different technologies were gathered from publically available sources where possible. Given the long lifetime of power generation investments, assumptions need to be made on future developments of electricity prices and plant dispatch. Such time series were obtained with the help of projections, generated with the METIS energy model[93]. Those projections are compatible with energy scenarios reaching the EU 2030 targets greenhouse gas neutrality in 2050[94].

8.3 Realised prices and business cases of key technologies

8.3.1 Solar PV

Table 31 –Maximum profitability observed for Solar PV

Country	Price	IRR (market)	IRR (support)
DE	44 EUR/MWh	-2%	6%
ES	59 EUR/MWh	- 3%	7%
FR	51 EUR/MWh	- 0%	6%
IT	58 EUR/MWh	- 2%	10%

The realised prices for solar PV generators on the EU's markets with the largest installed capacities show a significant variability over time and between different regions as can be seen in **Figure 179.** Average prices are higher on the Spanish electricity market than in France and Germany throughout the period considered. Germany, which has the highest installed PV capacity in the EU sees systematically the lowest realised prices for this form of energy. The realised prices follow the development of baseload prices shown in **Figure 4** and discussed in section 1.1 of this report. On all markets, the highest prices were obtained in 2018.

[93] More information on the METIS model can be found here: https://ec.europa.eu/energy/data-analysis/energy-modelling/metis_en

[94] See the in-depth analysis in support of COM(2018) 77, A Clean Planet for all - A European long-term strategic vision for a prosperous, modern, competitive and climate neutral economy

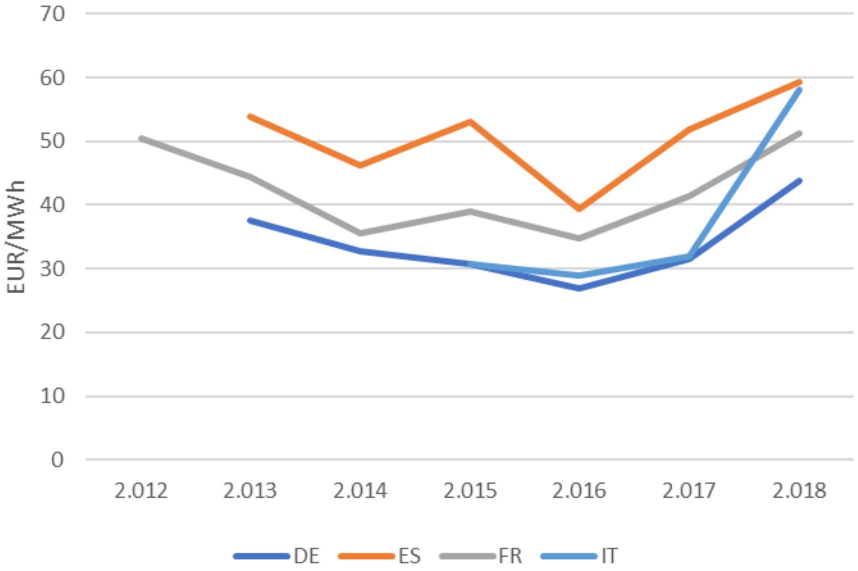

Figure 179 - Realised electricity price in EUR/MWh for solar PV

Source: Trinomics et al. 2020

The realised electricity price for PV generators as expressed in percentages of the baseload price have been fallen consistently over time (see **Figure 180**). Relative prices significantly above 100% have been falling to levels close to baseload remuneration. This trend was interrupted in the years 2017 and 2018 when relative price started rising again.

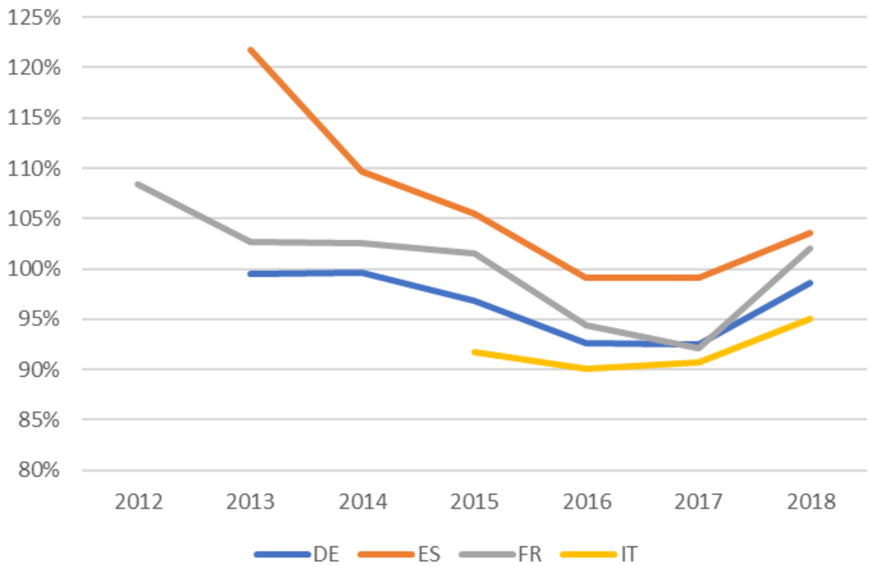

Figure 180 - Realised electricity price as percentage of baseload price for solar PV

Source: Trinomics et al. 2020

Costs for centralised PV generation have dropped by a factor of three between 2009 and 2018 and now stand below 1 000€/kW for most European countries. Yet, market based remunerations has so far not been sufficient for achieving a break-even of the investment in solar PV generation. If only considering revenues on electricity markets, the internal rate of return (IRR) for projects commissioned in 2018 ranges between -2% (Germany) and 3% (Spain) according to Trinomics et al. (2020). Market revenues are complemented by support intervention, increasingly determined by tenders as the technology is getting more mature. Taking additional revenues into account, the IRR increases to 3 - 4% for Germany and France respectively, given the assumptions on costs and market developments made.

8.3.2 Wind onshore

Table 32 – Maximum profitability observed for wind onshore

Country	Price	IRR (market)	IRR (support)
DE	47 EUR/MWh	3%	4%
ES	53 EUR/MWh	5%	10%
FR	48 EUR/MWh	4%	9%
IT	57 EUR/MWh	5%	18%

The realised electricity prices for wind onshore show similar characteristics as for the case of solar PV. Realised prices differ both over time and between regions, as can be seen from **Figure 181**, which shows the realised prices for wind onshore in the EU Member States with the highest installed capacities. As for wholesale electricity prices in general, realised prices for wind onshore electricity showed a strong increase up to 2018. The relative price of wind onshore remains below the baseload price for all regions considered. Values range between 80% (Germany average in 2017) and 99% (France average in 2017) of baseload prices.

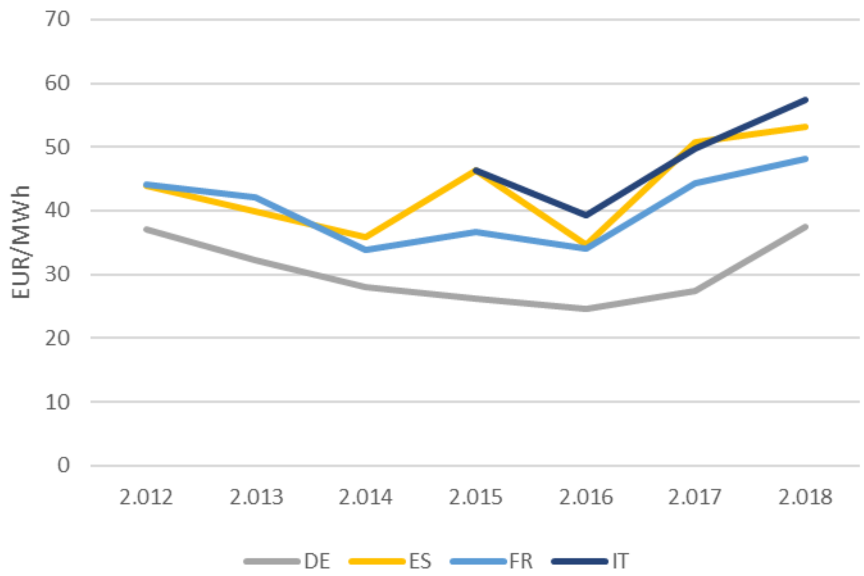

Figure 181 – Realised electricity price in EUR/MWh for wind onshore

Source: Trinomics et al. 2020

As shown in **Figure 182**, costs for wind onshore have shown a decreasing tendency between 2008 and 2018 which has, however slowed down in recent years, showing even some rebound for the case of Spain. Consequently, the internal rate of return for on-shore wind projects remunerated entirely by the electricity market has stayed rather constant over the last years, reaching 3 - 4% in 2018. Higher rates of return could be achieved when support schemes were granted, ranging between 3 - 4% in the case of Germany and 14 – 18% in case of Italy.

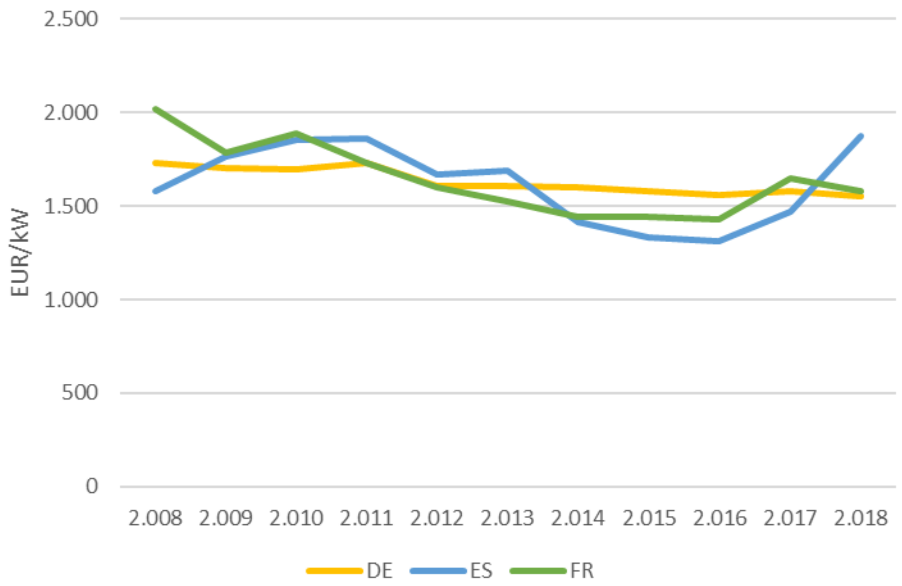

Figure 182 - CAPEX for wind onshore in EUR/kW

Source: Trinomics et al. 2020

8.3.3 Wind offshore

Table 33 – Maximum profitabvility observed for wind offshore

Country	Price	IRR (market)	IRR (support)
BE	52 EUR/MWh	3%	11%
DE	47 EUR/MWh	1%	9%
NL	50 EUR/MWh	5%	6%

Figure 183 shows the development of realised prices for wind offshore during the period of 2012 and 2018. Wind offshore sells for consistently higher prices then wind on-shore as can be seen on the example of Germany, where the average premium is 2-5 EUR/MWh. Overall, wind offshore trades at a discount (between 1 and 13% during 2015 -2018) to baseload prices. Significant differences can be observed between EU Member States with realised prices in Belgium exceeding those in Denmark by 14 EUR/ MWh in 2018.

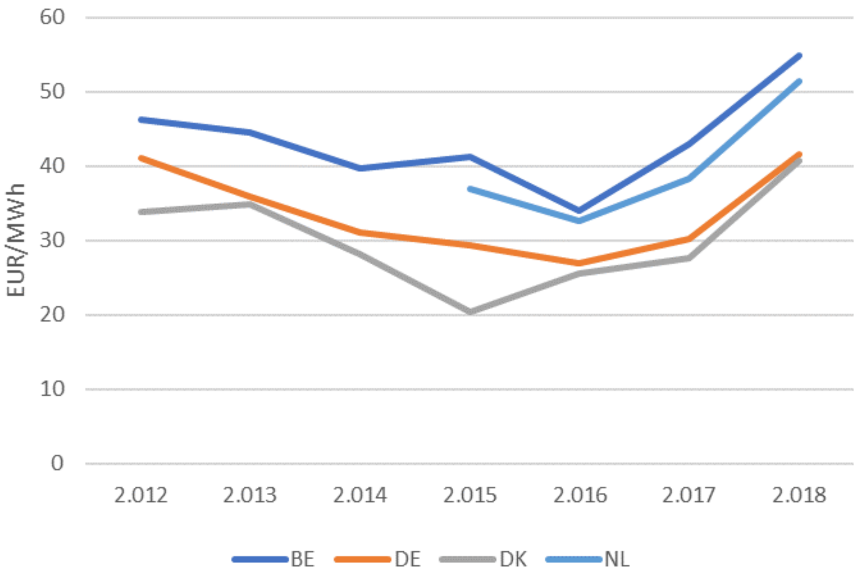

Figure 183 - Realised electricity price per as percentage of baseload price for wind offshore

Source: Trinomics et al. 2020

There is no easily identifiable trend for costs of wind offshore projects as these depend on location, distance from shore, water depth and other factors (see **Figure 184**). The variation observed from one year to another is mainly due to the low number of actual projects, which do not provide a meaningful average. The other factor is the nature of projects: distance from shore, depth of installations, location, etc. Annual averages can be influenced by individual projects.

Based on a remuneration on electricity markets, IRRs of wind offshore projects during the period of 2008 – 2018 are between -4 and 5%. Based on support remuneration, IRRs of up to 9% could be achieved for projects started in the year 2018 in Belgium or Germany.

As further elaborated in Trinomics et al. (2020), auction results of renewable energy projects seem to suggest that even offshore wind projects can be realised without subsidies. There are, however, several caveats when interpreting auction results, which may point to a higher cost and subsidy requirement if properly accounted for.

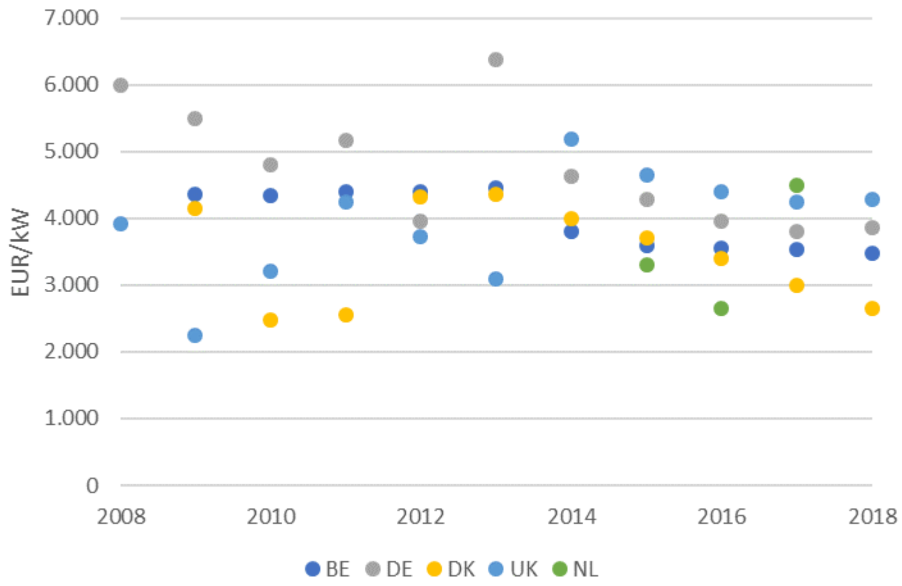

Figure 184 – CAPEX for wind offshore for selected countries

Source: Trinomics et al. 2020

8.3.4 Gas fired power generation

As opposed to wind and solar generation, gas-fired power plants realise higher than baseload power prices as they can adapt their output to changes in demand. These generators take the decision to produce electricity based on price signals, seeking to produce when market revenues cover the costs of producing an additional unit of electricity. As can be seen from **Figure 185**, realised prices for gas fired power plants are higher and vary less over time than realised prices of meteorologically driven sources. The general increase of electricity wholesale prices in the years 2017 and 2018 can be observed in the case of gas fired generation. Realised prices vary between Member States: annual averaged were between 51 and 68 EUR/MWh in 2018.

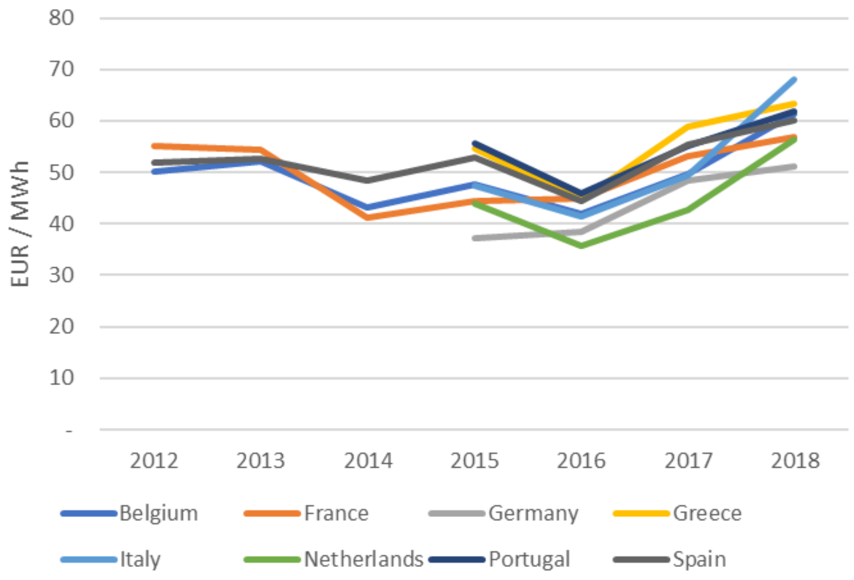

Figure 185 – Realised price for gas-fired power

Source: Trinomics et al. 2020

As a result of their flexibility, gas-fired power plants can provide system services (or ancillary services) such as frequency reserve. These provide additional revenues worth between 5-15% of the sales on electricity markets. In some cases, gas fired power plants receive capacity payments for their availability. Costs of gas fired power stations include the investment, fixed operating costs, fuel cost and costs for emission rights. These increase the number of uncertainties in the determination of profitability as a gas fired power plant built in 2018 with a life-span of 30 years could operate up to 2048 or even beyond. According to the projections used for the economic analysis, gas-fired power plants remain in the European energy mix but load factors will decrease substantially, leading to an erosion of revenues from electricity markets as shown in **Figure 186**. Costs are, however, pushed upwards by an anticipated increase in the prices for fuel and emissions rights, which are assumed to reach a price of 350 EUR/t in 2050. Based on the projections this results in relatively low and negative IRR rates for gas fired power generation.

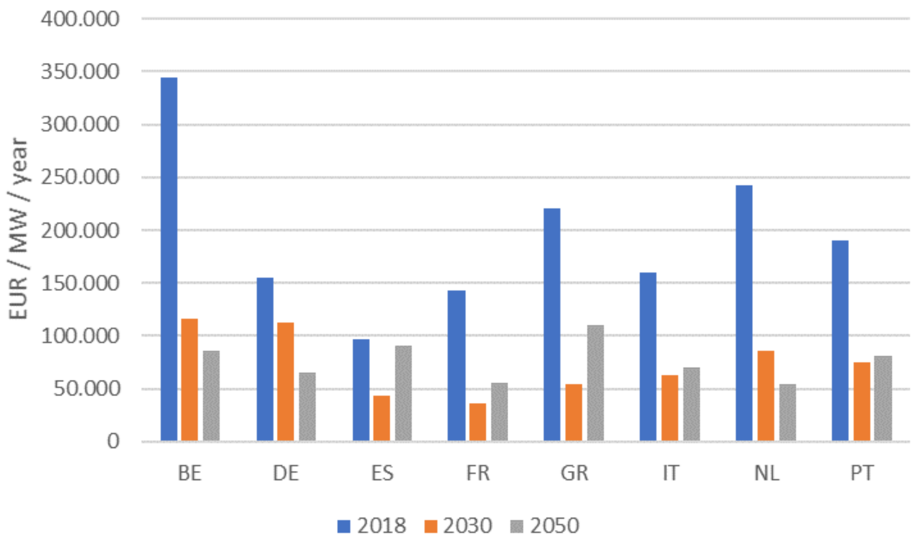

Figure 186 – Revenue for gas fired generation by installed MW

Source: Trinomics et al. 2020

8.3.5 Coal fired power generation

Coal fired power plants share technical and economic features of gas fired plants. They are dispatched based on price signals as they can largely adapt their output to demand. Depending on the plant's vintage, the key flexibility parameters such as minimum load and ramping capability of coal fired power plants might limit the load following capability. Coal fired power plants may also provide ancillary services, which generate additional revenues. The "marginal" costs of producing an additional unit of electricity depends largely on the price of the fuel and of emission rights. During the time period considered, coal fired power plants generally have lower marginal costs than gas fired plants, which leads to lower realised prices as can be seen when comparing **Figure 187** with **Figure 185**.

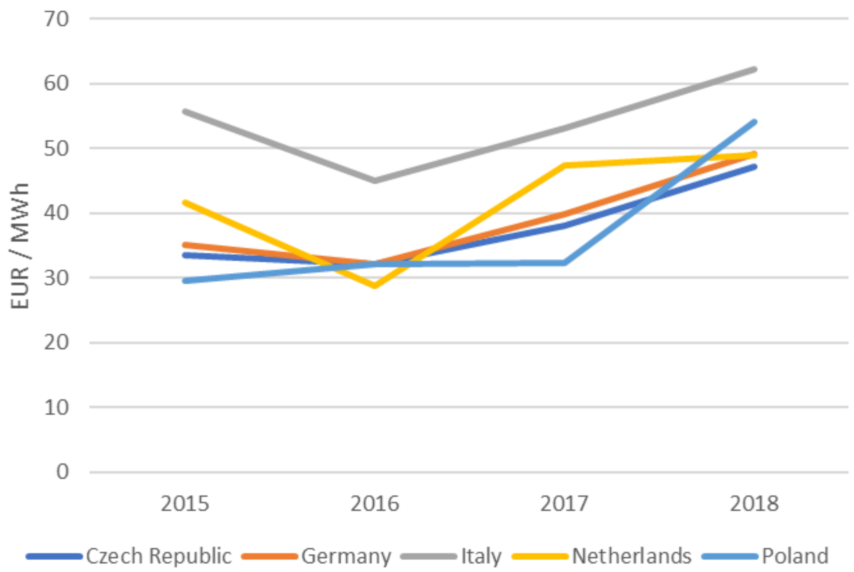

Figure 187 - Realised price for coal-fired power

Source: Trinomics et al. 2020

Coal fired power plants are more expensive to build than gas fired plants. In order to become profitable, these will have to run for a higher number of hours per year. Given a plant lifetime of 40 years, units built after 2010 could run well into the 2050s, if profitable. In the absence of carbon capture and storage, the assumed increasing costs of emission allowances drives up the marginal costs of coal fired power, reducing running hours at which producing is profitable and thus possible revenues. In the scenarios considered the revenues will not be sufficient to yield a positive IRR in Europe.

8.3.6 Nuclear Energy

The economics of nuclear power plants are mainly driven by their relatively high capital costs but low marginal costs. While nuclear power plants can ramp and produce electricity at part-load, baseload operation remains the natural economic choice, complemented by ancillary services. As a result, the realised prices of nuclear power plants have been very close to baseload electricity prices.

In future, the increasing penetration of wind and solar power is expected to reduce the running hours to a degree but, due to the absence of carbon emissions and the associated costs, existing nuclear power plants are expected to stay in the money in the projections considered. As no new nuclear power plants went online in Europe during the 2010s, data on possible project costs in Europe remains to be validated.