

BRIEFING PAPER

EUROPEAN UNION INDUSTRIAL ENERGY USE WITH A FOCUS ON NATURAL GAS

BY IULIA PISCA



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FOREWORD

In the 2016 study on EU gas demand¹, it was clear that projections of gas demand in the next decade vary widely. These variations are due to the assessment of the role of natural gas in energy transition, in particular, demand in the power sector in the EU.

In many such projections of future gas demand, gas demand in the industrial sector is assumed to be very stable, in essence forming the bedrock of gas demand. With the formulation of the 2030 energy and climate policies of the EU member states now underway, sectors other than the power sector come into view with respect to energy transition. In addition to the power sector, transportation, particularly passenger cars, as well as the residential heating sector, come under closer national policy scrutiny for their decarbonisation potential. In some member states, a more integrated energy system approach to energy transition, in Germany referred to as 'sektor kopplung', is gaining some traction. At some point in these discussions, energy use of the industrial sector will also become an issue.

Due to the long investment cycles in industry and the benefits of being in the vicinity of energy grids that serve the various demand functions in an economy, understanding the special needs of industrial energy demand becomes important when discussing the potential to increase energy and carbon efficiency, whilst maintaining competitiveness. Already, the emergence of new energy technologies in the energy system, particularly those with a variable production profile, increases the need to either store electric energy in batteries of some sort or convert electrons into (clean) molecules. These molecules could also find their way into industrial energy demand. At the same time, the logic, layout and economics of the current energy system will change when new energy technologies are introduced at a sufficient scale. This will also impact industrial energy consumers, which are connected to the same grids as other consumers. It is clear that we are moving and need to be moving from a sector by sector understanding of energy transition to a more comprehensive one that involves the entire energy system.

Very little information is publicly available to understand industrial energy and in particular industrial gas demand in the EU. In this briefing paper we attempt to do

¹ Iulia, Pisca, Outlook for EU Gas Demand and Import Needs to 2025, CIEP 2016.

just that by presenting some facts. What are the energy needs of the industrial sector, how are they met now, and the question that led to this research, what is the position of natural gas in meeting this industrial energy demand? The latter is important for understanding how stable industrial gas demand is (and why) against the background of the proposed energy transition pathways, also with regard to the complexities involved in energy transition when looking at industry. Some industries rely quite heavily on natural gas for their energy consumption and feedstock needs, while other industries might have more options to fulfil that demand with alternative sources. Some industries also greatly benefit from the clustered geography in their energy choices, while others have a different set of resources optionality.

Coby van der Linde, Director CIEP

INTRODUCTION

Industry is an important part of the EU economy in terms of gross value added and energy consumption. Industry contributes nearly 20% to the EU gross value added and consumes about a third of EU energy. Because industrial production involves several grades of processing, industrial outputs become industrial products only after they have undergone a few processing steps. These processing steps each have their own energy requirements, which are often served by particular energy sources.

The EU industrial base produced more than €6 trillion worth of industrial products in 2015. Both in terms of euro value creation and geographic spread, the distribution of industry is uneven and concentrated mainly in Western EU Member States. More than three quarters of the euro production value takes place there. Germany, Italy, France, Spain and the Netherlands, the largest industrial producers, have been historically strong industrial centers in Europe, and over the past two decades, they have consolidated their manufacturing position through specialisation and integration. Peripheral EU Member States, such as Eastern European countries², have modest industrial activity generating about a tenth of the EU euro production value in 2015. The distribution of industrial production value between Western Member States and Eastern EU Member States can be paralleled to their associated energy consumption. About 70% of the EU industrial energy consumption takes place in the 7 most industrialized countries of Western Europe³, and 15% in Eastern EU Member States.

Due to the long investment cycles in industry, the next phase of decarbonisation will include thinking about how industry can also contribute to reducing CO₂ emissions. Furthermore, the industrial energy transition should take existing rigidities built-in the system into account. They include long investment cycles and complex material and energy flows between industrial processes, whose premature and/or uncoordinated alteration could put pressure on the competitiveness of the EU industrial base.

In this paper, the relative size and geography of the main EU industrial sectors is mapped to get a better understanding of industrial energy consumption and

2 Notably: Poland, Czech Republic, Slovakia, Hungary, Romania and Bulgaria.

3 Germany, France, Italy, UK, Spain, Belgium and The Netherlands.

infrastructure clusters. We then look at the composition of industrial energy use and the industrial energy mix in order to understand the position of natural gas in industry. In the last sector, the natural gas use of industry is analysed per member state, to finalise the understanding of the main industrial gas markets in the EU. Industrial energy use, also representing a substantial share of natural gas consumption, receives much less attention in energy debates than discussions about the power sector, in part because demand has been so stable.

Natural gas delivers about a third of industry's energy needs by supplying the medium and high-temperature heat for energy-intensive industries. The role of natural gas in industry becomes important in the current energy mix, as the substitution of the energy-dense molecule is currently uneconomic and its electrification is technically unfeasible for the mid and high end of the temperature range. In this regard, natural gas enjoys a rather stable position in the EU industrial energy mix. This is a different situation compared to the EU residential and power sector, where the position of natural gas is less certain.

In this paper, the relative size and geography of the main EU industrial sectors is mapped to get a better understanding of industrial production at Member State level and sub-national clusters (Chapter 1). We then look at the composition of industrial energy consumption using three ways in which energy is consumed (Chapter 2). These breakdowns show the positioning of natural gas in industry which is then detailed in the last chapter. Chapter 3 presents natural gas consumption in industry, analysed per Member State and industrial sector, to finalise the understanding of the main industrial gas markets in the EU.

1 EU INDUSTRIAL PRODUCTION

A. DISTRIBUTION OF INDUSTRIAL ACTIVITY ACROSS EU MEMBER STATES – NATIONAL LEVEL

The construction of the industry production value for the European Union is based on 2015 Eurostat data. The aim of the EU industrial production map is to represent manufacturing production in a comprehensive manner across the largest European Member States and industrial sectors (Map 1). The monetary (euro) value of production is the chosen comparison unit because the produced volumes and production specs could not be translated otherwise to a comparable unit.

The Eurostat database provides the in euro denominated production value⁴ for each manufacturing activity described in the Eurostat statistical classification of economic activities (NACE), at the Member State level. The main industrial sectors selected from NACE are the following: primary metals (steel and non-ferrous metals), petrochemicals (refining and chemicals), construction materials (non-metallic minerals), machinery, paper and food. The share of the value production of an industrial sector in a Member State is graphically represented in the map by a dot. Dot sizes are clustered in 4 brackets: above 20% production share in EU total, between 10-20% production share in EU total, between 3-10% production share in EU total and below 3% production share in EU total. For example, German machinery accounts for more than 20% of the total production value of EU machinery production.

Two additional notes should be made with regard to data accuracy. First, there is the issue of missing production value data. Production value data in some specific industries and/or Member States can be sensitive information, and is thus kept confidential. Missing production value data was replaced with proxy-based estimates⁵. Second, the production value is expressed in 2015 euros. In 2015, only 19 of the 28 EU Member states were using the euro currency. An annual

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

5 The main proxies used for the euro production value estimates are production capacity and utilisation rate, corrected with the average of previous years. In some cases, missing production value data was checked against industry association reports.

exchange rate vis-à-vis other EU national currencies was used to align the industry production value estimates.⁶

Figure 2 shows the relative position of each EU Member State in one of the eight main industrial sectors, compared to the EU total. The highest concentration of industrial production at the EU level takes place in Germany whose euro production value in industrial sectors, such as primary metals, machinery and non-metallic minerals, is higher than 20% of the EU total. Other Member States with significant industrial production are Italy, the Netherlands, Belgium, France, Spain and the United Kingdom. Their individual contribution to the EU euro production value across industrial sectors is lower than Germany's (ranges between 3-20% of EU total) and each of them excels cumulatively in fewer industrial sectors than Germany. Furthermore, modest industrial performance is recorded by peripheral EU Member States with sectoral contributions generally lower than 3% of the EU total.

Showing the distribution of industrial production (by production value) in the EU is functional for a number of reasons. It shows, for instance, that more than 75% of industrial production (in euro value) is concentrated in Western European Member States.⁷ The remaining 25% of industrial production (in euro value) is distributed in small shares among the remaining Member States, often representing national champion types of industries. Examples include the pulp and paper industry in Sweden and Finland, steel in Poland and primary metals in Austria.

In absolute terms the production value of EU industry in 2015 was 6.1 trillion euros (Figure 1). In monetary terms, machinery, petrochemicals and food represent more than 75% of EU industrial production. Unsurprisingly, these are the EU's main export products to international markets according to the EU international trade balance.⁸ Nonetheless, such a value dwarfs the cumulative monetary contribution of primary metals, construction materials and paper, which are generally domestically traded industrial commodities.

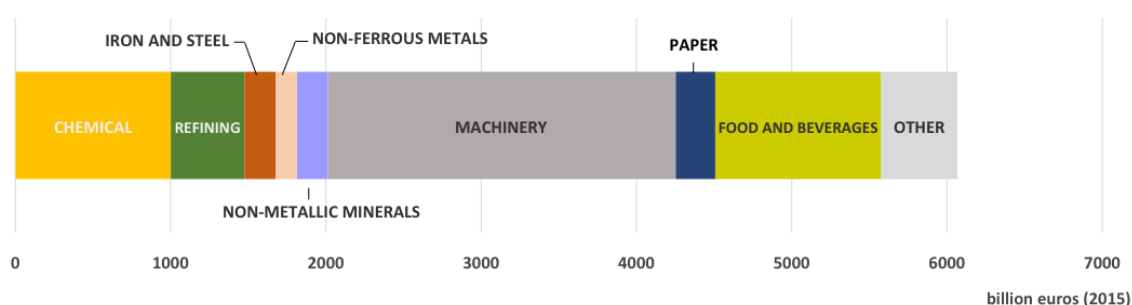
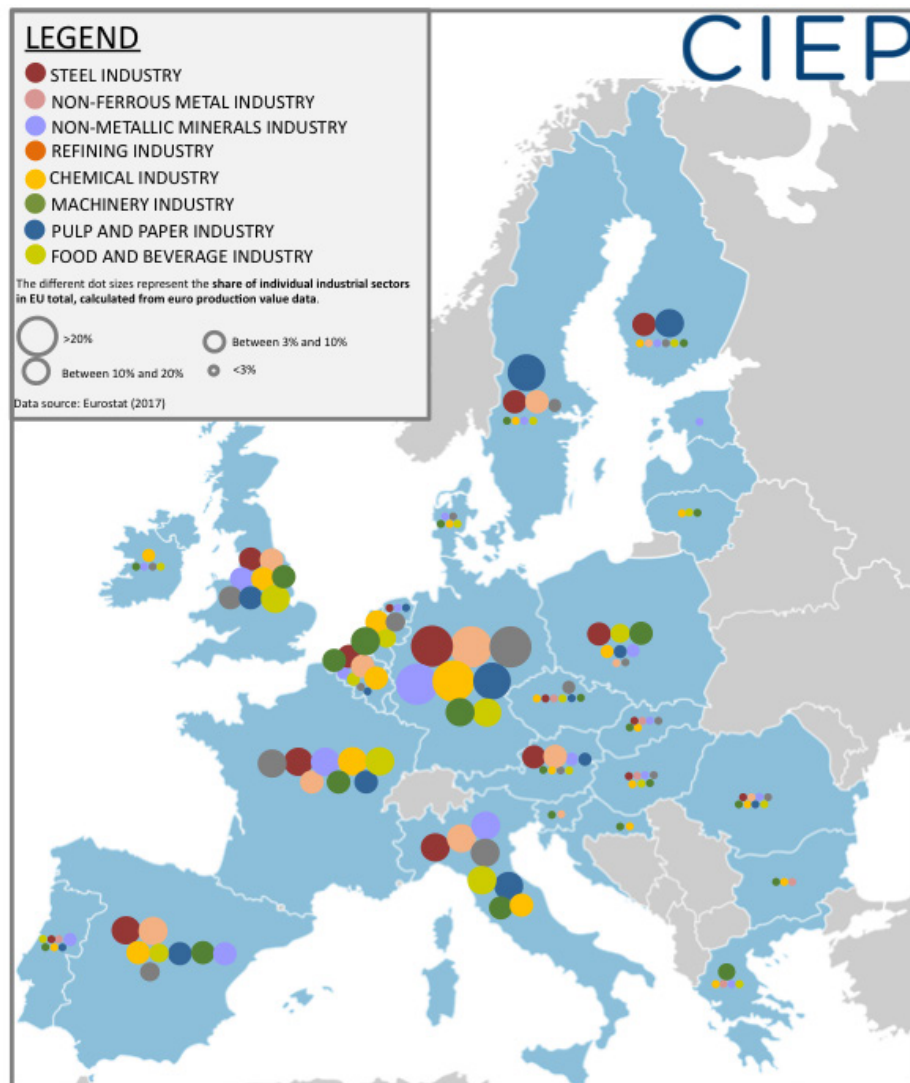


FIGURE 1 – EU PRODUCTION VALUE OF INDUSTRY BY SECTOR. SOURCE: EUROSTAT, CIEP.

6 The exchange rate list is available in the Eurostat production value metadata and Eurostat Structural Business Statistics for industry.

7 Notably Germany, the Netherlands, Belgium, UK, France, Spain and Italy.

8 Eurostat – Euro Indicators (September, 2017).



MAP 1 – DISTRIBUTION OF INDUSTRIAL PRODUCTION (EURO VALUE) BY INDUSTRIAL SECTOR, ACROSS EU MEMBER STATES. BASED ON 2015 EUROSTAT DATA. DOT SIZES ARE RELEVANT WITHIN THEIR RESPECTIVE SECTOR.

B. DISTRIBUTION OF INDUSTRIAL ACTIVITY ACROSS EU MEMBER STATES – SUB-NATIONAL LEVEL

The distribution of EU Member State industrial production by industrial sector, in Map 1, serves as an illustration for the relative industrial size (by euro production value) of Member States' economies relative to the EU total. Industrial production is often unevenly distributed across Member States. A more realistic approach to visualise the share of industrial production is to use a sub-national (regional) break-down to show these geographic concentrations.

The starting point for a sub-national inventory is the national inventory, again based on Eurostat data. Sub-national industrial production figures were extracted from national statistics and industry association reports. The result, Map 2, shows the distribution of industrial production (in relative terms) across the main sub-national breakdowns.

A consequence of displaying sub-national levels of industrial production is that the individual shares (dot sizes) become smaller. This required the adjustment of the dot size brackets to the following: above 10% production share in EU total, between 5-10% production share in EU total, between 1-5% production share in EU total and below 1% production share in EU total. For example, over 10% of the European non-ferrous metal production (by euro value) takes place in Northern Italy.

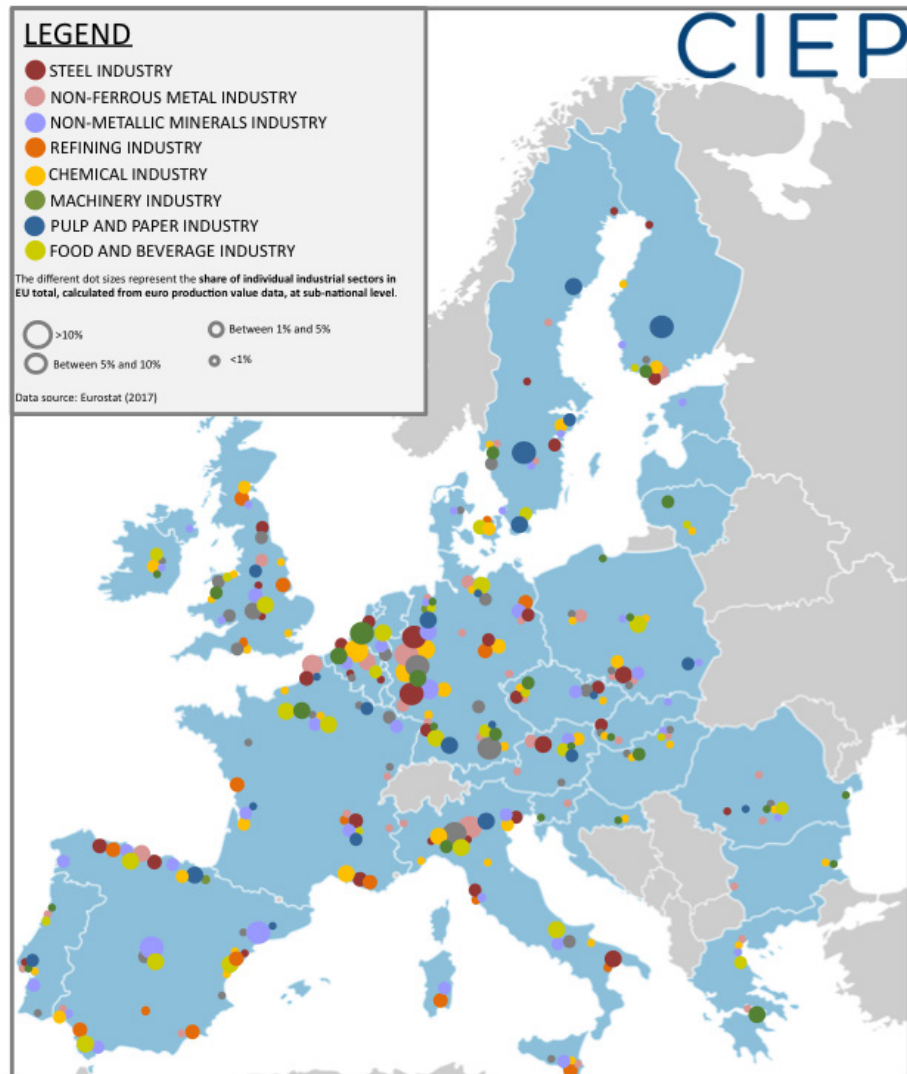
The distribution of industrial production at sub-national EU level is illustrative for a number of reasons.

- The location decision for many industrial activities is evident from the sub-national EU industrial production. For industries such as primary metals, non-metallic minerals and paper, whose processes of converting raw materials into products takes place in the vicinity of the extraction sites, proximity to raw materials and access to energy is the main driver for their location decision.⁹ For most refining and chemical industries, it is important to have access to logistic chains for input-output product flows.¹⁰
- Moreover, industrial sectors are often connected to each other through material and energy flows. The classic example is that of the machinery industry which uses various grades of material inputs from the steel and non-ferrous metal industries. Similarly, the chemical industry is dependent on the refining industry for some of its input materials. These interdependencies advance the development of industrial clusters which favor scale economies, foster innovation and favor the development of inter-sector synergies. Among the few industrial clusters in the EU, most are concentrated in Western Europe (Mid-Rhine, Antwerp-Rotterdam-Amsterdam, Northern Italy, UK central belt). Smaller clusters exist in regions such as Bohemia, Silesia and Northern Spain. Although their share in the total EU industrial production value is dwarfed by the large clusters, they are significant for the economy of their respective Member States.

9 Examples include industrial regions such as Rhine-Ruhr, Bohemia and Silesia which are the resource base for a significant part of primary metal industries, and biomass-rich inland Finland and Sweden which accommodate the highest concentration of pulp and paper mills in the EU.

10 Over 60% of the EU refining capacity is located in coastal areas, and has access to downstream logistic chains (inland waterways, petrochemical pipelines) to facilitate the uptake of their product output. See also Michiel Nivard and Maurits Kreijkes, *The European Refining Sector: A Diversity of Markets?*, CIEP, (2017).

- Aside from industrial production, the distribution of industrial activity by relative size is a useful proxy for where industrial energy consumption takes place in the EU.



MAP 2 –DISTRIBUTION OF INDUSTRIAL PRODUCTION (EURO VALUE) BY INDUSTRIAL SECTOR, ACROSS EU MEMBER STATES IN A SUB-NATIONAL BREAKDOWN. BASED ON 2015 EUROSTAT DATA.

2 EU INDUSTRIAL ENERGY CONSUMPTION

Industry is one of the largest energy consuming sectors in the EU economy, together with transportation and the residential sector. This section looks into EU industrial energy consumption associated with industrial production presented in the previous section. The scope is to show three ways of looking at industrial energy consumption based on the way energy is employed.

A. EU INDUSTRIAL ENERGY CONSUMPTION BY INDUSTRIAL SECTOR

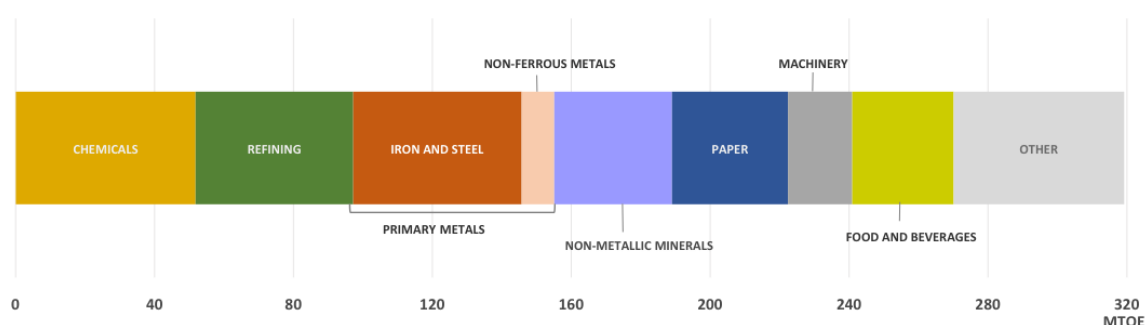


FIGURE 2 – EU INDUSTRIAL ENERGY CONSUMPTION BY INDUSTRIAL SECTOR, CORRESPONDING TO 2015 INDUSTRIAL PRODUCTION. SOURCE: EUROSTAT, EU ENERGY BALANCE, CIEP.

Figure 2 displays the total final energy consumption (TFEC) corresponding to the EU industrial production of 2015. The 320Mtoe consumed constitutes the energy used by the eight main industrial sectors¹¹ and other residual industrial activities. The eight main industrial sectors are responsible for about 85% of industrial energy consumption in the EU, of which the largest energy consumers are petrochemicals and primary metals.

The construction of Figure 2 is based on 2015 Eurostat data and EU Energy Balances. The reporting unit in both datasets is ktoe. For simplicity reasons, the data was converted to Mtoe.

¹¹ The industry sectors considered are: chemicals, refining, iron and steel (or ferrous metals), non-ferrous metals, non-metallic minerals, paper, machinery and food. The definitions for industry sectors used in the industrial energy consumption section are consistent with the definitions used in the previous section.

While the graph displaying industrial energy consumption by sector is illustrative on its own, analysing it in connection to the EU industrial production value (Map 1) offers an indication of the energy intensity of each sector. Energy intensity, defined as the energy per value created (expressed in ktoe per euro), is the closest to a standardised unit for a cross sector comparison of this type. In the case of the EU industrial base, manufacturing of steel and non-metallic minerals has the highest energy consumption per value of product created. Their energy intensity is nearly double that of non-ferrous metal production, and about three times as much as machinery.¹²

B. EU INDUSTRIAL ENERGY CONSUMPTION BY ENERGY SOURCE

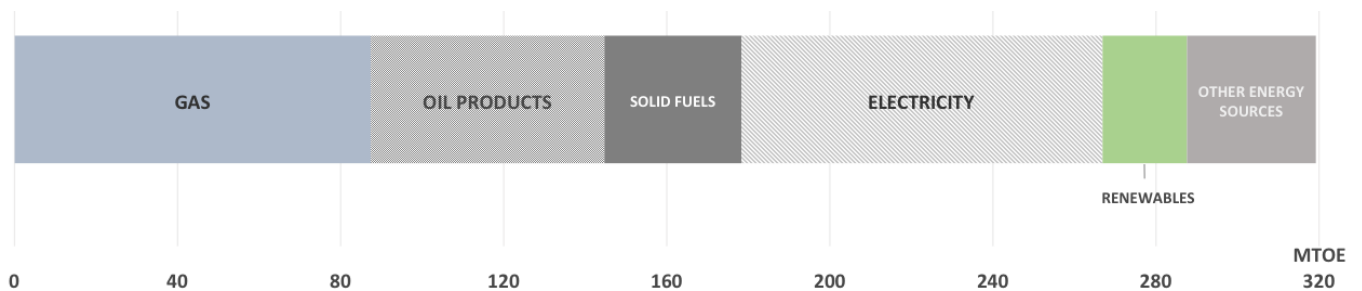


FIGURE 3 – EU INDUSTRIAL ENERGY CONSUMPTION BY ENERGY SOURCE, CORRESPONDING TO 2015 INDUSTRIAL PRODUCTION. SOURCE: EUROSTAT, EU ENERGY BALANCE, CIEP.

The same 320Mtoe of industrial energy consumption can be looked at from an energy source perspective (Figure 3). Three main energy sources contribute to the energy mix in industry. They are natural gas (87Mtoe), electricity (89Mtoe) and oil products (57Mtoe). Natural gas represents nearly 30% of industrial energy consumption, a share which it has comfortably maintained over the past decade.¹³ Oil products, which represent 18% of industrial energy consumption, include a range of derived products such as, refinery gas, LPG, diesel oil, fuel oil or petroleum coke. Renewables and other energy sources represent about 15% (50Mtoe) of the energy mix, and are specifically represented by biomass and residual heat (waste, derived or nuclear).

Electricity has been specifically reported in the industrial energy mix as a separate component, on account of it being largely sourced from the power sector and not generated on site from primary energy sources. Singling out electricity in this

¹² The energy intensity calculated which is comparable with the ODYSSEE-Mure database.

¹³ Jones, D., Dufour, M., Gaventa, J., 'Europe's Declining Gas Demand: Trends and Facts on European Gas Consumption', E3G, (2015).

way makes it easier to discuss the decarbonisation of industrial energy consumption. Most of the emissions associated with industrial energy consumption come from gas, oil products and solid fuels, which supply more than half of the energy needs of the sector. Although electricity used by various industries can be (and probably is) generated using also fossil fuels, the task of decarbonising those electrons falls on the power sector. Under the Renewable Energy Directive, power producers are mandated with reducing the carbon emissions associated with electricity production.

C. EU INDUSTRIAL ENERGY CONSUMPTION BY ENERGY FUNCTION

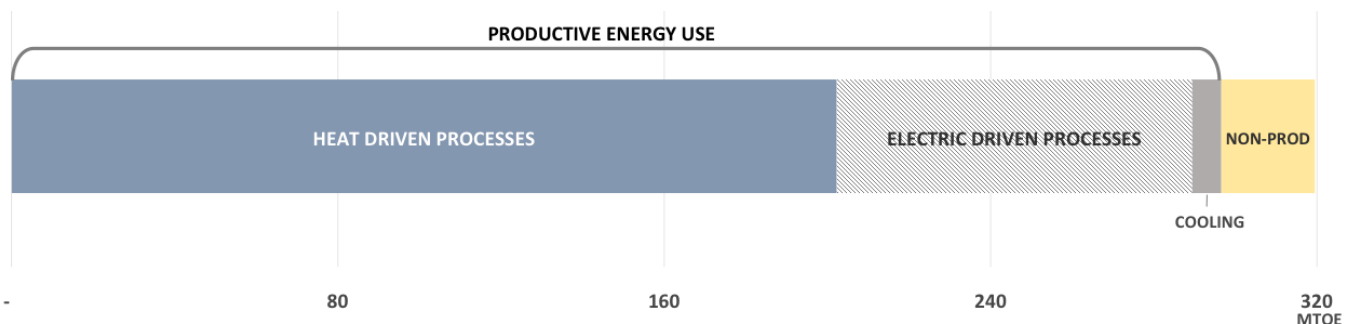


FIGURE 4 – EU INDUSTRIAL ENERGY CONSUMPTION BY ENERGY FUNCTION. SOURCE: EU ENERGY BALANCE, ICF, CIEP.

Another way to visualise EU industrial energy consumption, aside from the breakdown by industrial sector and energy source, is by energy function (Figure 4). Energy functions deal with the way specific industries use energy. A first classification is energy use for productive and non-productive activities.¹⁴ Productive energy use, which accounts for more than 90% of industrial energy consumption, translates into energy directly connected to the production of industrial outputs. A second classification, which is specific to the productive energy use, sees thermal, electric and cooling as the three main functions of productive energy use.

Data availability for energy consumption by function is scarce. The breakdown presented in Figure 6 was constructed from Eurostat, EU Energy Balance and an ICF study (commissioned by DG Energy).¹⁵ The starting point was the ICF study, which presents a breakdown of the different energy functions, based on 2013 Eurostat data. These figures were updated for 2015 using the Eurostat and

¹⁴ Non-productive energy use is associated with activities such as heating, ventilation and air conditioning of industrial sites.

¹⁵ 'Study on Energy Efficiency and Energy Saving Potential in Industry and on Possible Policy Mechanisms', ICF, (2015).

Energy Balance datasets. It involved the adjustment of energy consumption and industrial production between 2013 and 2015.¹⁶

Electric driven processes use about 30% of industrial energy and are sourced mainly from the power grid. The thermal function accounts for more than 60% of the entire industrial energy consumption. It is derived on site and it is subject to industrial process characteristics. Although heat is a generic term for all thermal processes used in industry, the temperature at which they operate ranges from 100°C to 1650°C. A breakdown by three temperature grades is generally used to differentiate thermal processes based on industrial heat needs:

- (i) Low temperature heat - Between 100°C and 250°C
- (ii) Mid temperature heat - Between 250°C and 600°C
- (iii) High temperature heat - Above 600°C.

The temperature grades presented above were applied to the data underlying Figure 4, and presented in Figure 5. Of the 320Mtoe industrial energy consumption, 202Mtoe are used in heat driven processes. Within industrial heat consumption, 94Mtoe were used to generate low temperature heat, 39Mtoe for mid temperature heat and 69Mtoe for high temperature heat.

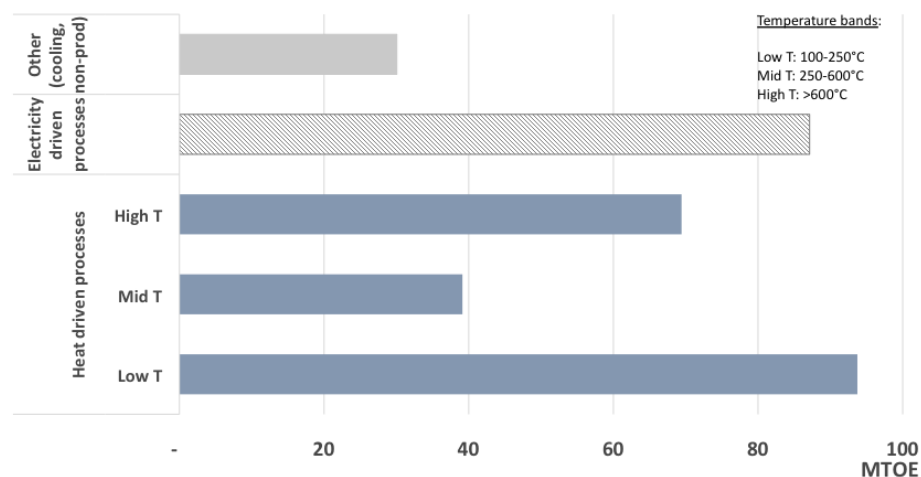


FIGURE 5 – INDUSTRIAL ENERGY CONSUMPTION BY ENERGY FUNCTIONS AND HEAT GRADES.
SOURCE: EU ENERGY BALANCE, ICF, CIEP.

¹⁶ Change in energy consumption between 2013 and 2015. The figure used in the 2013 energy use assessment is 322Mtoe. By 2015 it came down by less than 1%, to 320Mtoe. Because the difference between 2013 and 2015 industrial energy consumption is marginal, it was unproblematic to apply the conversions for energy functions from 2013 to 2015. Minor adjustments were applied for energy efficiency improvements of industrial processes and industrial production. The Eurostat database records a 2.5% energy efficiency improvement and an industrial production index growth of 1.8%. The production growth was recorded only in some industrial sectors, which received the necessary adjustment.

The thermal function of industrial energy consumption can be related to both the energy sources and industrial sectors, presented in Figure 2 and Figure 3.

The relation between the heat function and energy sources rests in the heat temperature individual energy sources can deliver and sustain. Table 1 provides a list of the main industrial processes and their typical temperature range. The operational temperature range is dictated by the technical characteristics of the transformation process of each industry. For example, primary steelmaking requires temperatures higher than 600°C, often supplied from solid fuels and/or natural gas. Pulp and paper production, require temperatures no higher than 250°C, often supplied from biomass. These examples, and the ones provided in Table 1, suggest that the energy density of a fuel source is an important criterion for its selection to deliver the necessary heat grade.

Main industrial processes	Application	Typical temperature range
Smelting and metal melting	Casting; steelmaking and other metal production	720-1650°C
Metal heat treating and reheating	Hardening; annealing; tempering; forging; rolling	500-1200°C
Coking	Ironmaking and other metal production	380-1100°C
Non-metal melting	Plastics and rubber manufacturing; curing and forming; softening and warming	930-1650°C
Calcining	Lime calcining	620-1200°C
Drying	Water and organic compounds removal	160-550°C
Fluid heating	Food preparation; chemical production; reforming; distillation; cracking; hydrotreating	110-460°C
Curing and forming	Coating; polymer production; enameling; molding; extrusion	140-460°C
Other	Preheating; catalysis; thermal oxidation; incineration; other heating	100-1650°C

TABLE 1 – LIST OF TYPICAL TEMPERATURE RANGES AT WHICH THE MAIN INDUSTRIAL PROCESSES RUN. SOURCE: CIEP.

The relation between the heat function and industrial energy use can be described through the mix of heat grades, specific to each industrial sector. As stated previously, each industrial activity has a particular configuration consisting of a chain of industrial processes. It is often the case that individual processes operate within a specific thermal range. At the industrial sector level, the assemblage of all processes can yield a mix of heat grades, as presented in Figure 6.

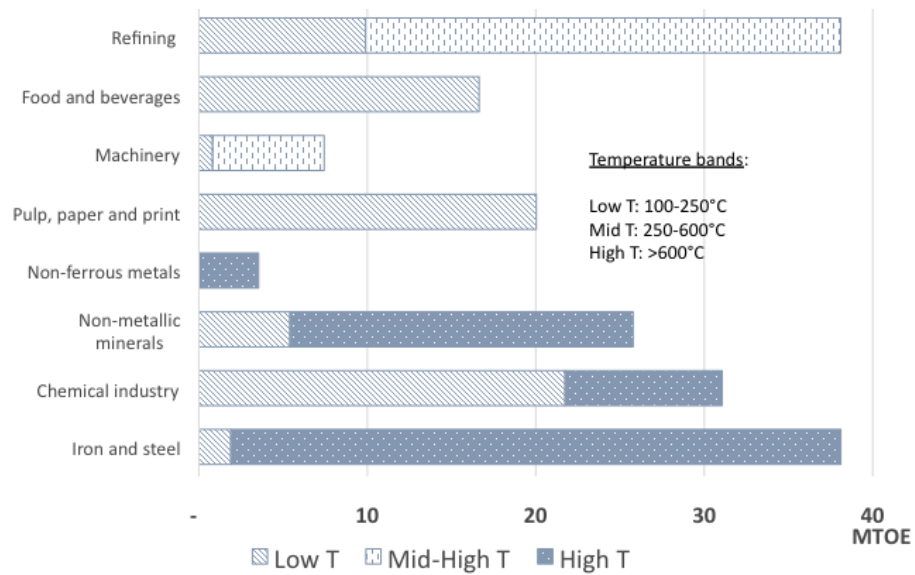


FIGURE 6 - THE MIX OF HEAT GRADES, SPECIFIC FOR EACH OF THE EIGHT MAIN INDUSTRIAL SECTORS ANALYSED. SOURCE: EUROSTAT, EU ENERGY BALANCE, ICF, CIEP.

Because of its complexity, the breakdown of industrial energy consumption by energy function is one of the most challenging aspects to describe regarding industrial energy consumption. It is also the most rewarding, as it provides a foundation for discussing any major structural shifts in industrial energy consumption, such as electrification and the energy efficiency improvement potential. Moreover, it can be the starting point for assessments regarding the decarbonisation potential of individual industrial sectors.

3 EU INDUSTRIAL GAS CONSUMPTION

A. EU GAS CONSUMPTION BY ECONOMIC SECTOR

Natural gas is used widely across a range of economic sectors in the EU. While in the power sector it is in close competition with alternative sources and in the residential sector it is subject to weather induced seasonal variation, industrial gas consumption has been regarded as a stable natural gas demand sector.

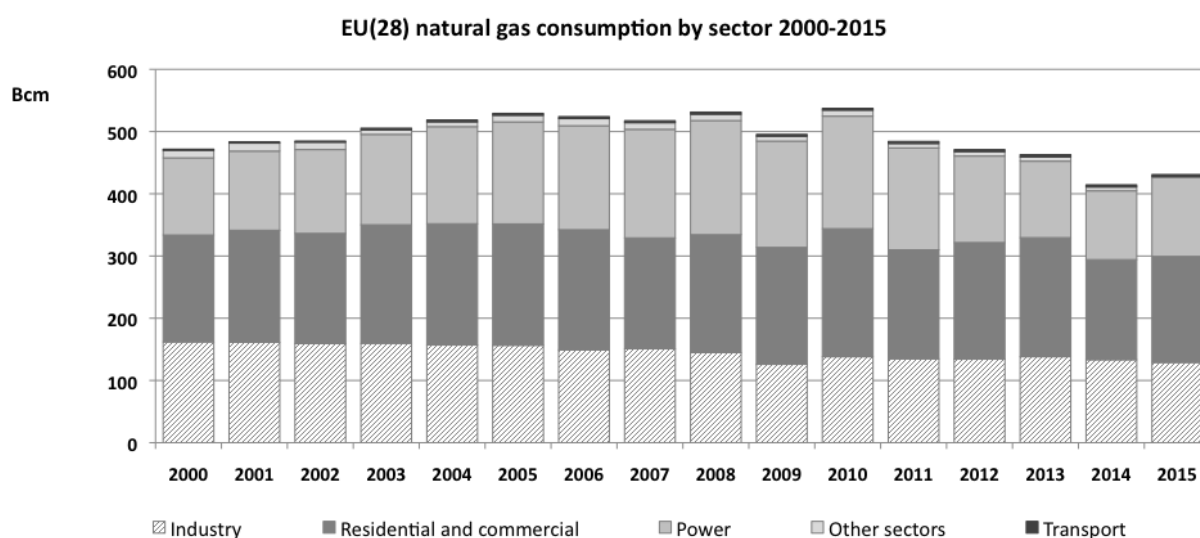


FIGURE 7 – DEVELOPMENT OF EU NATURAL GAS CONSUMPTION BY ECONOMIC SECTOR BETWEEN 2000 AND 2015. SOURCE: EUROSTAT, CIEP.

On the whole, EU natural gas consumption experienced an overall volume decline since 2000 (Figure 7). Between 2000 and 2008, gas consumption in the EU grew from 472Bcm to 500Bcm supported by buoyant economic activity. In the period that followed, EU gas consumption was subject to two depressions. The first was in the wake of the economic and financial crisis (2009) and was caused by a dip in economic activity. The second materialised in the period from 2011-2014, as natural gas was gradually pushed out of the power mix when cheap coal and low carbon prices coincided to push natural gas further down the merit order. EU natural gas consumption reached a record low (since 2000) consumption level in 2014 (414Bcm). Throughout this period, industrial gas consumption retained a relatively stable volume consumption.

The data presented in Figure 9 was constructed using Eurostat data. For consistency, the industry sector definitions used in the previous chapters were used here as well. The reporting units (ktoe) were converted to Mtoe and Bcm.

B. EU INDUSTRIAL GAS CONSUMPTION

Aside from being an important sector for EU gas consumption, industry is an overall important energy and non-energy consumer in the EU economy. The Sankey diagram below displays, in a simple manner, the energy and non-energy flows in EU industry (Figure 8).

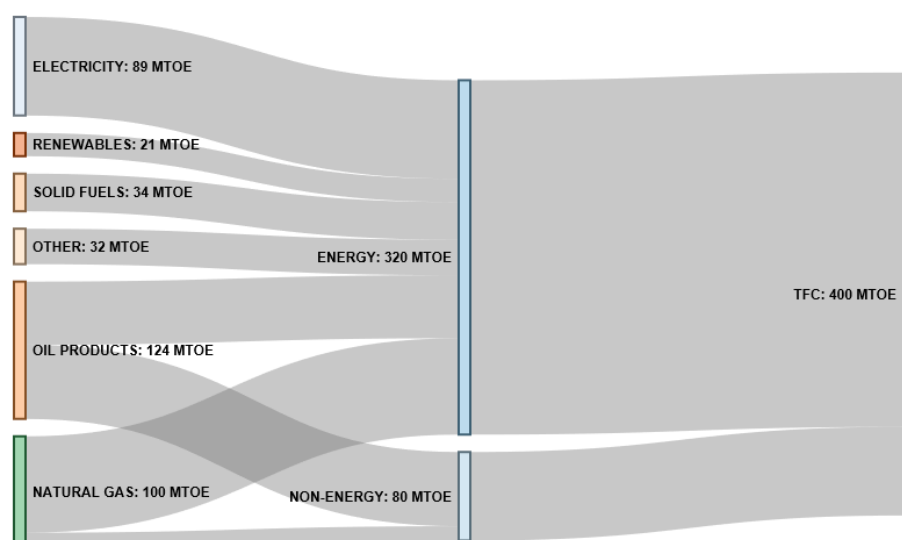


FIGURE 8 – SANKEY DIAGRAM DESCRIBING THE INDUSTRIAL ENERGY AND NON-ENERGY CONSUMPTION OF EU MANUFACTURING. SOURCE: EUROSTAT, CIEP.

The total final consumption (TFC) of energy and non-energy inputs by industry was 400Mtoe in 2015. The energy flow is the same as the breakdown by energy source, presented earlier in Figure 3. New in this diagram is the addition of the non-energy flow. About 80Mtoe of gas and oil products were used in 2015 as a feedstock source for industrial activities. Although relatively small, non-energy inputs represent a fifth of the EU industry inputs.

The 100Mtoe (or 120Bcm) of natural gas consumed in industry makes up a quarter of industry final consumption. The largest share of gas is transformed into energy (87%), and only a modest share is used as a non-energy input (13%). While the choice for natural gas as an energy source is conditioned by industrial process characteristics and the heat grade requirements, the choice for gas as a feedstock is much more specific. Because of its molecular composition, natural gas is the preferred choice for feedstock in the production of ammonia based fertilisers.

C. EU INDUSTRIAL GAS CONSUMPTION BY SECTOR

Similar to the graphs displaying EU industrial energy consumption, the following two graphs zoom into industrial gas consumption. As described in Figure 8, industrial gas consumption consists of an energy and non-energy component. In the following graphs, they are presented together.

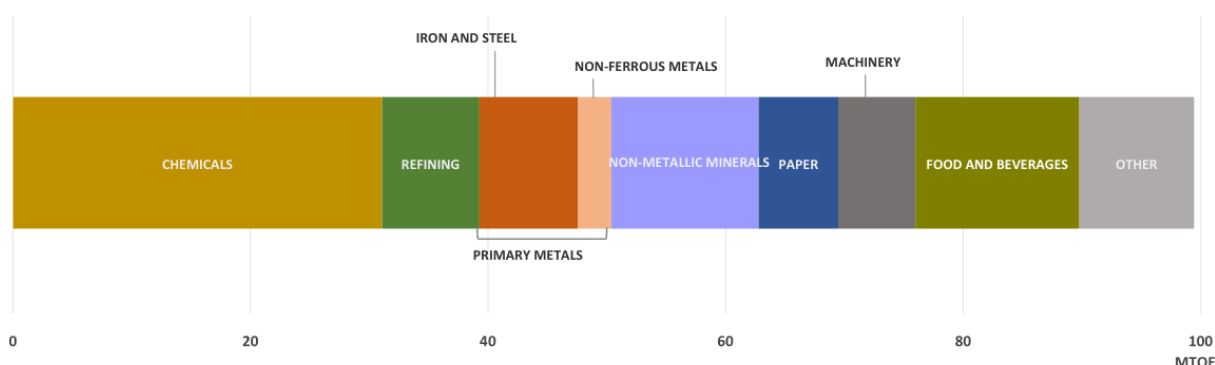


FIGURE 9 – EU INDUSTRIAL NATURAL GAS CONSUMPTION BY INDUSTRIAL SECTOR. SOURCE: EUROSTAT, CIEP.

Natural gas is used across all major EU industrial sectors (Figure 9). The largest gas volumes consumed in industry are used in the chemical sector (31Mtoe). About half of the gas volume consumption in the chemical sector is for feedstock purposes. Other gas-intensive sectors include primary metals (11Mtoe), non-metallic minerals (12Mtoe) and refining (8Mtoe), but their cumulative gas use is dwarfed by the gas volume consumption in chemical transformations.

The data underlying Figure 9 is sourced from 2015 Eurostat. The Eurostat database reports gas consumption figures by the NACE classification. For consistency purposes, the sector definitions used for Figure 9 are the same as the ones used for the EU industry map of euro production value and the figure of EU industrial energy consumption.

The display of EU industrial gas consumption by sector is relevant as it shows in which sectors the value proposition of gas is highest, and thus demand is more resilient. This is mostly in the energy and gas intensive industries which have high temperature requirements that are hard to replace due to economic and technical considerations. Moreover, the main industrial sectors to which gas caters are the ones that perform well on the EU trade balance. They are chemicals, machinery and food.

D. EU INDUSTRIAL GAS CONSUMPTION BY MEMBER STATE

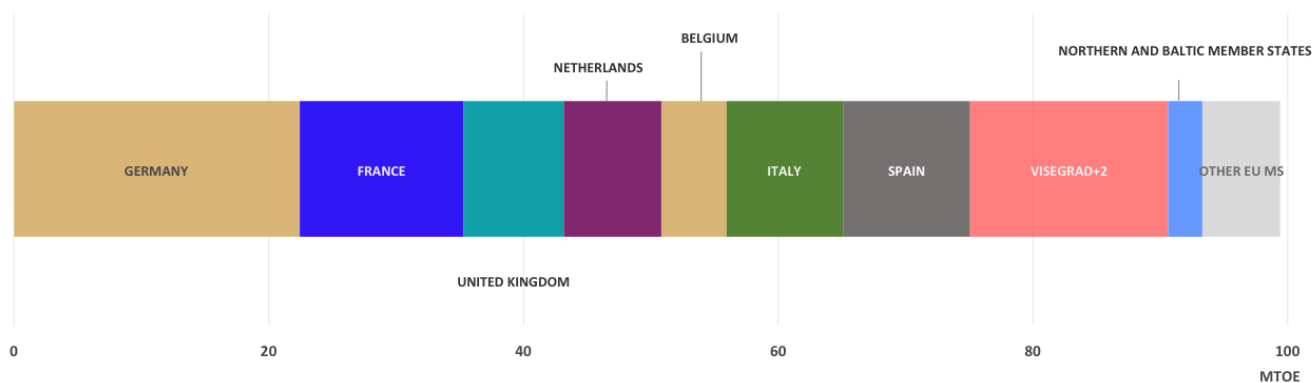


FIGURE 10 – EU INDUSTRIAL GAS CONSUMPTION BY MEMBER STATE. SOURCE: EUROSTAT, CIEP.

The map of EU industrial activity by euro production value demonstrates, among other things, that manufacturing is concentrated in a few Member States. This pairs with industrial gas consumption, of which 75% takes place in Germany, Italy, France, the United Kingdom, the Netherlands, Spain and Belgium. Eastern European Member states, such as the Visegrad+2 group, account for about 15% of the EU industrial gas consumption.

The data underlying Figure 10 has been extracted from the same Eurostat database as Figure 9.

The industrial production map of EU Member States presents the geographic distribution of industrial value creation by industrial sector. What comes out of Map 1 is that seven, geographically close, EU Member States account for nearly 80% of manufacturing euro production value, while consuming 70% of EU industrial energy, and 75% of EU industrial gas. Moreover, the Western European states benefit from a wide network of energy and feedstock infrastructure and have developed over time a powerful logistical foundation. It is safe to argue that this is the core of EU industrial energy and gas consumption.



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