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Energy prices and costs in Europe

{COM(2019) 1 final}

ANNEX 1 – SECTORIAL CASE STUDIES

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A1.1 INTRODUCTION

A1.1.1 Overview

This annex presents the main results on energy prices and costs for the following sectors: iron and steel, aluminium, brick and roof tiles, wall and floor tiles, glass tableware, packaging glass, nitrogen fertilisers and refineries. For each sectorial case study, it presents:

- General information on the main characteristics of the sector, the recent trends, how it performs on international markets and the sample composition;
- Electricity prices, costs and intensity of the sector;
- Natural gas prices, costs and intensity of the sector;
- Wherever relevant for the sector, prices, costs and intensity of other fuels including feedstocks;
- Competitiveness indicators of the sector (share of energy costs in production costs and ratio of energy costs to EBITDA).

Table 1 defines the main indicators analysed.

Table 1. Main indicators

Indicators	**Definition**
Statistics	
Simple average	It is the arithmetic mean of the sample, computed as the sum of the individual observations divided by the number of observations in the sample.
Weighted average[1]	It is the weighted arithmetic mean of the sample, computed as the sum of weights times individual observations divided by the sum of the weights. A specific weight is assigned to each individual observation in the sample.
Median	It is the middle value of the sample, which separates the lower half from the higher half of the sample, when the observations are arranged in ascending order.
Electricity indicators	
Electricity price	It is the electricity unit price (in EUR/MWh), computed as total price paid to purchase electricity (net of recoverable taxes, such as VAT) divided by total amount of electricity purchased. Therefore, electricity price is net of any *ex ante* exemption, i.e. net of taxes and levies that are not paid by certain categories of energy intensive consumers. For instance, some energy intensive consumers do not pay RES levies or pay reduced rates for RES levies.
Components of the electricity price	They are classified in four groups: energy component, network costs (including costs of the capacity market), RES levies and other non-recoverable taxes/levies than RES levies.

[1] Note that the estimates for this statistical indicator are generally not reported in this annex but they are all available in the CEPS and Ecofys study.

Electricity costs	They are electricity unit costs measured in both EUR/MWh and EUR/tonne. Electricity costs in EUR/MWh are computed as follows: [Total price paid to purchase electricity – reimbursement – payment for flexibility schemes + total costs for self-generated electricity – revenues from self-generated electricity sold to the grid + taxes on self-generation] / [Total electricity purchased + total self-generated electricity – total self-generated electricity sold to the grid]. Electricity costs in EUR/tonne are computed by relying on the same formula but using as a denominator the total production output in tonnes.
Electricity intensity	It is the units of electricity used per unit of output produced (in MWh/tonne). Electricity intensity is computed as follows: [Total electricity purchased + total self-generated electricity – total self-generated electricity sold to the grid] / [Total production output].
Natural gas indicators	
Natural gas price	It is the natural gas unit price (in EUR/MWh), computed as total price paid to purchase natural gas (net of recoverable taxes, such as VAT) divided by total amount of natural gas purchased. Therefore, in principle, natural gas price is net of any *ex ante* exemption, i.e. net of taxes and levies that are not paid by certain categories of energy intensive consumers. However, based on desk research, *ex ante* exemptions seem to play a marginal role when it comes to natural gas prices.
Components of the natural gas price	They are classified in three groups: energy component, network costs and (other) non-recoverable taxes/levies (note that there are no RES levies for natural gas).
Natural gas costs	They are natural gas unit costs measured in EUR/tonne. Natural gas costs are computed as follows: [Total price paid to purchase natural gas – payment for flexibility schemes] / [Total production output]. Natural gas costs in EUR/MWh are not shown here, as payment for flexibility schemes are mostly irrelevant for natural gas and no significant difference between natural gas prices in EUR/MWh and natural gas costs in EUR/MWh was detected.
Natural gas intensity	It is the units of natural gas used per unit of output produced. Natural gas intensity is computed as follows: [Total natural gas purchased] / [Total production output].
Indicators for other fuels including feedstocks	
Total gas costs	They are total gas unit costs measured in EUR/tonne. Total gas costs are computed as follows: [Total price paid to purchase natural gas

	– payment for flexibility schemes + total costs for self-produced gas – revenues from self-produced gas sold to the grid + taxes on self-generation] / [Total production output].
Total gas intensity	It is the units of total gas (including natural gas and other gases) used per unit of output produced (in MWh/tonne). Total gas intensity is computed as follows: [Total natural gas purchased + total self-produced gas – self-produced gas sold to the grid] / [Total production output].
Price of other fuels including feedstocks (e.g. crude oil, fuel oil, petroleum coke)	It is the unit price of other fuels including feedstocks (in EUR/MWh), computed as total price paid to purchase other fuels including feedstocks divided by total amount of other fuels purchased including feedstocks.
Costs of other fuels including feedstocks (e.g. crude oil, fuel oil, petroleum coke)	They are the unit costs of other fuels including feedstocks measured in EUR/tonne. The costs of other fuels including feedstocks are computed as follows: [Total price paid to purchase other fuels including feedstocks] / [Total production output].
Intensity of other fuels including feedstocks (e.g. crude oil, fuel oil, petroleum coke)	It is the units of other fuels including feedstocks used per unit of output produced (in MWh/tonne). The intensity of other fuels including feedstocks is computed as follows: [Total other fuels purchased including feedstocks] / [Total production output].
Competitiveness indicators	
Total energy costs	It is the sum of electricity and natural gas unit costs measured in EUR/tonne. In the case of refineries, the costs of other fuels including feedstocks (crude oil, fuel oil, petroleum coke and refinery gases) are also included in the sum. Note that the costs of coking coal and coke (mainly relevant for iron and steel) are not included in total energy costs.
Share of electricity costs in total production costs	It is the ratio of electricity costs over total production costs (in %). Total production costs include all the costs (both OPEX, annual depreciation and amortisation of CAPEX, and other costs) borne by the plant and directly relating to the production process, while non-operating (e.g. interest expenses) and extraordinary cost items are not included.
Share of natural gas costs in total production costs	It is the ratio of natural gas costs over total production costs (in %). Total production costs include all the costs (both OPEX, annual depreciation and amortisation of CAPEX, and other costs) borne by the plant and directly relating to the production process, while non-operating (e.g. interest expenses) and extraordinary cost items are not included.

Share of costs of other fuels including feedstocks (e.g. crude oil, fuel oil, petroleum coke, refinery gases) in total production costs	It is the ratio of the costs of other fuels including feedstocks over total production costs (in %). Total production costs include all the costs (both OPEX, annual depreciation and amortisation of CAPEX, and other costs) borne by the plant and directly relating to the production process, while non-operating (e.g. interest expenses) and extraordinary cost items are not included.
Share of total energy costs in total production costs	It is the ratio of total energy costs over total production costs (in %). Total production costs include all the costs (both OPEX, annual depreciation and amortisation of CAPEX, and other costs) borne by the plant and directly relating to the production process, while non-operating (e.g. interest expenses) and extraordinary cost items are not included.
EBITDA (Earnings before interest, taxes, depreciation and amortisation)	They represent the earning per unit of output produced after paying costs for production inputs and labour costs.
Ratio of total energy costs to EBITDA	It is the ratio of total energy costs over EBITDA. If EBITDA is positive (normal case), the opposite of this ratio can be seen as the "elasticity" of EBITDA to total energy costs, i.e. the potential effect of 1% increase in total energy costs on EBITDA in %, all else being equal (note the potential effect is negative, i.e. a 1% increase in total energy costs leads to a decrease in EBITDA).

A1.1.2 Methodology of the analysis

Each sectorial case study relies on a bottom-up approach with plant level data collected through a questionnaire on a sample of 'typical' plants/companies, which reflect the average features of EU plants operating in the sector under consideration[2]. The samples include plants from as many Member States as possible to ensure broad geographical coverage. In order to respect confidentiality, sectorial data cannot be presented at Member State level but are aggregated at EU and, where possible, regional level with the following regions:

- North-Western Europe (NWE): Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Luxembourg, the Netherlands, Sweden, the UK;
- Southern Europe (SE): Cyprus, Greece, Italy, Malta, Portugal, Spain;
- Central-Eastern Europe (CEE): Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovak Republic, Slovenia.

The time span of the analysis goes from 2008 to 2017[3]. A full time series of indicators was collected for the following sectors: fertilisers, glass tableware and packaging glass. For the other sectors (steel, aluminium, bricks and roof tiles, wall and floor tiles and refineries), data were collected for 2016 and

[2] The construction of a 'statistically representative' plant sample per sector was not feasible due to the constraints of the study. Instead, a sample of typical plants with a broad geographical coverage and which represents at least 10% of the sectoral turnover or production capacity was built for each sector. Result findings were further cross-checked through stakeholder consultation and secondary data validation.

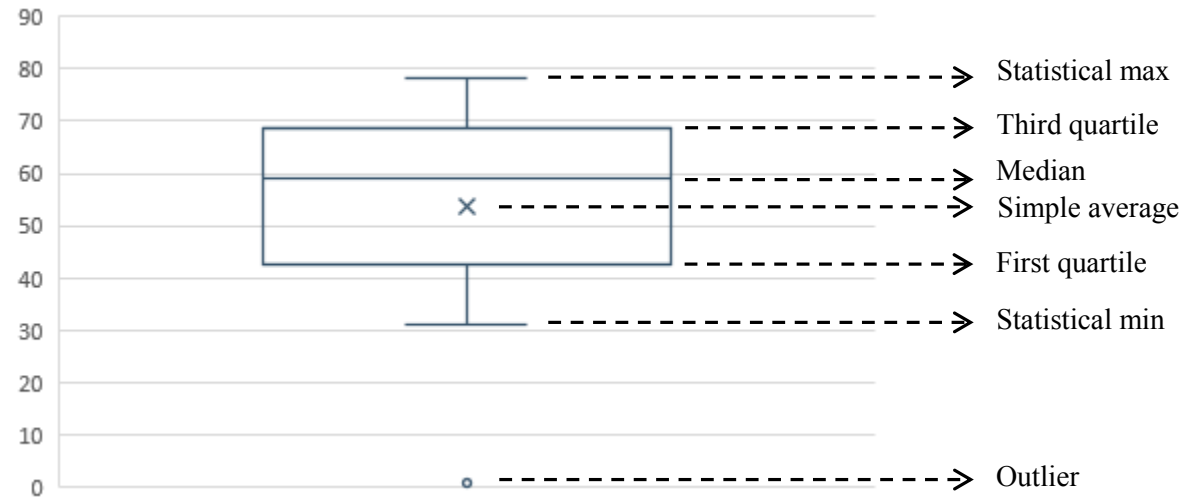
[3] For a given year, in a given sector, it may happen that data cannot be showed for confidentiality reasons.

2017 only while time series were completed by data available from the previous edition of the study[4]. In the latter case, the composition of the samples may differ for the 2008-2015 period compared to the 2016-2017 period.

We should always bear in mind that the sample includes only plants operating in the entire period under observation; results may therefore overestimate profitability indicators and underestimate production costs and energy costs, taking into consideration that between 2008 and 2017, a number of relatively less efficient plants and companies left the market.

The analysis presents both ranges and average values. Ranges are displayed via box plots, which show the statistical minimum, first quartile, median, third quartile, statistical maximum and, potentially, any outlier of the data set (Figure 1). The cross in each box represents the simple average (unweighted).

Figure 1. Example of box plot



To preserve confidentiality, averages are presented only when based on observations from at least three independent companies. Box plots are shown only when data are available from at least six plants belonging to three independent companies.

In addition to simple averages, weighted averages were also estimated but are not presented here. Unless specified, average values always refer to simple averages in the text, tables and figures below.

For full details on the methodology applied, including the composition of the samples, data collection and validation process, or the estimates of the weighted averages, we refer the reader to the report prepared by CEPS and Ecofys[5].

[4] CEPS et al. (2016). Composition and drivers of energy prices and costs: Case studies in selected energy-intensive industries.

[5] CEPS and Ecofys (2018). Study on composition and drivers of energy prices and costs: case studies in selected energy intensive industries – 2018.

A1.2 IRON AND STEEL

A1.2.1 General information and sample composition

Steelmaking covers all the processes required to transform raw materials into finished steel products and includes the activities from coke ovens, sinter and pellet plants, blast furnaces, steel furnaces and rolling and finishing mills. In terms of NACE Rev.2 classification, it includes sectors 24.1, 24.2, 24.31, 24.32, 24.51 and 24.52.

Steelmaking plants are usually classified into different groups:

- Integrated mills: these plants transform iron ore into sinter (sinter plant) or pellets (pellet plant) and coking coal into coke (coke ovens); sinter/pellets, coke and scrap are then transformed into steel through a blast furnace and basic oxygen furnace (BOF) and casted into semi-finished products, which are further processed in rolling and finishing facilities. All the production stages are generally performed on the same site. In the following, these plants are referred to as BOF plants.
- Minimills: these plants, much smaller than the integrated ones, recycle steel scrap in electric arc furnaces (EAF) to make steel. Semi-finished casting products are further processed in rolling and finishing facilities. In the following, these plants are referred to as EAF plants.
- Other steelworks: these steelmaking plants are based on other production route, such as smelting reduction (which avoids the coke making process of the integrated mills) or direct reduced iron (which is used as feedstock in EAF). These plants are, however, still marginal in Europe.
- Rolling and finishing mills: these plants only process casting products (ingots, slabs, billets or blooms) to transform them into finished steel products.

The analysis here focusses on EAF and BOF plants (other steelworks are marginal, while rolling and finishing plants are much less energy intensive). Electricity is the main energy source for EAF plants (around 10% of total production costs). In the case of BOF plants, main energy source is coking coal (or coke), but no reliable information could be gathered on this fuel. Electricity and natural gas are secondary fuels for BOF plants (their costs altogether represent on average less than 5% of total production costs).

The steel sector went through consolidation in the EU, where relatively few companies account for a large share of steel production. The sector is particularly characterised by high capital investments, high economies of scale and excess capacities (high entry and exit barriers). EU steel production has remained fairly stable since 2012 but is still far from the pre-crisis level. On average, BOF plants account for 60% of EU steel production whereas EAF plants account for 40%. Main EU producing countries (based on 2016 production value) include Germany (26%), Italy (14%), France (9%), Spain (8%), Poland (6%) and Belgium (5%).

Overall, the EU is a net importer of steel, importing in particular from Russia and China. Major EU export destinations include Turkey, closely followed by the United States.

In the EU there are 32 BOF plants and 170 EAF plants. A typical BOF plant has a capacity of 3.75 million tonnes/year whereas EAF plant capacity is around 0.5 million tonnes/year. The BOF sample includes 7 plants across Europe (three in CEE region and four in NWE region), representing around 26% of total EU BOF crude steel capacity (2016). The EAF sample includes 18 plants across Europe (three in CEE region, 13 in NWE region and two in SE region), representing around 14% of total EU EAF crude steel capacity (2016). The SE region is under-represented in both samples (no SE plant in the BOF sample).

BOF and EAF steelmaking plants differ greatly in terms of production technologies, regional distribution, capacities and energy consumption profiles and are therefore analysed separately in the following sections.

A1.2.2 BOF plants

A1.2.2.1 Electricity prices, costs and intensity

Key electricity indicators for BOF plants are presented in Table 2.

EU average electricity prices fluctuated in the range of 58-71 EUR/MWh between 2010 and 2017 (62 EUR/MWh in 2017). When looking at the EU average electricity price components (Figure 2), the energy component represented by far the highest share of the price, though this share decreased over time (85% in 2010 vs. 72% in 2017). Large consumers faced lower electricity prices (weighted average by purchased electricity is significantly below simple average) and actually paid less for all the price components, including energy but also network costs, RES levies and other non-recoverable taxes/levies.

EU average electricity costs in EUR/MWh (Figure 3) went down by 13% from 2010 (67 EUR/MWh) to 2017 (54 EUR/MWh). The difference between electricity price and electricity costs in EUR/MWh is mostly caused by plants producing self-generated electricity on site. EU average electricity costs in EUR/tonne (Figure 4) followed the same trend passing from 22 EUR/tonne in 2012 to 16 EUR/tonne in 2017. Better price conditions and economies of scale occurred for larger plants (weighted average – by production output – electricity costs are below simple average ones).

Electricity intensity of BOF plants (Figure 5) remained fairly stable between 2012 and 2017, around 0.35 MWh/tonne (the slight increase of the EU average is in fact mainly driven by a change in the sample). Larger plants were more electricity efficient than smaller ones (weighted average – by production output – electricity intensity is constantly below simple average one).

A1.2.2.2 Natural gas and total gas prices, costs and intensity

Key natural gas indicators for BOF plants are presented in Table 3.

EU average natural gas prices (Figure 6) show a clearly descending trend, which is quite visible from 2013 to 2016, when prices dropped by 37% from 30 to 17 EUR/MWh. In 2017, the average price was at 19 EUR/MWh. As shown in Figure 7, the natural gas price is made up mostly by the energy component (93% in 2017), the remaining coming from the network component (non-recoverable taxes/levies play here a very minor role). Overall, large consumers faced lower natural gas prices (weighted average by purchased natural gas is below simple average), though the differential compared to small consumers tends to be marginal in the most recent years. In fact, large consumers seem to pay less for the network component but not for the energy component.

EU average natural gas costs (in EUR/tonne) decreased by 27% from 2010 to 2017 (Figure 8). In 2017, the costs were at 6 EUR/tonne. Larger plants tend to bear lower unit costs (weighted average by production output is generally below simple average) due to lower natural gas prices and economies of scale.

EU average natural gas intensity (Figure 9) decreased from 2008 to 2012 but increased afterwards. Over the period, the average intensity decreased from 0.36 MWh/tonne in 2008 to 0.31 MWh/tonne in 2017. When including waste gas consumption, the EU average total gas intensity (Figure 10) also went down from 1.63 MWh/tonne in 2008 to 1.46 MWh/tonne in 2017. Unlike for electricity, it appears that larger plants do not seem to be more gas efficient than smaller ones.

A1.2.2.3 Competitiveness

Between 2008 and 2017, electricity and natural gas costs in BOF plants represented on average 3-4% and 1-2% of total production costs, respectively (Table 4). The share of electricity and natural gas costs altogether in production costs decreased from 5% in 2012 to 4% in 2017. However, it should be underlined that this energy share in production costs does not account for coking coal/coke which is the main energy source in BOF plants.

Between 2012 and 2017, EU average EBITDA per tonne (Figure 11) significantly increased from 1 to 34 EUR/tonne, while the costs of electricity and natural gas together went down from 28 to 23 EUR/tonne. It is not possible to draw firm conclusions on the impact of energy costs on profitability given the fact that coking coal/coke purchases are missing in these figures. Nevertheless, the opposite pattern of electricity and natural gas costs compared to EBITDA and the fact that these costs are higher than or in the same order of magnitude as, EBITDA shows the importance of electricity, natural gas and more generally energy costs and the potential direct impact they can have on margins of BOF steel production. The ratio of energy costs to EBITDA indicates that a 1 % reduction in electricity and natural gas costs would potentially lead, depending on the observation year (2012 excluded, as it is an atypical year), to around 0.7-3.3% increase in EBITDA.

A1.2.2.4 Tables and graphs

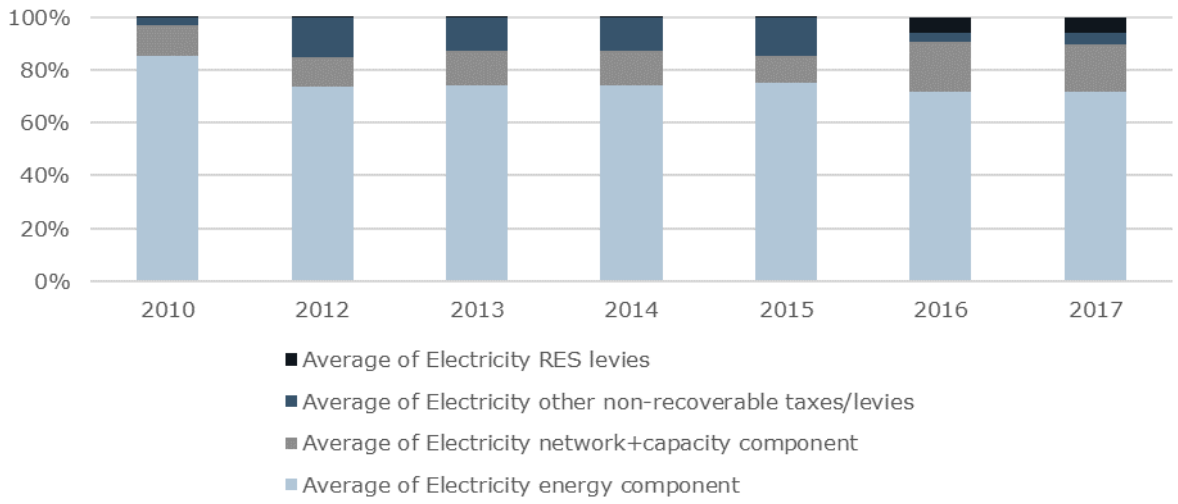
Electricity

Table 2. Key electricity indicators of BOF steel production (EU averages)

Indicator	2010	2011	2012	2013	2014	2016	2017
Electricity price (€/MWh)	64.0	57.5	70.6	62.7	59.5	57.6	62.4
Electricity costs (€/MWh)	62.6	92.2	73.7	64.8	64.0	52.1	54.3
Electricity costs (€/tonne)	n.a.	20.9	22.0	20.6	18.9	15.2	16.4
Electricity intensity (MWh/tonne)	n.a.	0.29	0.35	0.36	0.35	0.34	0.37

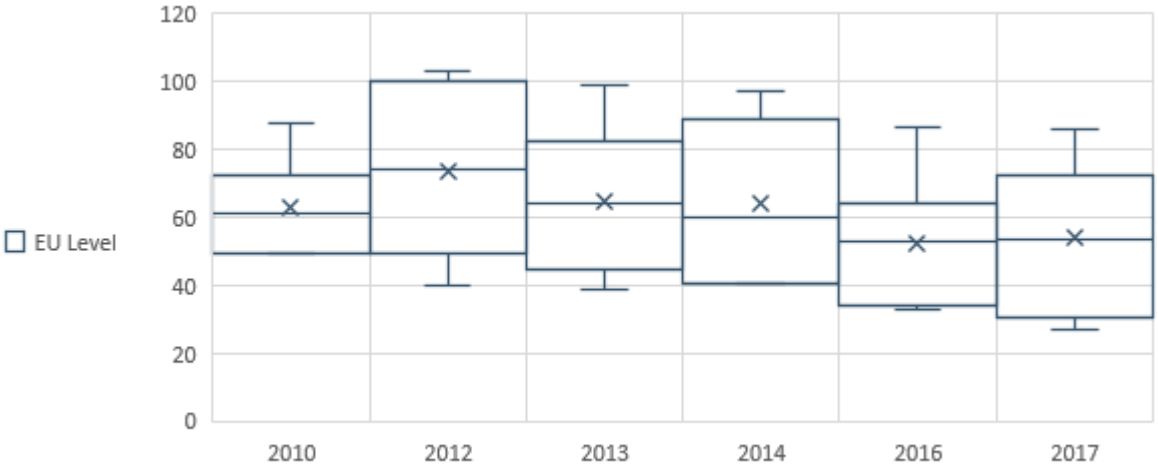
Source: CEPS/Ecofys.

Figure 2. Components of the EU average electricity price for BOF steel production (%)



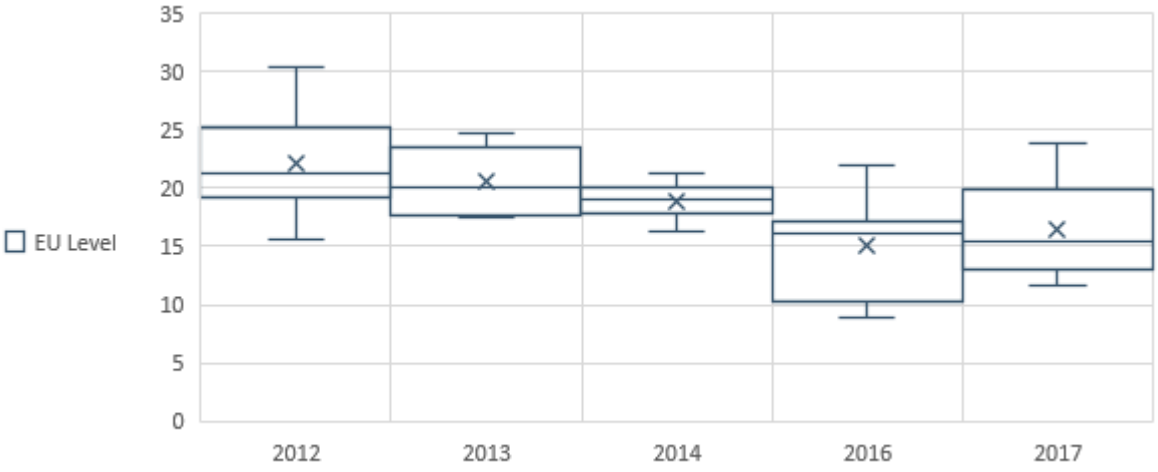
Source: CEPS/Ecofys.

Figure 3. Electricity costs of BOF steel production (€/MWh)



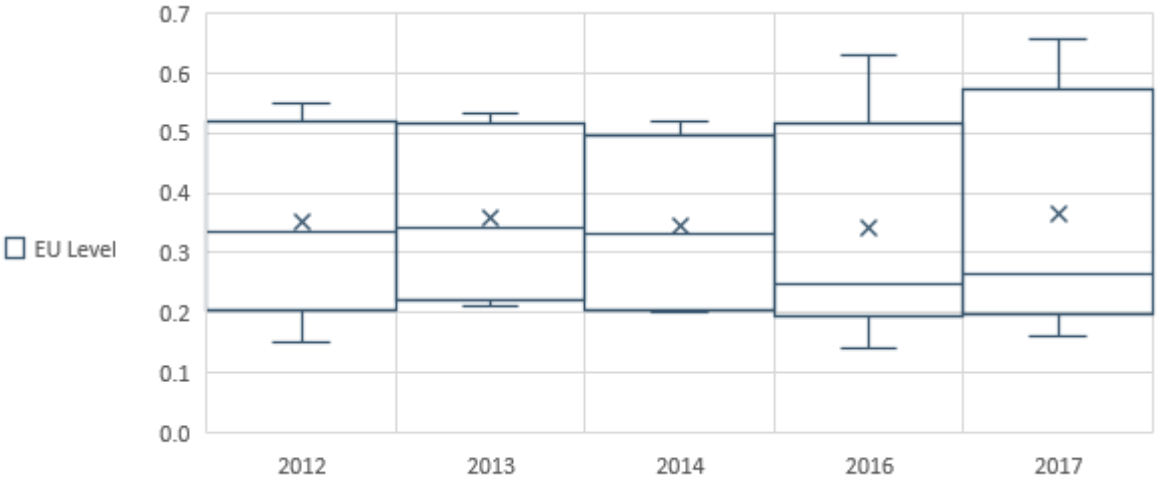
Source: CEPS/Ecofys.

Figure 4. Electricity costs of BOF steel production (€/tonne)



Source: CEPS/Ecofys.

Figure 5. Electricity intensity of BOF steel production (MWh/tonne)



Source: CEPS/Ecofys.

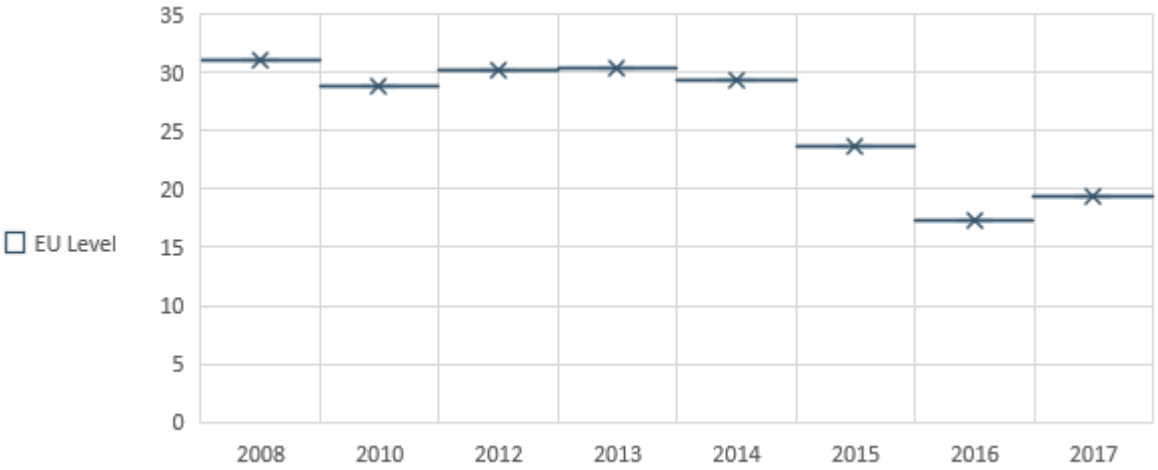
Natural gas

Table 3. Key natural gas indicators of BOF steel production (EU averages)

Indicator	2008	2010	2012	2013	2014	2015	2016	2017
Natural gas price (€/MWh)	31.1	28.9	30.3	30.4	29.3	23.6	17.2	19.3
Natural gas costs (€/tonne)	n.a.	8.8	6.4	7.5	7.0	6.7	5.1	6.4
Natural gas intensity (MWh/tonne)	0.36	0.32	0.22	0.25	0.25	0.29	0.27	0.31
Total gas intensity (MWh/tonne)	1.63	1.35	1.07	1.27	1.05	1.04	1.38	1.46

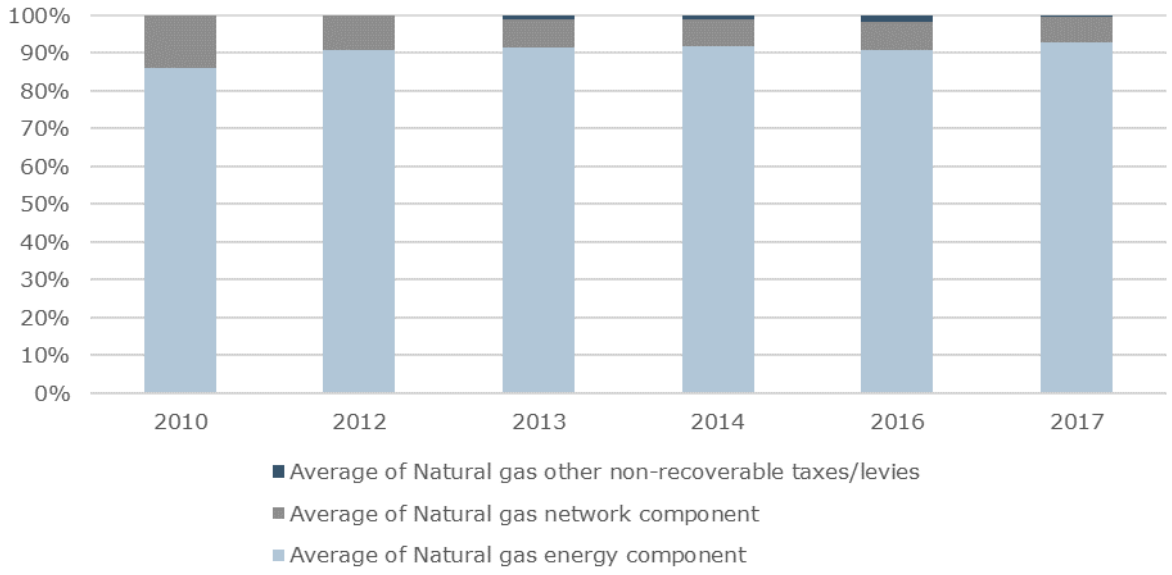
Source: CEPS/Ecofys.

Figure 6. Natural gas prices of BOF steel production (€/MWh)



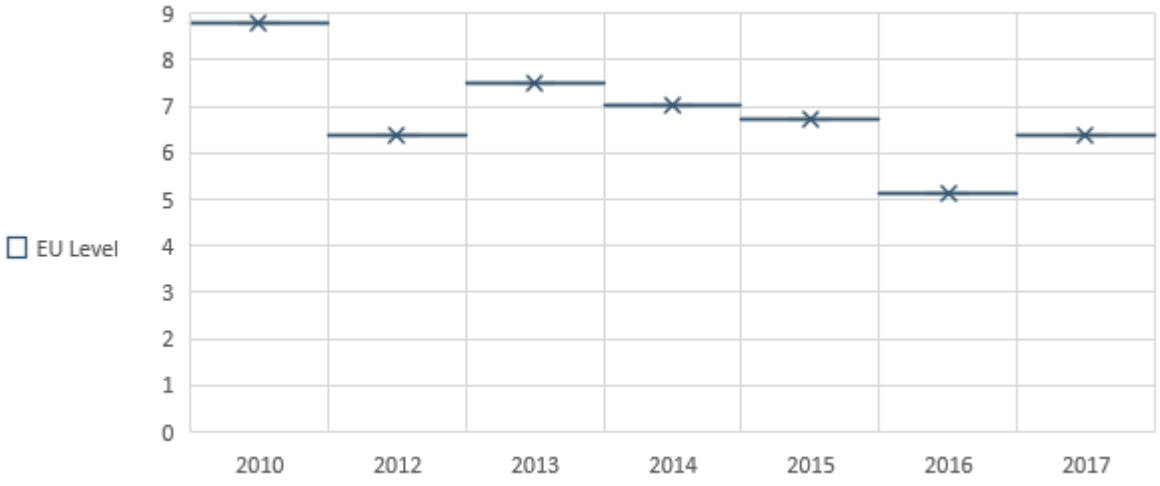
Source: CEPS/Ecofys.

Figure 7. Components of the EU average natural gas price for BOF steel production (%)



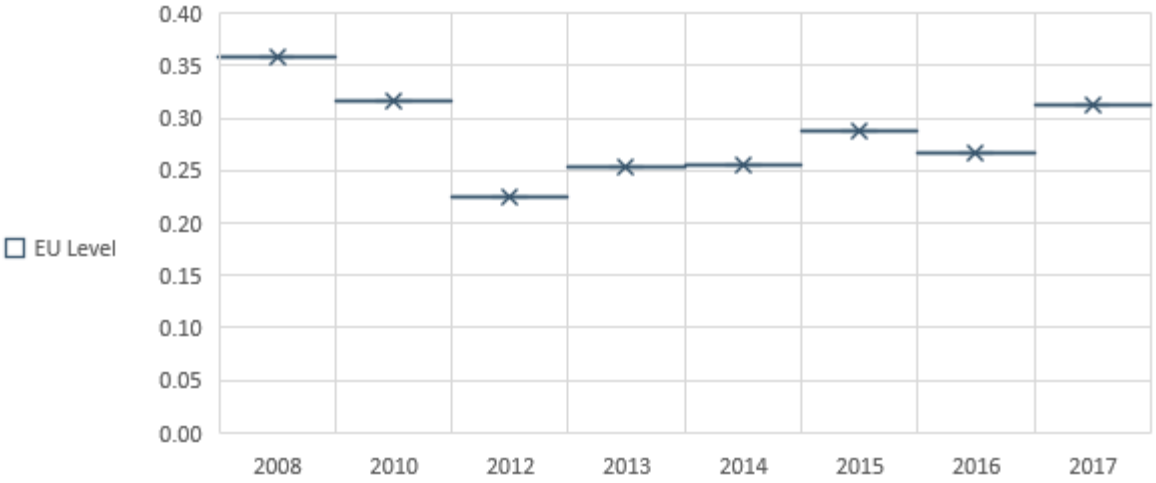
Source: CEPS/Ecofys.

Figure 8. Natural gas costs of BOF steel production (€/tonne)



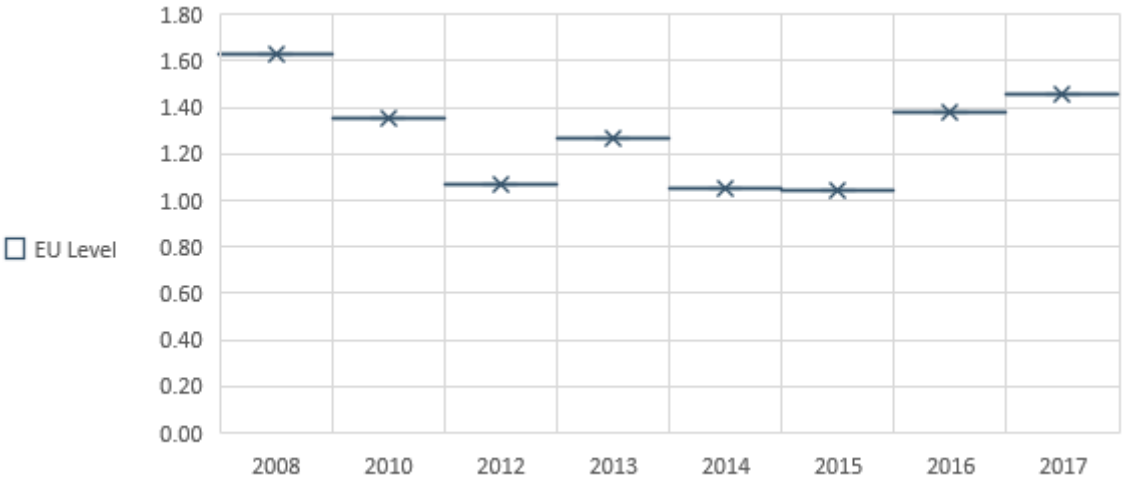
Source: CEPS/Ecofys.

Figure 9. Natural gas intensity of BOF steel production (MWh/tonne)



Source: CEPS/Ecofys.

Figure 10. Total gas intensity of BOF steel production (MWh/tonne)



Source: CEPS/Ecofys.

Competitiveness

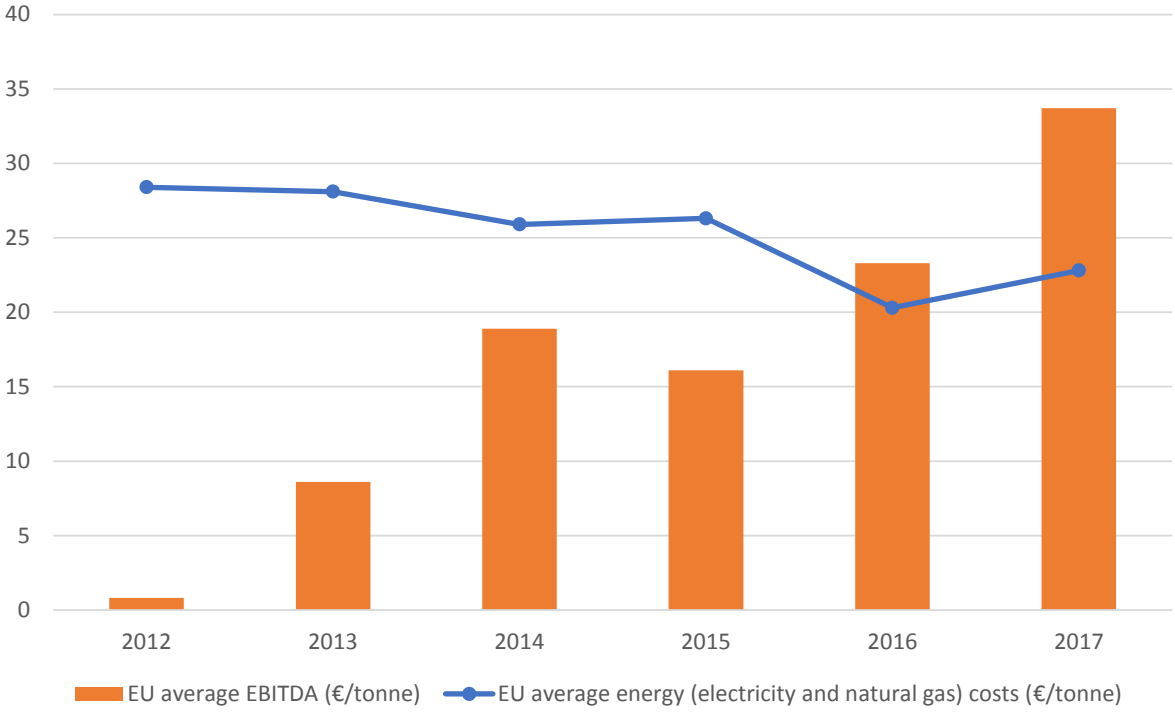
Table 4. Key competitiveness indicators of BOF steel production (EU averages)

Indicator	2012	2013	2014	2015	2016	2017
Share of electricity costs in production costs (%)	4.3	4.3	4.5	4.2	3.3	3.1
Share of natural gas costs in production costs (%)	1.2	1.6	1.7	1.4	1.1	1.2
Share of energy costs* in total production costs (%)	5.5	5.9	6.2	5.6	4.4	4.3
Energy costs* (€/tonne)	28.4	28.1	25.9	26.3	20.3	22.8
EBITDA (€/tonne)	0.8	8.6	18.9	16.1	23.3	33.7
Ratio of energy costs* to EBITDA	35.5	3.3	1.4	1.6	0.9	0.7

* Energy costs include the costs of electricity and natural gas but not the costs of coking coal and coke.

Source: CEPS/Ecofys.

Figure 11. Energy costs versus EBITDA of BOF steel production (€/tonne)



Source: CEPS/Ecofys.

A1.2.3 EAF plants

A1.2.3.1 Electricity prices, costs and intensity

Key electricity indicators for EAF plants are presented in Table 5.

The electricity prices and costs in EUR/MWh remained fairly stable between 2008 and 2013 but dropped afterwards.

EU average electricity prices decreased overall by around 13% over the period (61 EUR/MWh in 2008 vs. 53 EUR/MWh in 2017). When looking at the EU average electricity price components (Figure 12), the energy component still represents the main price component but has declined over time (from 86% in 2008 to 76% in 2017). In contrast, RES levies and other non-recoverable taxes/levies significantly increased over the period, both in relative and absolute terms. They represented altogether nearly 10% of the electricity price in 2016-2017 (compared to 2% in 2008). Larger consumers faced lower electricity prices (weighted average by purchased electricity is below simple average) and actually paid less for all the price components, including energy but also network costs, RES levies and other non-recoverable taxes/levies.

EU average electricity costs in EUR/MWh (Figure 13) went down from 61 EUR/MWh in 2008 to 50 EUR/MWh in 2017. The slight difference between electricity price and costs in EUR/MWh is caused by plants that received ex post reimbursements and compensations from an interruptibility scheme. It is interesting to note that on average EAF plants show slightly lower electricity costs (better deals) than BOF plants (e.g. 50 vs. 54 EUR/MWh in 2017, respectively), while in absolute terms their electricity consumption is less than half (around 330 GWh for an EAF compared to 820 GWh for a BOF plant based on 2016 median figures).

EU average electricity costs in EUR/tonne (Figure 14) followed the same trend as electricity costs in EUR/MWh and went downwards from 34 EUR/tonne in 2008 to 26 EUR/tonne in 2017 in EAF plants. Larger plants benefitted from better price conditions and economies of scale (weighted average – by production output – electricity costs are below simple average ones).

EU average electricity intensity of EAF plants (Figure 15) was around 0.55 MWh/tonne over the period (we can see a slight decrease over time from 0.56 MWh/tonne in 2008 to 0.53 MWh/tonne in 2017). Larger plants were more electricity efficient than smaller ones (weighted average – by production output – electricity efficiency is constantly below simple average one).

A1.2.3.2 Natural gas prices, costs and intensity

Key natural gas indicators for EAF plants are presented in Table 6.

EU average natural gas prices (Figure 16) dropped from 2008 to 2010, increased from 2010 to 2012 and then significantly decreased from 2012 to 2017. This is in line with international natural gas market price developments. The prices were at 26 EUR/MWh in 2008 and 20 EUR/MWh in 2017. As shown in Figure 17, the natural gas price is made up mostly by the energy component (86% in 2017), the remaining coming from the network component (non-recoverable taxes/levies play here a very minor role). Overall, large consumers faced lower natural gas prices (weighted average by purchased natural gas is generally below simple average). In fact, large consumers do not necessarily pay less for the energy component but do pay relatively less for the network costs and non-recoverable taxes/levies. Unlike for electricity, on average EAF plants faced since 2012 slightly higher gas prices than BOF plants (e.g. 20 vs. 19 EUR/MWh in 2017, respectively).

EU average natural gas costs (in EUR/tonne) were volatile throughout the 2008-2017 period (Figure 18). Overall, they still decreased by around 15% (9 EUR/tonne in 2008 vs. 8 EUR/tonne in 2017). Larger plants tend to bear lower unit costs due to lower natural gas prices and economies of scale (weighted average – by production output – natural gas costs are generally below simple average ones).

EU average natural gas intensity (Figure 19) remained fairly stable throughout the period, with a 2–3% overall decrease between 2008 (0.39 MWh/tonne) and 2017 (0.38 MWh/tonne). Larger plants are more natural gas efficient than smaller ones (weighted average by production output is below simple average).

A1.2.3.3 Competitiveness

As shown in Table 7, over the period, electricity and natural gas costs per tonne made up around 10% and 3% of total production costs per tonne, respectively. Overall, the share of total energy (electricity + natural gas) costs in production costs ranged around 12-13%.

EU average EBITDA per tonne (Figure 20) underwent a 63% decrease from 2008 to 2010. Since then, it has remained fairly stable at around 13-17 EUR/tonne. Larger plants showed higher margins (weighted average by production output is generally higher than simple average). The fact that total energy costs are higher than EBITDA shows the importance of electricity and natural gas costs and the potential direct impact they can have on margins of EAF steel production. The ratio of total energy costs to EBITDA indicates that a 1 % reduction in total energy costs would potentially lead, depending on the observation year (2008 excluded, as it is an atypical year), to around 2.4-2.9% increase in EBITDA. Nevertheless, we can also observe that despite lower total energy costs over time, EBITDA did not improve, which means that other major divers than electricity and natural gas costs play a role in EAF profitability as well.

A1.2.3.4 Tables and graphs

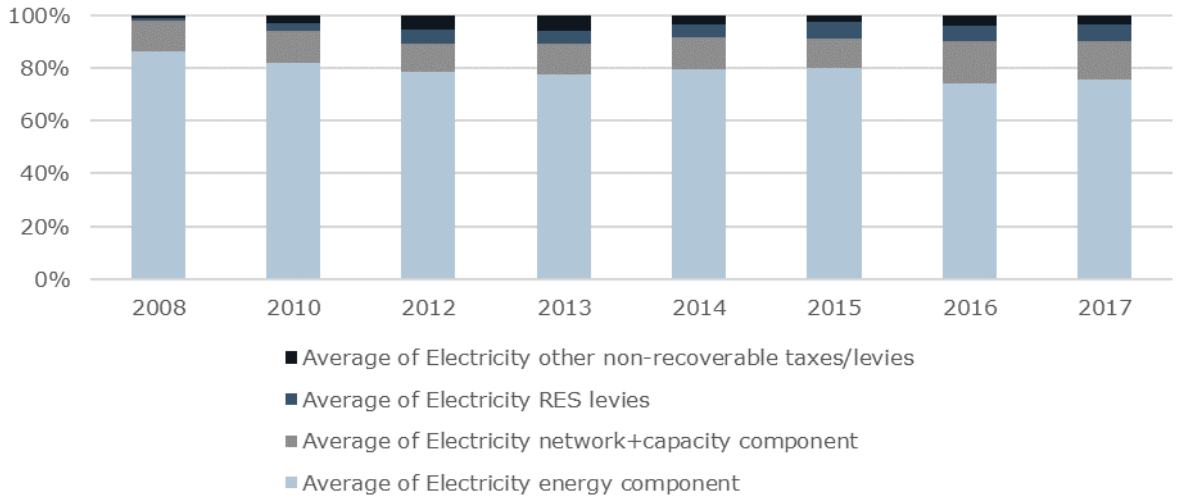
Electricity

Table 5. Key electricity indicators of EAF steel production (EU averages)

Indicator	2008	2010	2012	2013	2014	2015	2016	2017
Electricity price (€/MWh)	61.4	58.7	61.5	63.8	58.7	57.9	53.7	53.2
Electricity costs (€/MWh)	61.3	58.4	61.1	63.5	58.4	56.1	50.6	50.1
Electricity costs (€/tonne)	34.1	32.4	33.8	34.3	29.8	30.9	25.8	25.9
Electricity intensity (MWh/tonne)	0.56	0.55	0.57	0.55	0.53	0.56	0.51	0.53

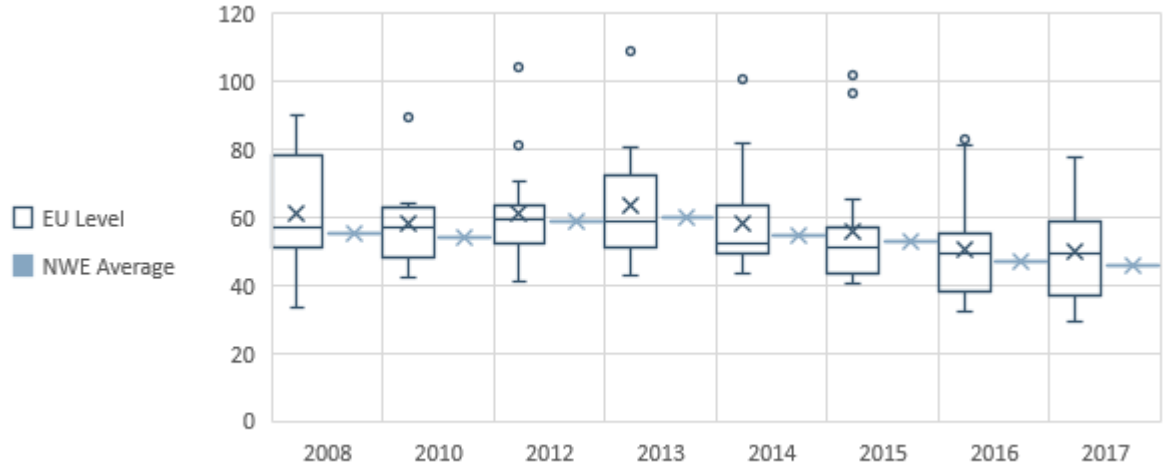
Source: CEPS/Ecofys.

Figure 12. Components of the EU average electricity price for EAF steel production (%)



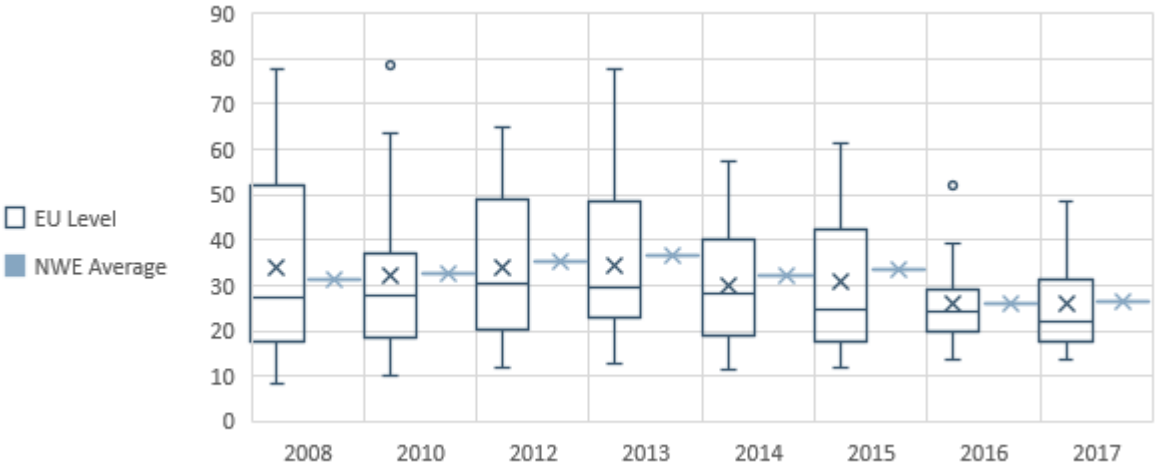
Source: CEPS/Ecofys.

Figure 13. Electricity costs of EAF steel production (€/MWh)



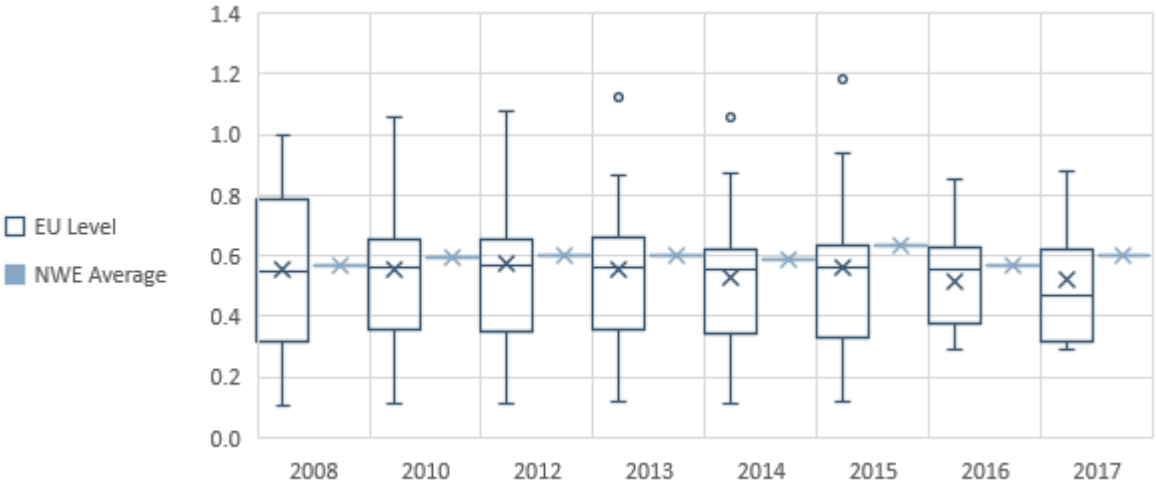
Source: CEPS/Ecofys.

Figure 14. Electricity costs of EAF steel production (€/tonne)



Source: CEPS/Ecofys.

Figure 15. Electricity intensity of EAF steel production (MWh/tonne)



Source: CEPS/Ecofys.

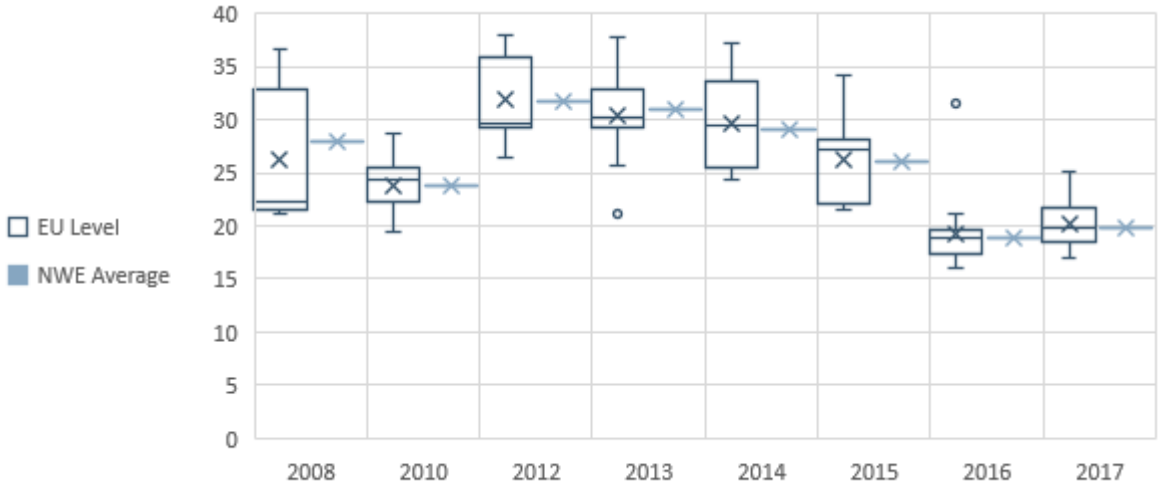
Natural gas

Table 6. Key natural gas indicators of EAF steel production (EU averages)

Indicator	2008	2010	2012	2013	2014	2015	2016	2017
Natural gas price (€/MWh)	26.3	23.9	31.8	30.4	29.6	26.3	19.2	20.2
Natural gas costs (€/tonne)	8.9	8.7	10.8	9.3	8.8	9.3	6.6	7.6
Natural gas intensity (MWh/tonne)	0.39	0.36	0.34	0.32	0.31	0.37	0.35	0.38

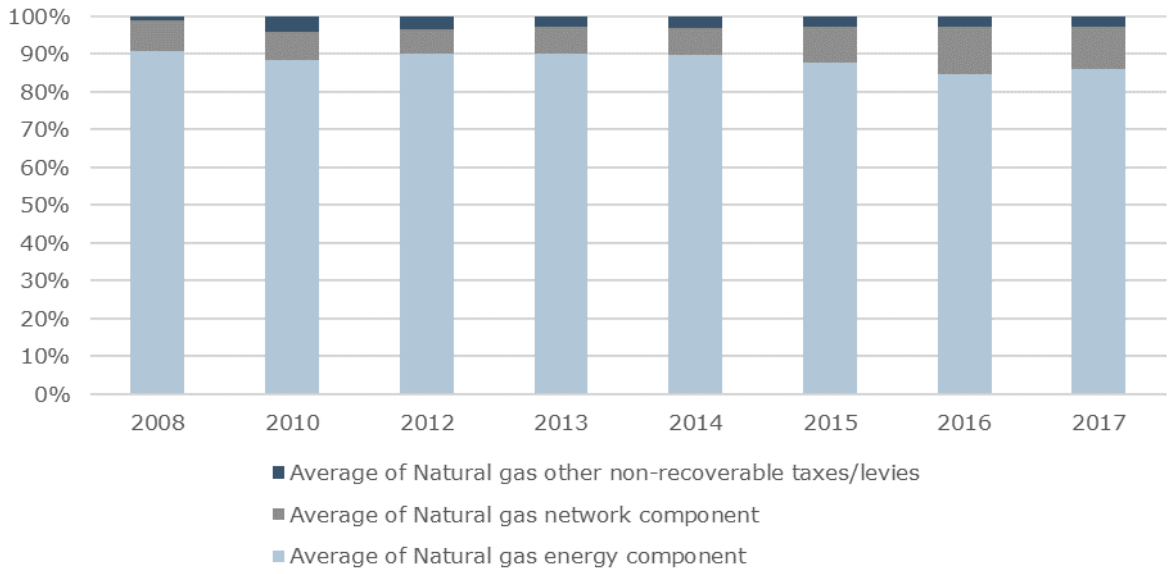
Source: CEPS/Ecofys.

Figure 16. Natural gas prices of EAF steel production (€/MWh)



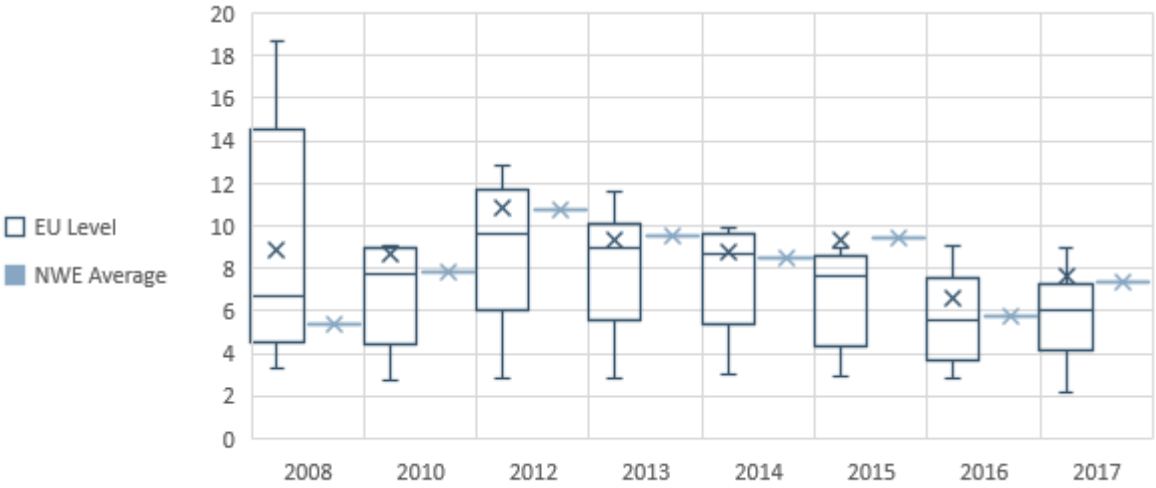
Source: CEPS/Ecofys.

Figure 17. Components of the EU average natural gas price for EAF steel production (%)



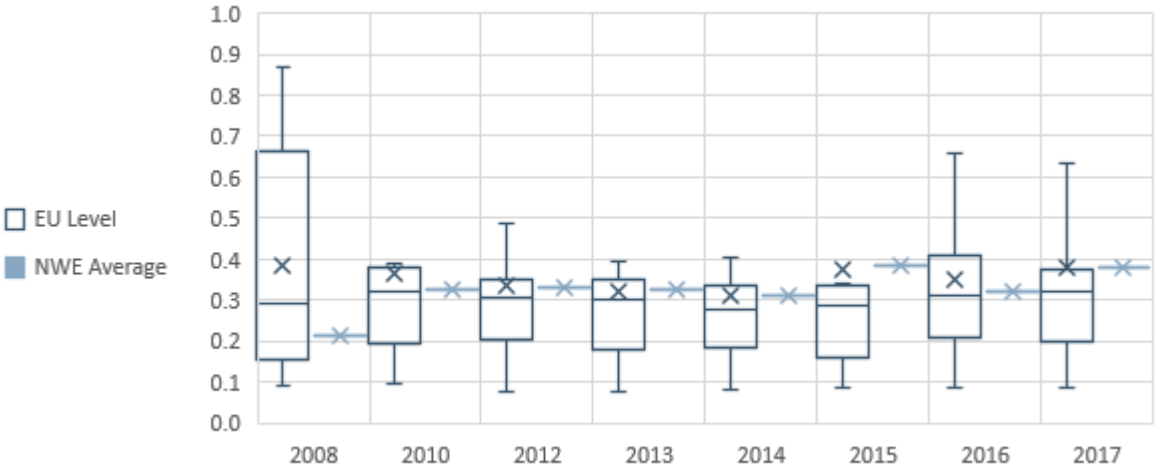
Source: CEPS/Ecofys.

Figure 18. Natural gas costs of EAF steel production (€/tonne)



Source: CEPS/Ecofys.

Figure 19. Natural gas intensity of EAF steel production (MWh/tonne)



Source: CEPS/Ecofys.

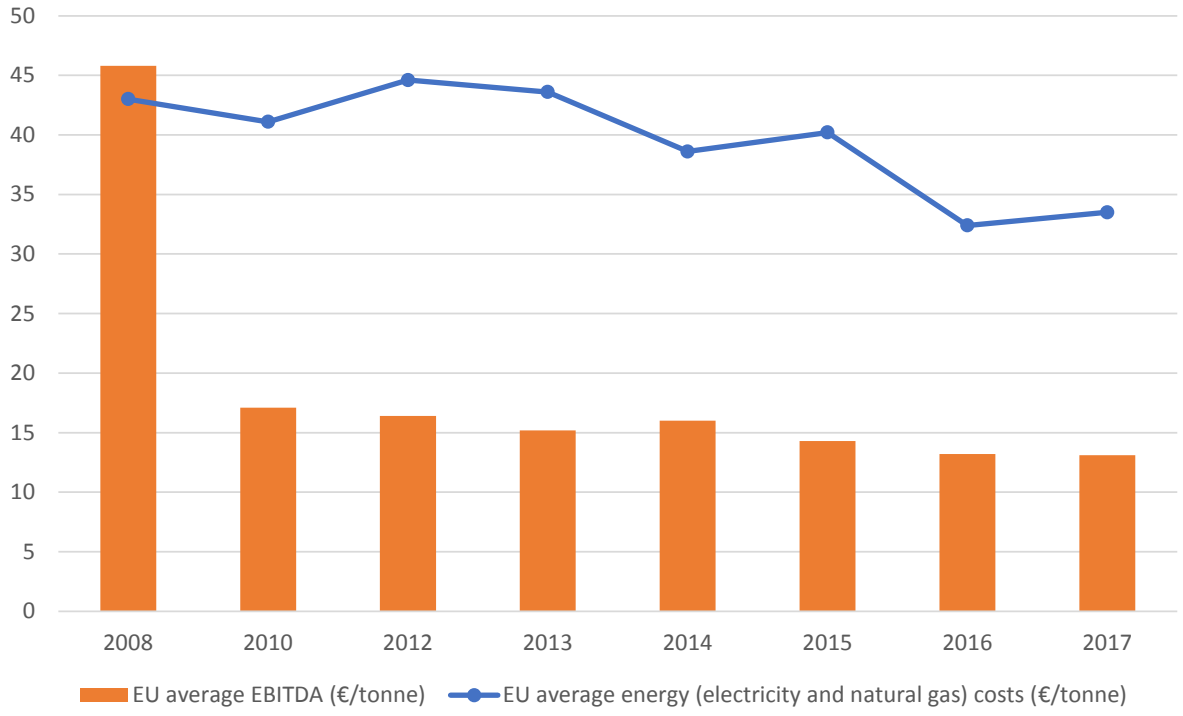
Competitiveness

Table 7. Key competitiveness indicators of EAF steel production (EU averages)

Indicator	2008	2010	2012	2013	2014	2015	2016	2017
Share of electricity costs in production costs (%)	9.0	9.8	9.8	10.7	10.2	11.8	9.8	9.6
Share of natural gas costs in production costs (%)	2.4	2.6	3.2	2.9	3.0	3.6	2.5	2.8
Share of total energy costs in total production costs (%)	11.4	12.5	13.0	13.6	13.2	15.4	12.3	12.4
Total energy costs (€/tonne)	43.0	41.1	44.6	43.6	38.6	40.2	32.4	33.5
EBITDA (€/tonne)	45.8	17.1	16.4	15.2	16.0	14.3	13.2	13.1
Ratio of total energy costs to EBITDA	0.9	2.4	2.7	2.9	2.4	2.8	2.5	2.6

Source: CEPS/Ecofys.

Figure 20. Energy costs versus EBITDA of EAF steel production (€/tonne)



Source: CEPS/Ecofys.

A1.3 ALUMINIUM

A1.3.1 General information and sample composition

The aluminium sector (sector 24.42 in NACE Rev. 2) includes primary and secondary aluminium production as well as semi-manufactured aluminium products.

Aluminium producers are usually classified into different groups, including:

- Primary aluminium smelters: these integrated plants smelt alumina into primary aluminium and then cast it into ingots. The smelting process requires three main inputs: alumina, electricity and carbon (in the form of anodes). In the following, these plants are referred to as primary aluminium plants.
- Aluminium refiners: these plants produce secondary aluminium by recycling very different types of aluminium scraps while tolerating a relatively high level of impurity (up to 15%). In the following, these plants are part of secondary aluminium plants.
- Aluminium remelters: these plants produce secondary aluminium by recycling relatively pure (2-3% maximum impurity tolerance) aluminium scraps (mostly industrial scraps). In the following, these plants are included in secondary aluminium plants as well.
- Rolling mills and extruders: these plants process and transform aluminium ingots into semi-finished or finished products. Rolling mills use hot, cold or foil rolling to produce different types of sheets, plates and foils. Extruders push through a die hot or cold aluminium alloys to make objects with a cross-sectional profile. In the following, these plants are referred to as downstream aluminium plants.

Note that further downstream plants, including casting and foil plants, are not part of the analysis.

Main energy source for primary and downstream aluminium production is electricity while secondary aluminium production uses both electricity and natural gas. Downstream aluminium production uses natural gas as a secondary energy source.

The aluminium sector went through a restructuration in Europe with some plant closures in the last decade. Primary and secondary production did not recover from the crisis. Since 2012, primary production has remained fairly stable while secondary production has increased, but both are still far from pre-crisis production levels. In 2015, primary and secondary aluminium production covered 17% and 37% of EU aluminium needs, respectively, while the rest (46%) was imported. Based on 2017 capacity, main EU primary aluminium producing countries include Germany, Spain, France, Romania and Greece, while major EU secondary aluminium producing countries include France, Italy, Spain, the UK and Poland. As regards downstream aluminium plants, most important EU producing countries include Germany, Italy, Spain, France and the UK.

Overall, the EU is a net importer of aluminium, importing in particular from Norway and Russia. Major EU export destinations include Switzerland and the United States, followed by China.

In the EU there were in 2017 16 primary aluminium plants, 214 secondary aluminium plants including 101 refining plants and 113 remelting facilities, and 368 downstream aluminium plants including 59 rolling mills and 309 extruders. A typical primary aluminium plant in the analysis has an electricity intensity of 12.4-16.2 MWh/tonne. Typical secondary aluminium plants have an electricity intensity of 0.12-0.95 MWh/tonne and a natural gas intensity of 1.1-2.8 MWh/tonne. Typical downstream aluminium plants have an electricity intensity of 0.5-1.3 MWh/tonne and a natural gas intensity of 0.9-1.7 MWh/tonne. The sample includes ten primary aluminium plants (representing about 60% of total primary aluminium production), nine secondary aluminium plants and eight downstream aluminium plants (representing around 13% of downstream aluminium production) across the EU. Note that the representativeness of the secondary aluminium sample cannot be assessed due to data unavailability. For confidentiality reasons, only an analysis at EU level is performed for this sector.

Primary aluminium, secondary aluminium and downstream aluminium production differ greatly in terms of technologies, regional distribution, capacities and energy consumption profiles and are therefore analysed separately in the following sections.

A1.3.2 Primary aluminium plants

A1.3.2.1 Electricity prices, costs and intensity

Key electricity indicators for primary aluminium plants are presented in Table 8.

EU average electricity prices increased over the period (34 EUR/MWh in 2008 vs. 40 EUR/MWh in 2017) with two peaks in 2012 and 2015 (44 EUR/MWh for both years). As shown in Figure 21, the electricity price is made up mostly by the energy component (above 85% in all years). Larger plants tend to face lower electricity prices (weighted average by purchased electricity is generally below simple average) by negotiating better deals on the energy component, though the difference with smaller plants is limited. It should be noted that the majority of primary aluminium plants buy electricity on the wholesale electricity market.

EU average electricity costs in EUR/MWh (Figure 22) rose from 34 EUR/MWh in 2008 to 36 EUR/MWh in 2017. Almost all primary aluminium plants took part in a flexibility scheme and some of them can associate on-site generation or self-generation from small hydro turbines or solar PVs, which explains the small difference between electricity prices and costs in EUR/MWh. EU average electricity costs in EUR/tonne (Figure 23) followed the same trend as electricity costs in EUR/MWh and rose from 461 EUR/tonne in 2008 to 542 EUR/tonne in 2017.

EU average electricity intensity of primary aluminium plants (Figure 24) went upwards in the sample (13.8 MWh/tonne in 2008 vs 15.4 MWh/tonne in 2017), but this is an apparent increase as it is mainly due to sample composition change. This sample change and the associated electricity intensity increase also explain why we can observe a significantly larger increase in costs in EUR/tonne than in EUR/MWh (17% vs. 5%, respectively, between 2008 and 2017).

A1.3.2.2 Natural gas prices, costs and intensity

Key natural gas indicators for primary aluminium plants are presented in Table 9.

EU average natural gas prices (Figure 25) dropped from 2008 to 2010, increased from 2010 to 2012 and then significantly decreased from 2012 to 2017. The prices were at 27 EUR/MWh in 2008 and 20 EUR/MWh in 2017. It is interesting to note that larger consumers did not face lower natural gas prices.

EU average natural gas costs (in EUR/tonne) fluctuated over the period under observation between 17 and 26 EUR/tonne (Figure 26). There was a sharp decrease from 2014 due to a reduction in the natural gas wholesale price, and an increase in 2017. The average natural gas costs were 22 EUR/tonne in 2017. Larger consumers bore slightly lower unit costs (weighted average is marginally below simple average), reflecting some very small economies of scale.

EU average natural gas intensity for primary aluminium producers (Figure 27) was around 1 MWh/tonne between 2008 and 2017 (variation is mainly explained by sample composition change).

A1.3.2.3 Competitiveness

As shown in Table 10, over the period, the share of electricity costs in total production costs increased from 29% to 38% while the share of natural gas costs in total production costs remained relatively stable (between 1% and 2%). As a result, the share of total energy (electricity + natural gas) costs in production costs increased from 30% in 2008 to 40% in 2017.

EU average EBITDA per tonne (Figure 28) fluctuated between 131 and 350 EUR/tonne. The high volatility in unit EBITDA and energy costs makes difficult to draw any firm conclusion. Nevertheless, we observe overall that total energy costs per output went upwards whereas EBITDA per output tended to go in the opposite direction. The ratio of total energy costs to EBITDA indicates that a 1 % reduction in total energy costs would potentially lead to an increase in EBITDA of 1.4% to 4.4%

(depending on the observation year). In addition, the unit electricity costs are always higher than unit EBITDA. All this shows the extreme importance of energy costs for primary aluminium producers, in particular electricity costs, and the potential direct impact they can have on their margins.

A1.3.2.4 Tables and graphs

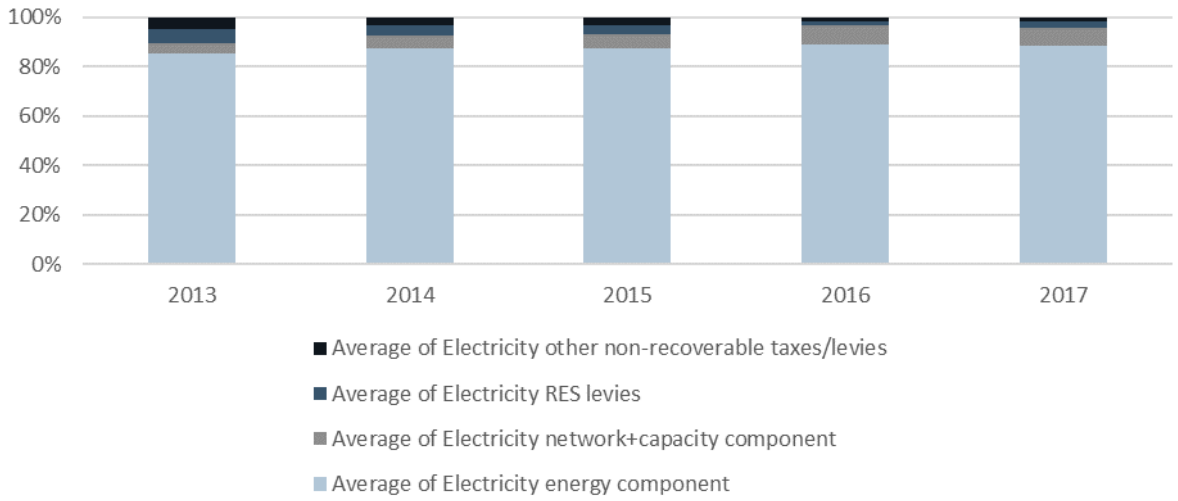
Electricity

Table 8. Key electricity indicators of primary aluminium production (EU averages)

Indicator	2008	2010	2012	2013	2014	2015	2016	2017
Electricity prices (€/MWh)	34.2	38.0	43.6	38.4	38.1	43.5	39.4	39.6
Electricity costs (€/MWh)	34.2	38.0	43.6	37.9	37.3	42.4	37.0	35.8
Electricity costs (€/tonne)	461.3	496.6	609.6	554.1	536.4	587.6	544.1	541.9
Electricity intensity (MWh/tonne)	13.8	14.1	14.0	14.4	14.2	14.3	14.7	15.4

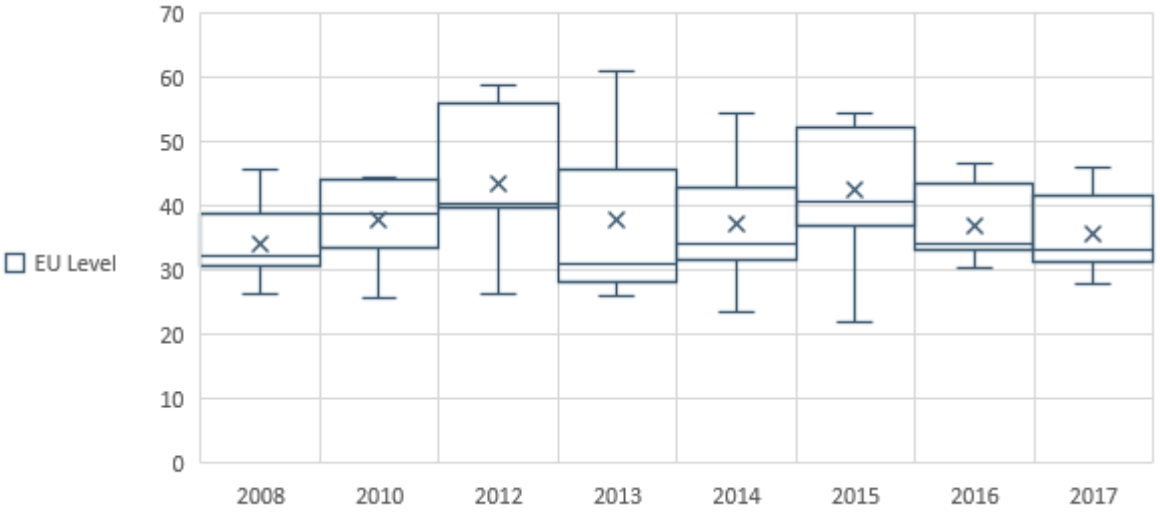
Source: CEPS/Ecofys.

Figure 21. Components of the EU average electricity price for primary aluminium production (%)



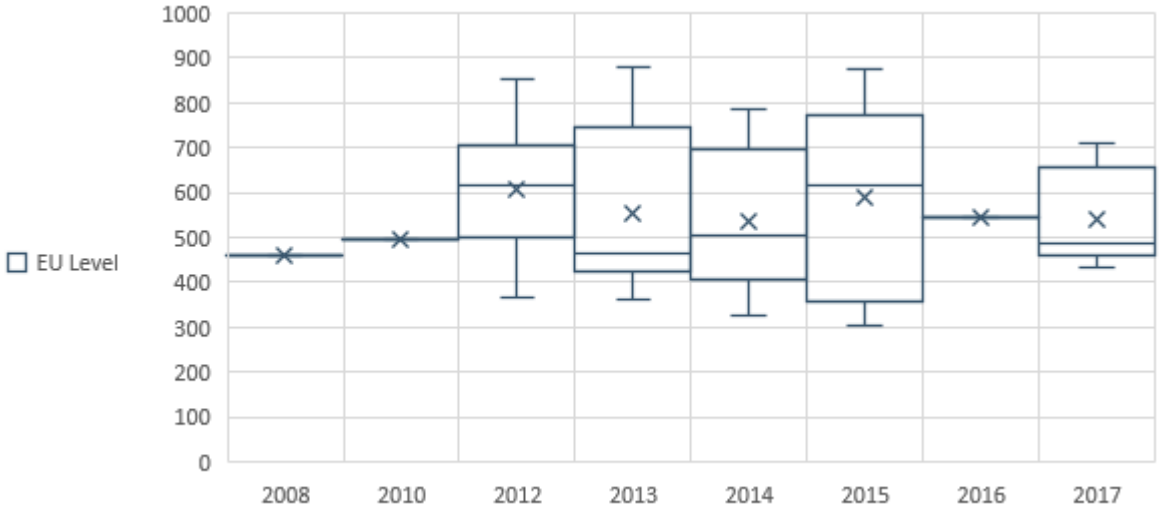
Source: CEPS/Ecofys.

Figure 22. Electricity costs of primary aluminium production (€/MWh)



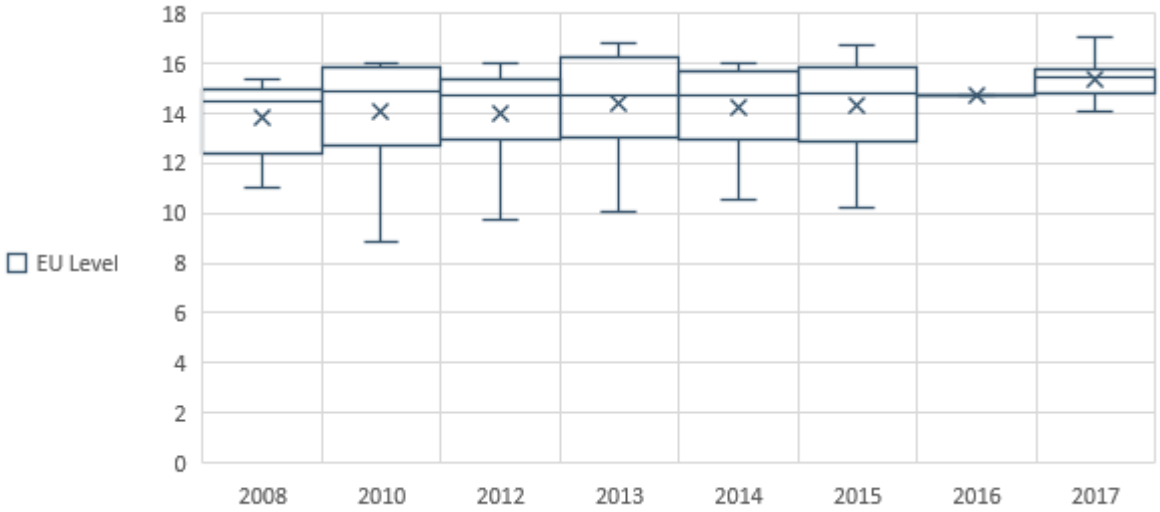
Source: CEPS/Ecofys.

Figure 23. Electricity costs of primary aluminium production (€/tonne)



Source: CEPS/Ecofys.

Figure 24. Electricity intensity of primary aluminium production (MWh/tonne)



Source: CEPS/Ecofys.

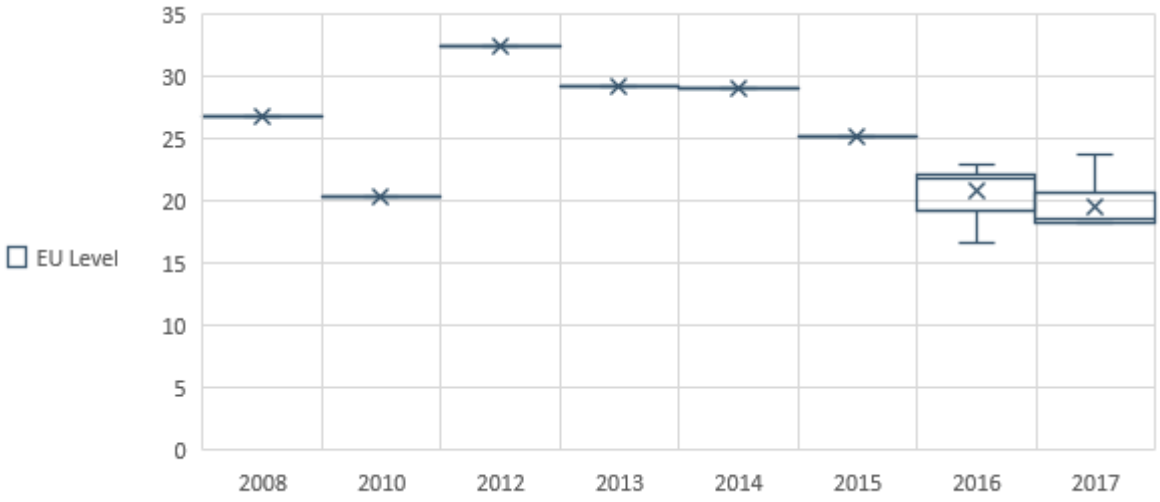
Natural gas

Table 9. Key natural gas indicators of primary aluminium production (EU averages)

Indicator	2008	2010	2012	2013	2014	2015	2016	2017
Natural gas prices (€/MWh)	26.8	20.4	32.5	29.2	29.0	25.1	20.9	19.5
Natural gas costs (€/tonne)	25.5	20.1	25.8	23.5	25.9	22.5	17.1	21.7
Natural gas intensity (MWh/tonne)	1.00	1.01	0.97	0.94	1.00	0.95	0.88	1.15

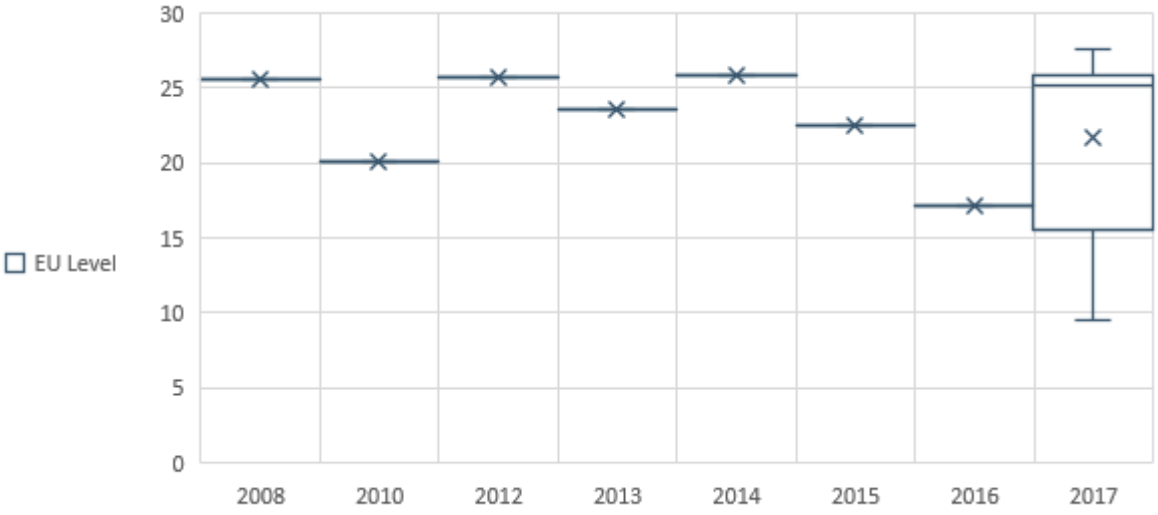
Source: CEPS/Ecofys.

Figure 25. Natural gas prices of primary aluminium production (€/MWh)



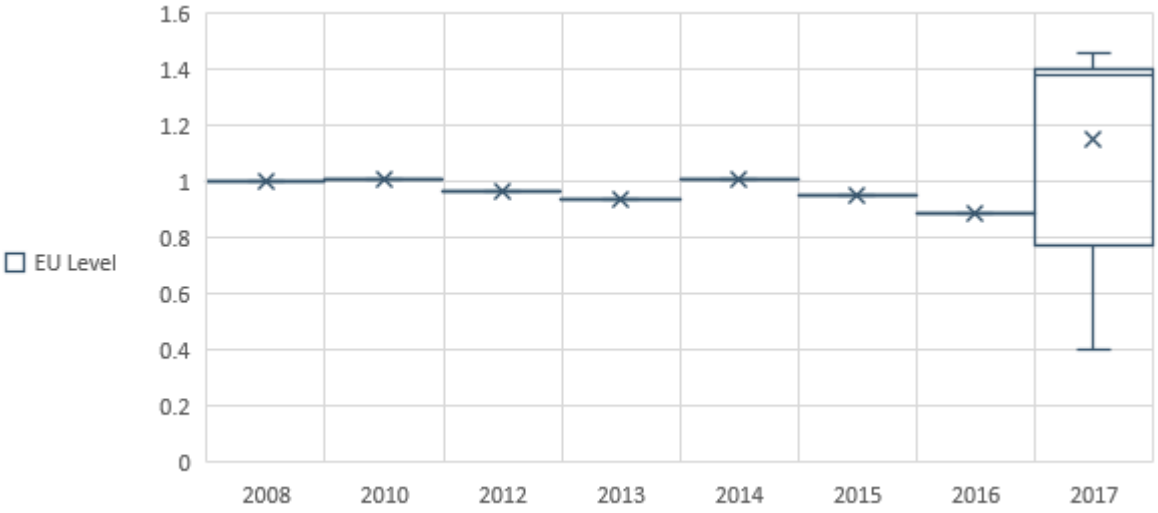
Source: CEPS/Ecofys.

Figure 26. Natural gas costs of primary aluminium production (€/tonne)



Source: CEPS/Ecofys.

Figure 27. Natural gas intensity of primary aluminium production (MWh/tonne)



Source: CEPS/Ecofys.

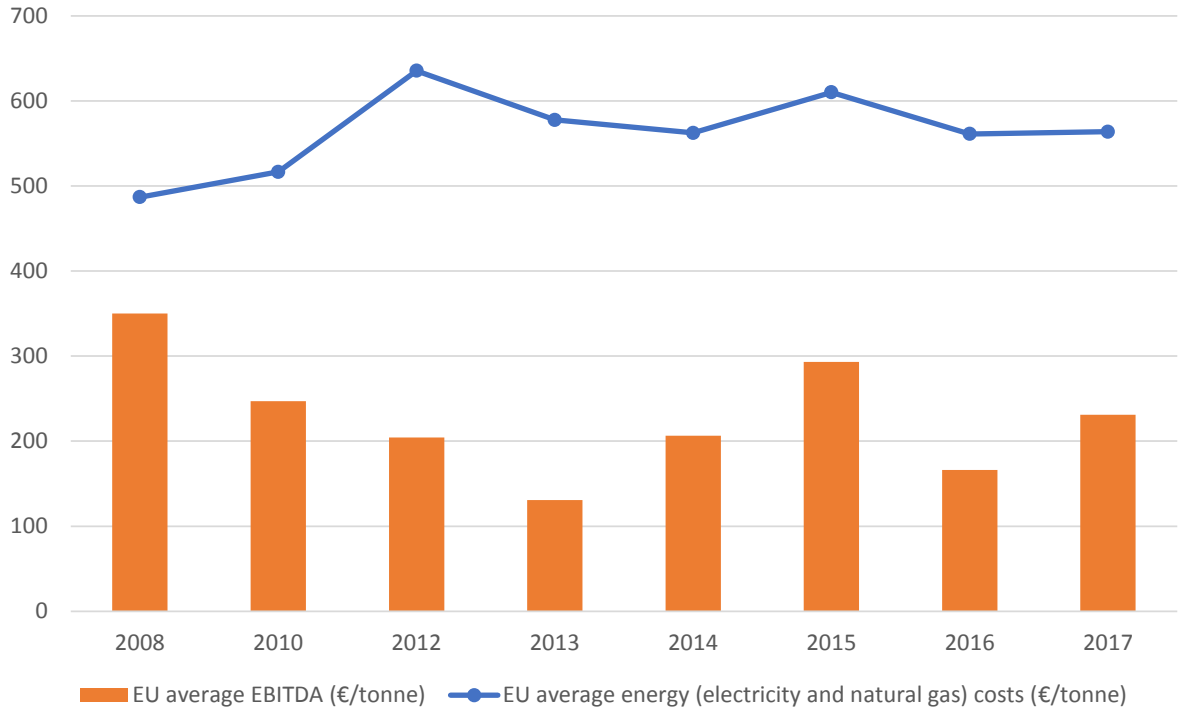
Competitiveness

Table 10. Key competitiveness indicators of primary aluminium production (EU averages)

Indicator	2008	2010	2012	2013	2014	2015	2016	2017
Share of electricity costs in production costs (%)	28.7	33.5	39.2	36.7	38.8	41.6	41.6	38.3
Share of natural gas costs in production costs (%)	1.6	1.4	1.7	1.6	1.9	1.6	1.3	1.5
Share of total energy costs in production costs (%)	30.3	34.8	40.9	38.2	40.7	43.2	42.9	39.8
Total energy costs (€/tonne)	486.8	516.6	635.4	577.6	562.3	610.1	561.2	563.6
EBITDA (€/tonne)	350.0	247.0	204.2	130.8	206.5	293.1	166.0	231.1
Ratio of total energy costs to EBITDA	1.4	2.1	3.1	4.4	2.7	2.1	3.4	2.4

Source: CEPS/Ecofys.

Figure 28. Energy costs versus EBITDA of primary aluminium production (€/tonne)



Source: CEPS/Ecofys.

A1.3.3 Secondary aluminium plants

A1.3.3.1 Electricity prices, costs and intensity

Key electricity indicators for secondary aluminium plants are presented in Table 11.

EU average electricity prices fluctuated over the period but decreased overall (101 EUR/MWh in 2008 vs. 90 EUR/MWh in 2017) with a peak in 2012 (129 EUR/MWh). In terms of price components (Figure 29), the energy component went down between 2008 and 2017 (both in absolute and relative terms) and accounted for 55% of the price in 2017, while the network component went up (both in absolute and relative terms) and accounted for 29% of the price in 2017. It is interesting to note that larger secondary aluminium plants do not benefit from lower prices. Unlike primary aluminium producers, secondary aluminium plants mostly buy electricity through providers, with a limited number sourcing a share of their electricity from the wholesale market.

EU average electricity costs in EUR/MWh (Figure 30) decreased from 101 EUR/MWh in 2008 to 86 EUR/MWh in 2017, with a sharper decrease between 2016 and 2017. The small difference between electricity prices and costs in EUR/MWh is due to ex post electricity price reimbursements granted to some producers. EU average electricity costs in EUR/tonne (Figure 31) fell from 42 EUR/tonne in 2008 to 27 EUR/tonne in 2017.

EU average electricity intensity of secondary aluminium plants (Figure 32) decreased from 0.49 MWh/tonne in 2008 to 0.37 MWh/tonne in 2017.

A1.3.3.2 Natural gas prices, costs and intensity

Key natural gas indicators for secondary aluminium plants are presented in Table 12.

EU average natural gas prices (Figure 33) dropped from 2008 to 2010, increased from 2010 to 2012 and then significantly decreased from 2012 to 2017. The prices were at 33 EUR/MWh in 2008 and 22 EUR/MWh in 2017. As shown in Figure 34, the natural gas price is made up mostly by the energy component (84% in 2017), though this share tends to decrease over time. Larger consumers bore slightly lower unit prices (weighted average is marginally below simple average).

EU average natural gas costs (in EUR/tonne) declined from 62 EUR/tonne in 2008 to 35 EUR/tonne in 2017 (Figure 35).

Overall, EU average natural gas intensity for secondary aluminium producers (Figure 36) decreased from 1.89 MWh/tonne in 2008 to 1.60 MWh/tonne in 2017. Larger plants tend to be more efficient than smaller ones (weighted average – by production output – natural gas intensity is constantly below simple average one).

A1.3.3.3 Competitiveness

As shown in Table 13 (data are available for 2016 and 2017 only), electricity and natural gas costs per tonne made up around 5-6% and 6-8% of total production costs per tonne, respectively. Overall, the share of total energy (electricity + natural gas) costs in production costs ranged around 12-14%.

Data on EBITDA per tonne are not available for this subsector and cannot be compared with energy costs. We can still note the relative significance of total energy costs in production costs, which underlines their importance when looking at competitiveness issues in secondary aluminium production.

A1.3.3.4 Tables and graphs

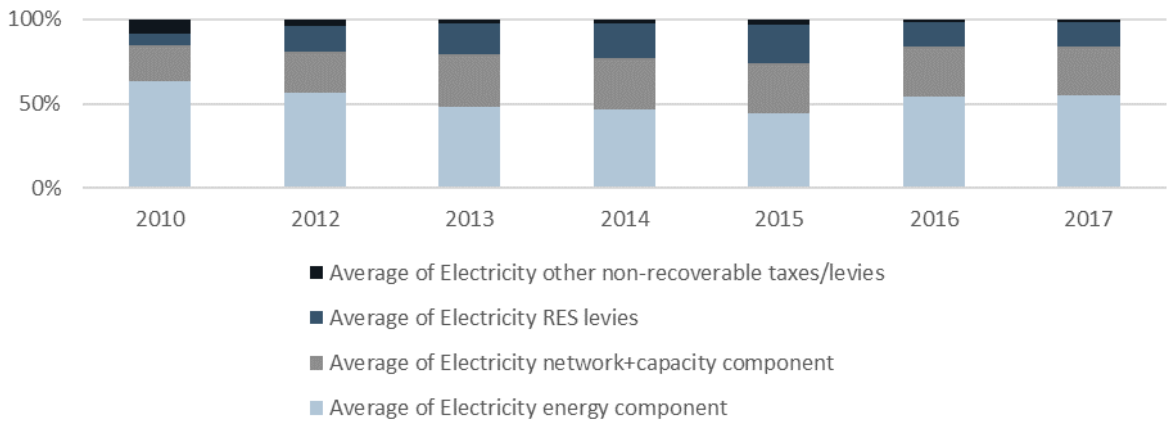
Electricity

Table 11. Key electricity indicators of secondary aluminium production (EU averages)

Indicator	2008	2010	2012	2013	2014	2015	2016	2017
Electricity prices (€/MWh)	100.7	99.3	128.5	125.9	125.3	122.8	97.6	89.5
Electricity costs (€/MWh)	100.7	99.3	102.8	100.7	98.7	94.9	93.9	86.4
Electricity costs (€/tonne)	42.0	31.2	41.3	41.5	42.6	43.7	30.8	27.4
Electricity intensity (MWh/tonne)	0.49	0.50	0.63	0.52	0.55	0.58	0.39	0.37

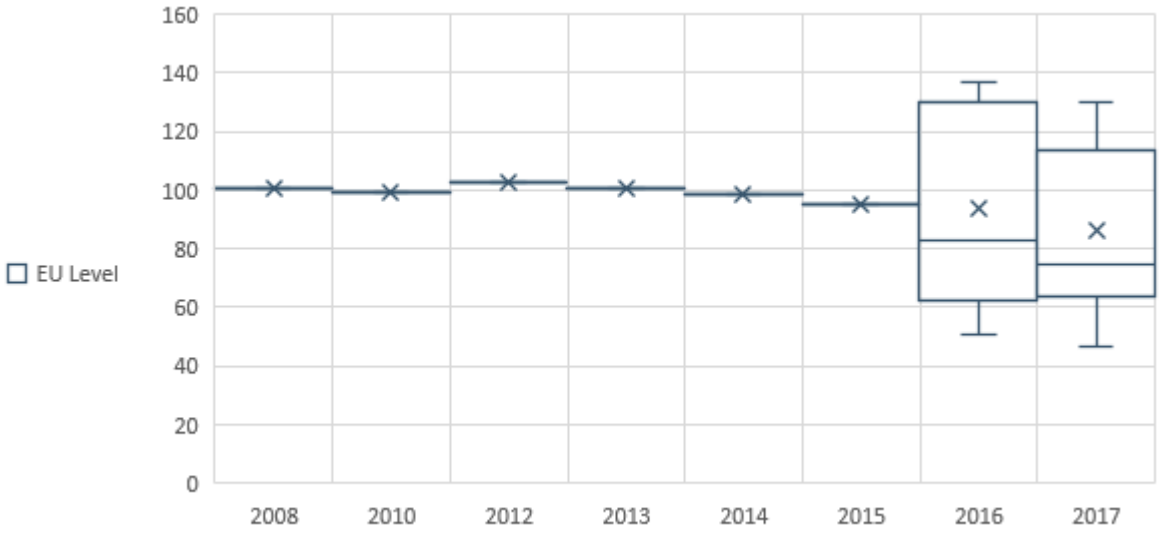
Source: CEPS/Ecofys.

Figure 29. Components of the EU average electricity price for secondary aluminium production (%)



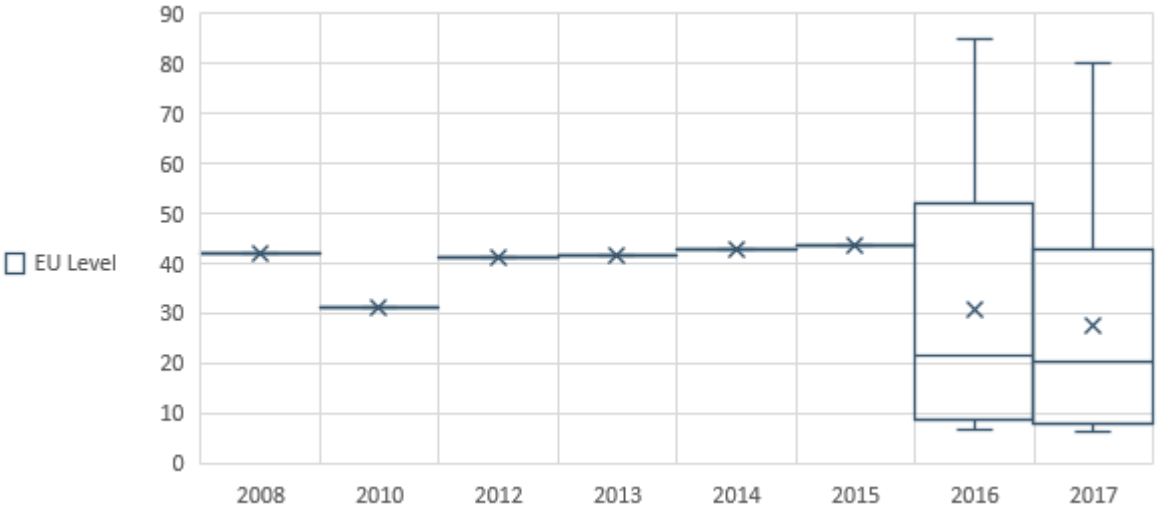
Source: CEPS/Ecofys.

Figure 30. Electricity costs of secondary aluminium production (€/MWh)



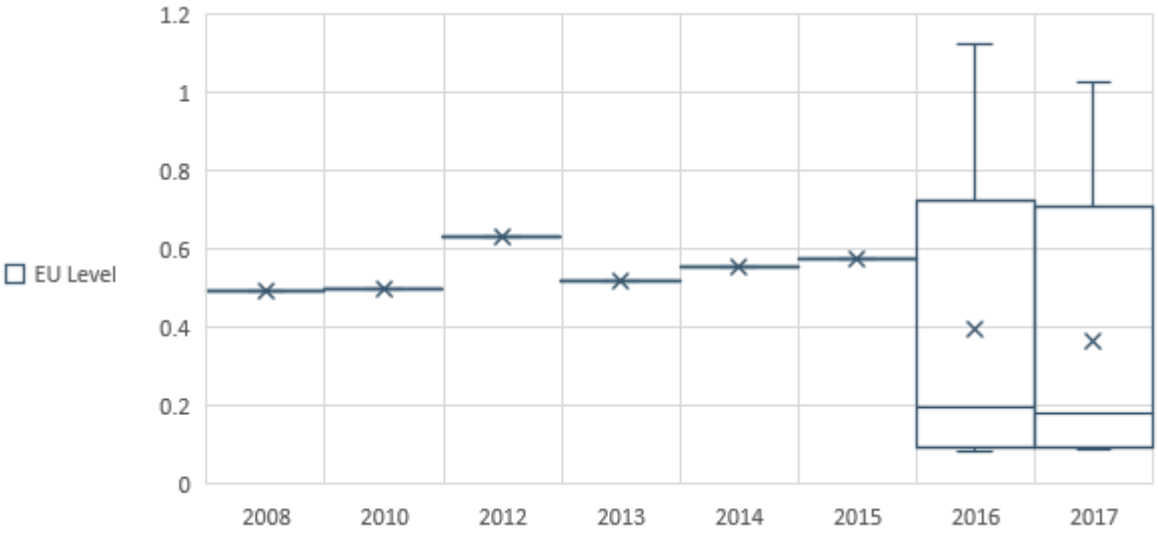
Source: CEPS/Ecofys.

Figure 31. Electricity costs of secondary aluminium production (€/tonne)



Source: CEPS/Ecofys.

Figure 32. Electricity intensity of secondary aluminium production (MWh/tonne)



Source: CEPS/Ecofys.

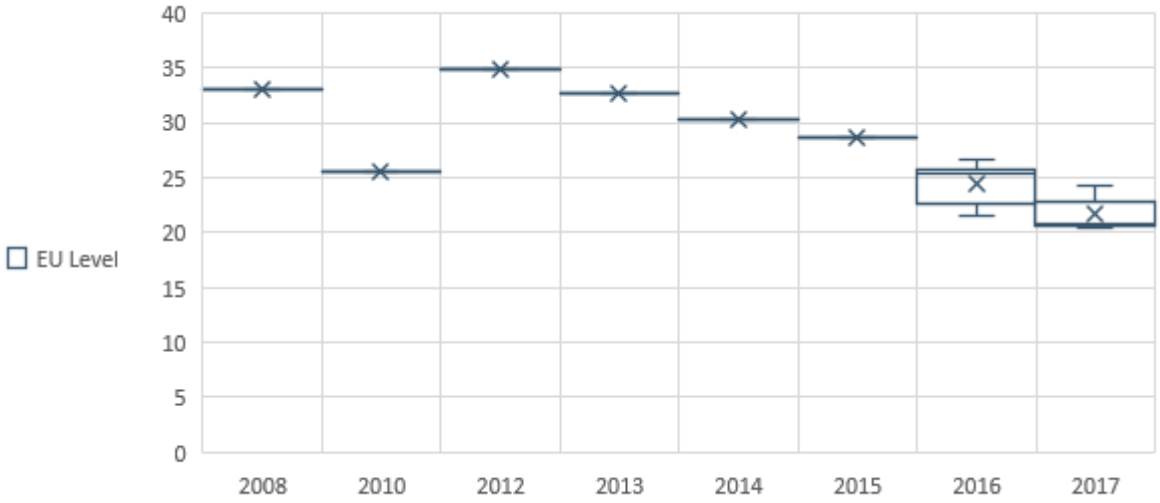
Natural gas

Table 12. Key natural gas indicators of secondary aluminium production (EU averages)

Indicator	2008	2010	2012	2013	2014	2015	2016	2017
Natural gas prices (€/MWh)	33.0	25.7	34.9	32.8	30.3	28.7	24.4	21.6
Natural gas costs (€/tonne)	61.9	45.6	61.3	58.1	56.7	59.2	39.6	34.7
Natural gas intensity (MWh/tonne)	1.89	1.81	1.76	1.75	1.84	1.97	1.64	1.60

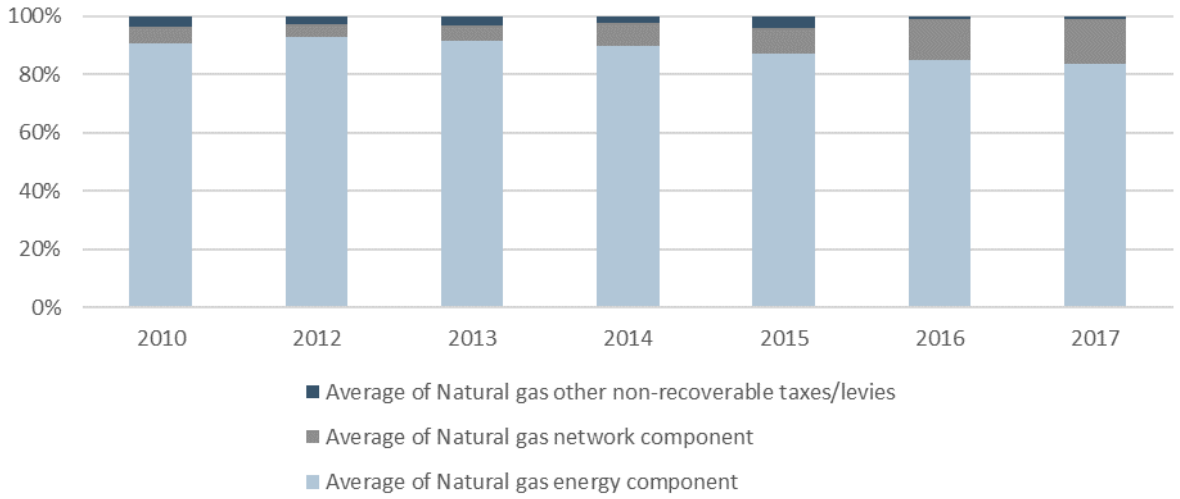
Source: CEPS/Ecofys.

Figure 33. Natural gas prices of secondary aluminium production (€/MWh)



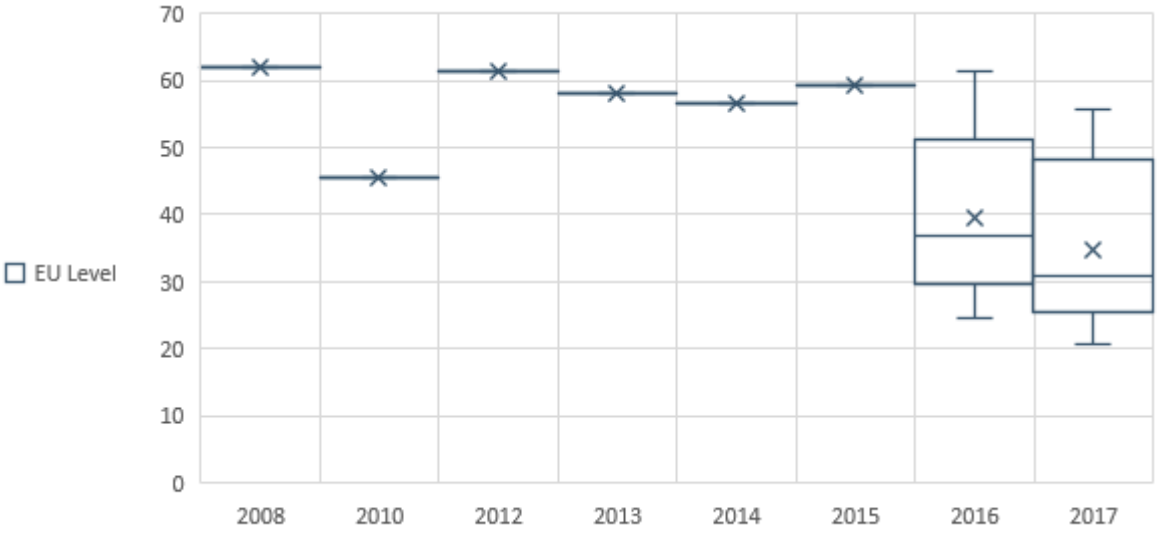
Source: CEPS/Ecofys.

Figure 34. Components of the EU average natural gas price for secondary aluminium production (%)



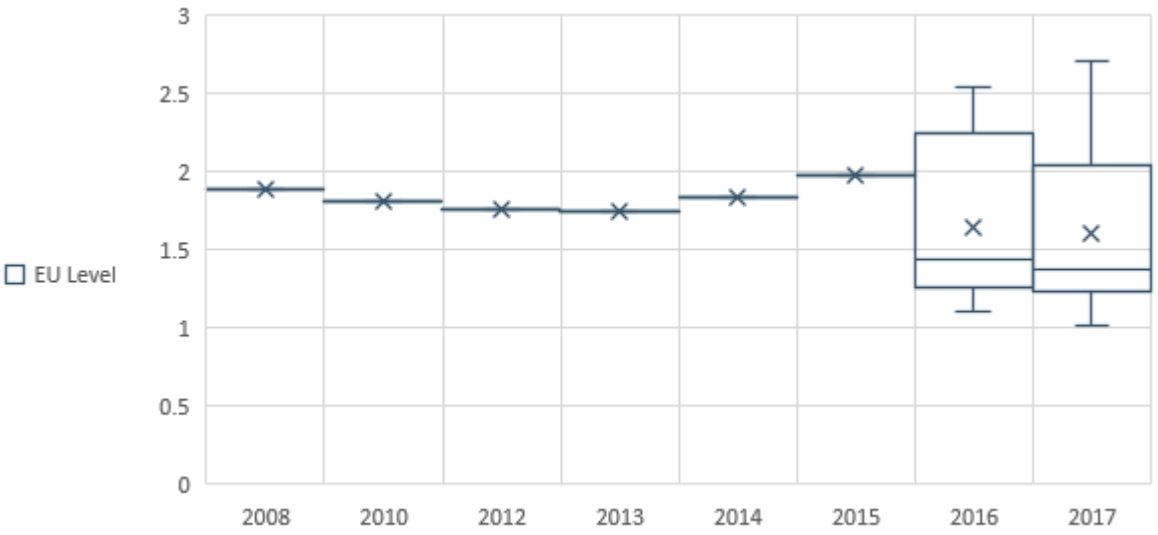
Source: CEPS/Ecofys.

Figure 35. Natural gas costs of secondary aluminium production (€/tonne)



Source: CEPS/Ecofys.

Figure 36. Natural gas intensity of secondary aluminium production (MWh/tonne)



Source: CEPS/Ecofys.

Competitiveness

Table 13. Key competitiveness indicators of secondary aluminium production (EU averages)

Indicator	2016	2017
Share of electricity costs in production costs (%)	6.1	5.1
Share of natural gas costs in production costs (%)	7.9	6.4
Share of total energy costs in production costs (%)	14.0	11.5
Total energy costs (€/tonne)	70.4	62.1

Source: CEPS/Ecofys.

A1.3.4 Downstream aluminium plants

A1.3.4.1 Electricity prices, costs and intensity

Key electricity indicators for downstream aluminium plants are presented in Table 14.

EU average electricity prices increased from 2010 to 2013 and decreased afterwards until 2016, but they were on the rise again in 2017. Over the period, prices increased overall (69 EUR/MWh in 2008 vs. 84 EUR/MWh in 2017). In terms of price components (Figure 37), the energy component remained fairly stable over the period in absolute terms but slightly decreased in relative terms and accounted for 65% of the price in 2017, while the network and RES levies components went up (both in absolute and relative terms) and accounted for 21% and 7% of the price in 2017, respectively. It is striking that larger consumers faced much lower electricity prices (weighted average by purchased electricity is well below simple average) by: i) benefitting from stronger bargaining power when negotiating electricity prices (lower energy component); and ii) paying relatively less for network costs and non-recoverable taxes/levies, including RES levies. Like secondary aluminium producers, downstream aluminium plants mostly buy electricity through providers, with a limited number sourcing a share of their electricity from the wholesale market.

EU average electricity costs in EUR/MWh (Figure 38) increased from 58 EUR/MWh in 2010 to 83 EUR/MWh in 2017. The difference between electricity prices and costs in EUR/MWh is due to ex post electricity price reimbursements granted to some producers. EU average electricity costs in EUR/tonne (Figure 39) have been on a decreasing trend since 2013, but over the period they slightly increased from 54 EUR/tonne in 2008 to 59 EUR/tonne in 2017.

EU average electricity intensity of downstream aluminium plants (Figure 40) decreased from 1.21 MWh/tonne in 2010 to 0.93 MWh/tonne in 2017.

A1.3.4.2 Natural gas prices, costs and intensity

Key natural gas indicators for downstream aluminium plants are presented in Table 15.

EU average natural gas prices (Figure 41) fell by more than half since 2012 (42 EUR/MWh in 2008 vs. 20 EUR/MWh in 2017). As shown in Figure 42, the natural gas price is made up mostly by the energy component (85% in 2017). Larger consumers bore lower unit prices (weighted average is below simple average), but this price differential between larger and smaller consumers tends to disappear in the most recent years.

As shown in Figure 43, EU average natural gas costs (in EUR/tonne) followed the same trend as natural gas prices and dropped by half between 2012 and 2017 (59 vs. 28 EUR/tonne, respectively)

EU average natural gas intensity (Figure 44) ranged between 1.2 and 1.5 MWh/tonne over the period. Unlike for secondary aluminium, downstream aluminium producers are not more efficient than smaller ones.

A1.3.4.3 Competitiveness

As shown in Table 16 (data are available for 2016 and 2017 only), electricity and natural gas costs per tonne made up around 1% and 0.5% of total production costs per tonne, respectively. Overall, the share of total energy (electricity + natural gas) costs in production costs ranged around 1-2%.

Data on EBITDA per tonne are not available for this subsector and cannot be compared with energy costs. We can nevertheless note that total energy costs represent a very small share of production costs and therefore seem less relevant for competitiveness issues in downstream aluminium production.

A1.3.4.4 Tables and graphs

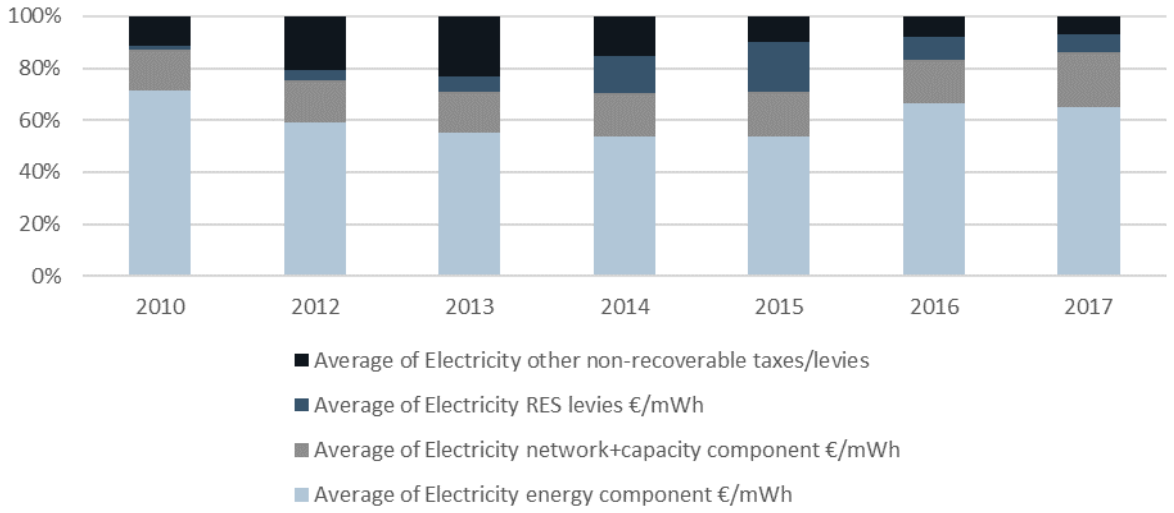
Electricity

Table 14. Key electricity indicators of downstream aluminium production (EU averages)

Indicator	2010	2012	2013	2014	2015	2016	2017
Electricity prices (€/MWh)	69.3	91.4	99.1	98.5	89.2	80.0	84.1
Electricity costs (€/MWh)	57.8	78.4	99.1	98.3	89.2	80.0	82.5
Electricity costs (€/tonne)	54.2	64.8	97.1	87.3	67.5	68.2	58.6
Electricity intensity (MWh/tonne)	1.21	1.08	1.11	1.05	0.93	1.04	0.93

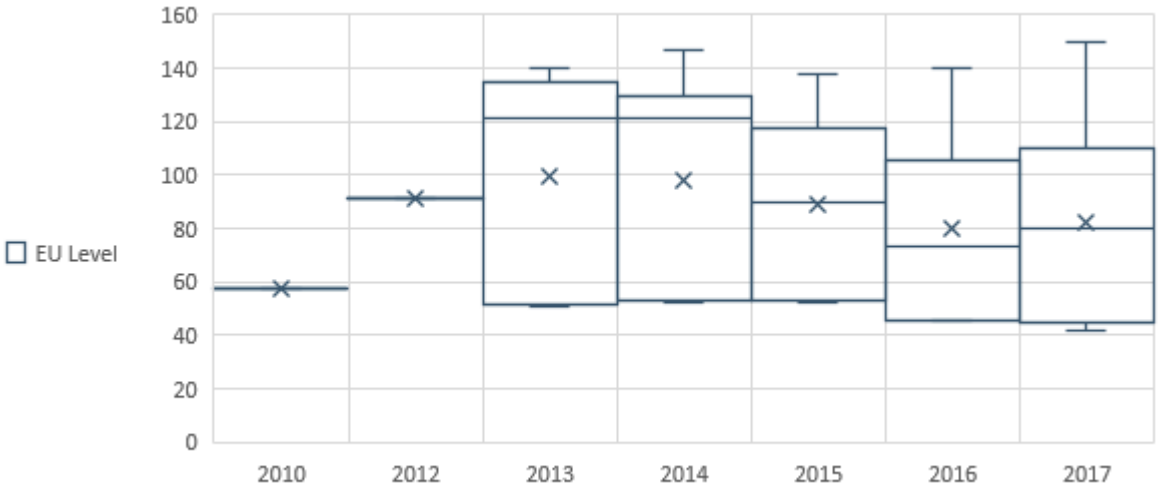
Source: CEPS/Ecofys.

Figure 37. Components of the EU average electricity price for downstream aluminium production (%)



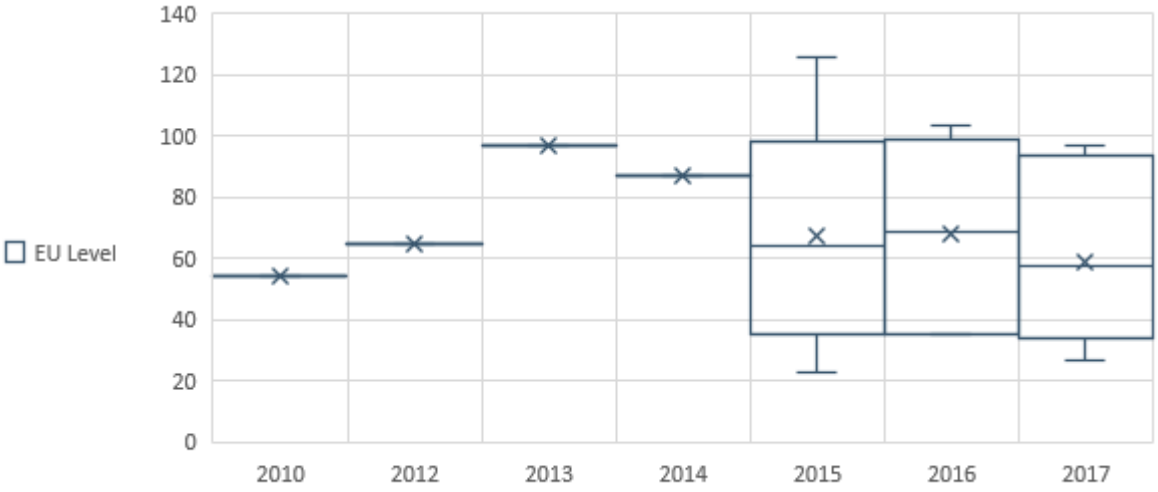
Source: CEPS/Ecofys.

Figure 38. Electricity costs of downstream aluminium production (€/MWh)



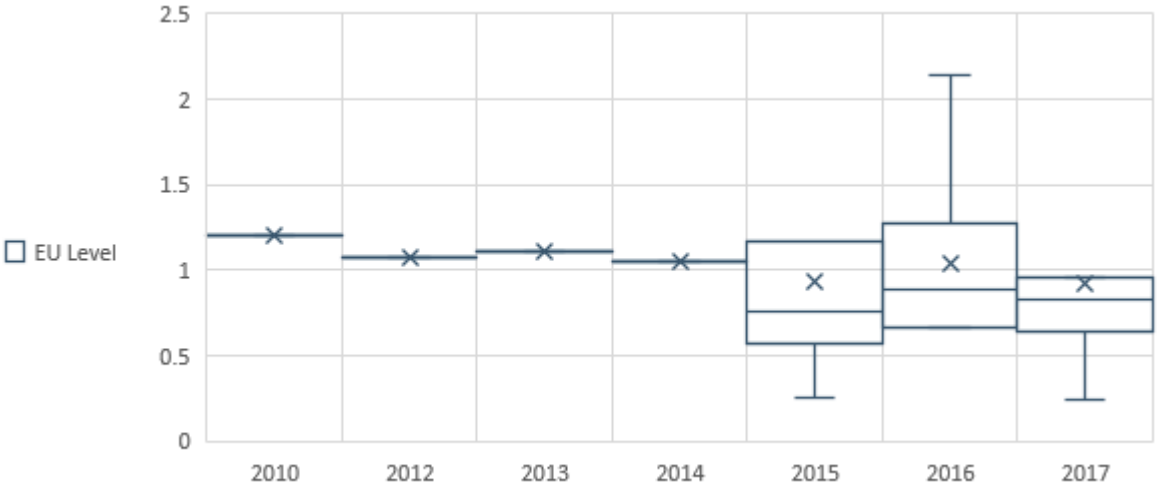
Source: CEPS/Ecofys.

Figure 39. Electricity costs of downstream aluminium production (€/tonne)



Source: CEPS/Ecofys.

Figure 40. Electricity intensity of downstream aluminium production (MWh/tonne)



Source: CEPS/Ecofys.

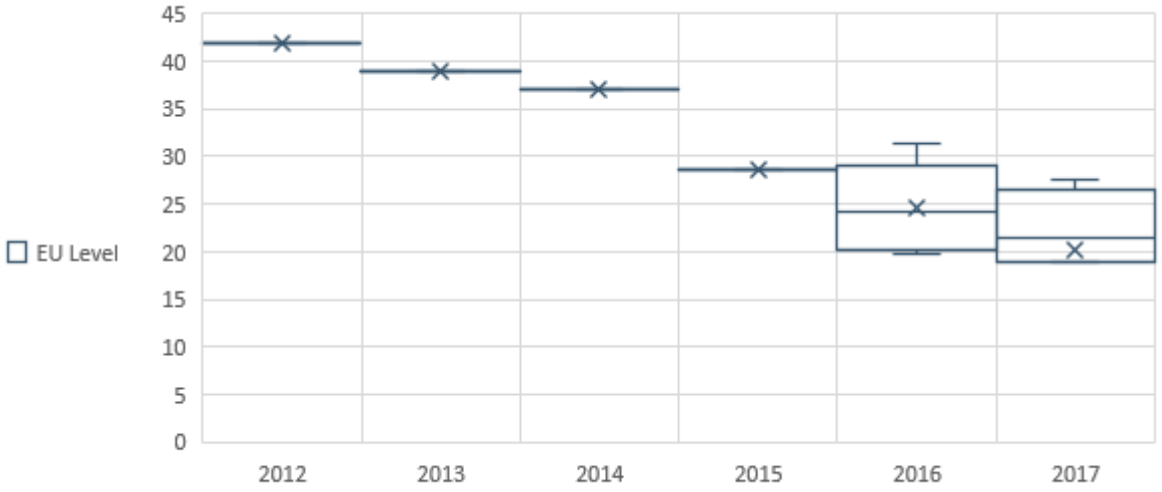
Natural gas

Table 15. Key natural gas indicators of downstream aluminium production (EU averages)

Indicator	2012	2013	2014	2015	2016	2017
Natural gas prices (€/MWh)	41.8	38.9	37.0	28.7	24.7	20.2
Natural gas costs (€/tonne)	58.6	68.8	58.3	42.0	32.2	28.0
Natural gas intensity (MWh/tonne)	1.33	1.48	1.32	1.21	1.32	1.30

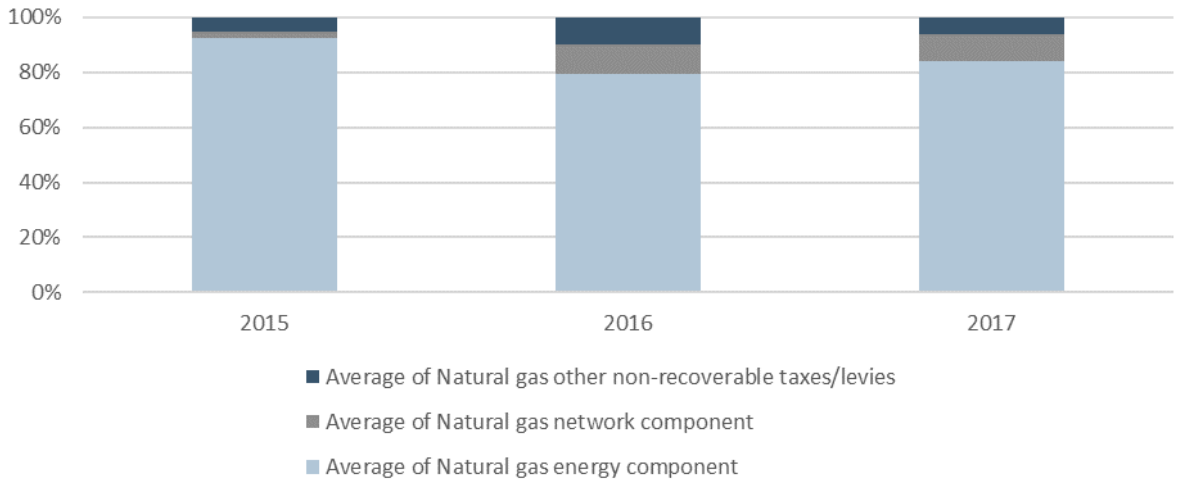
Source: CEPS/Ecofys.

Figure 41. Natural gas prices of downstream aluminium production (€/MWh)



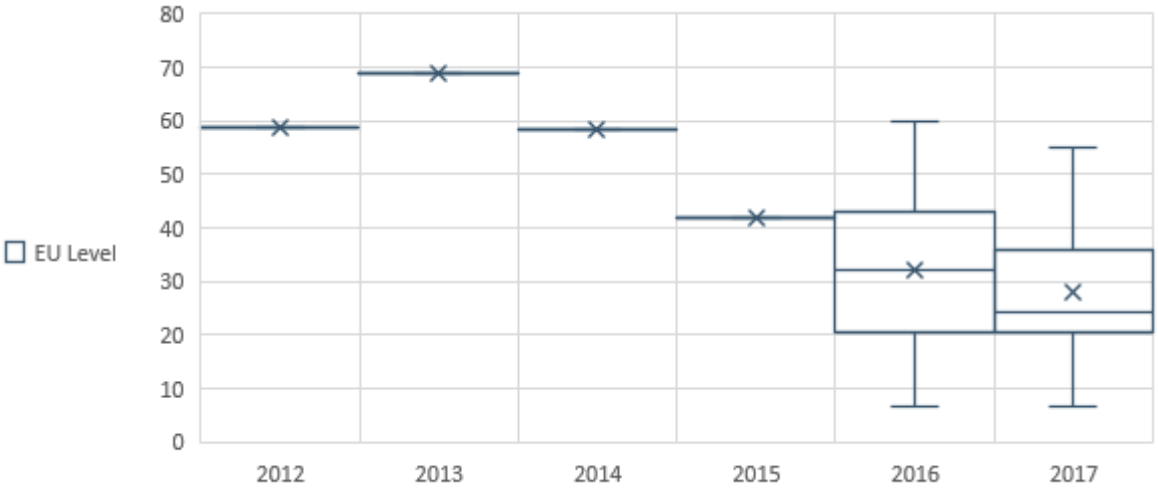
Source: CEPS/Ecofys.

Figure 42. Components of the EU average natural gas price for downstream aluminium production (%)



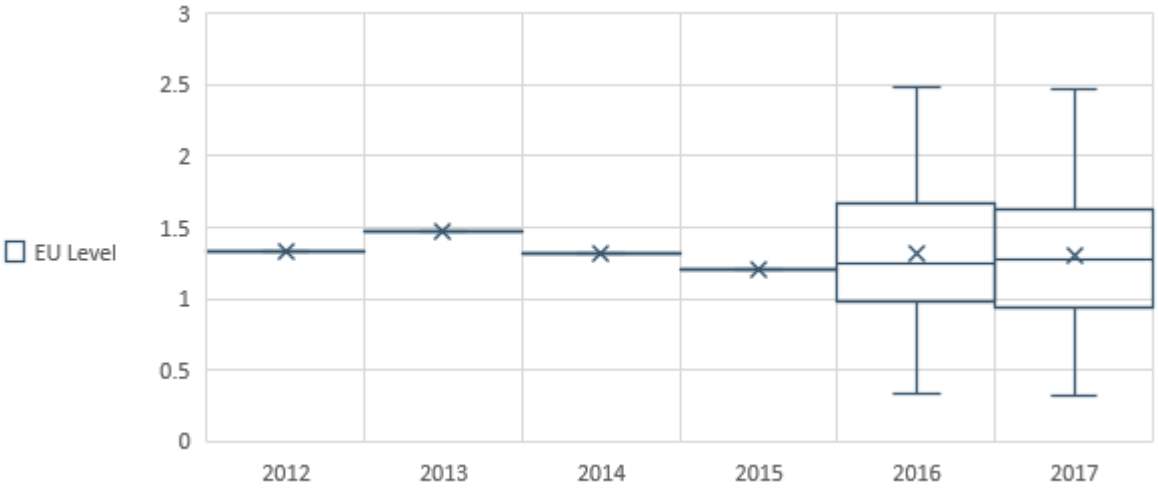
Source: CEPS/Ecofys.

Figure 43. Natural gas costs of downstream aluminium production (€/tonne)



Source: CEPS/Ecofys.

Figure 44. Natural gas intensity of downstream aluminium production (MWh/tonne)



Source: CEPS/Ecofys.

Competitiveness

Table 16. Key competitiveness indicators of downstream aluminium production (EU averages)

Indicator	2016	2017
Share of electricity costs in production costs (%)	1.3	0.9
Share of natural gas costs in production costs (%)	0.6	0.4
Share of total energy costs in production costs (%)	1.9	1.4
Total energy costs (€/tonne)	100.4	86.6

Source: CEPS/Ecofys.

A1.4 BRICKS AND ROOF TILES

A1.4.1 General information and sample composition

The bricks and roof tiles sector (sector 23.32 in NACE Rev. 2) includes manufacturers of products with diverse shapes and properties: i) building bricks, including both clay blocks and facing bricks; ii) roof tiles; iii) paving bricks; and iv) chimney bricks and other clay building products. In general, products are characterised by a low value-added and low tradability.

The most common energy source used in brick and roof tile production is natural gas. Electricity is used as a secondary energy source.

The sector, which closely follows the economic trend of the construction sector (its main customer), has been severely hit by the crisis. Its production value declined by about 25% between 2008 and 2015. In 2015, there were 1,810 brick and tile enterprises in the EU, amongst which around half are SMEs. It should be noted that the sector has gone through a consolidation phase (the number of enterprises fell by almost 35% between 2008 and 2015, which resulted in larger enterprises in terms of production value). Plants tend to be spread throughout Europe, usually near raw material extraction sites. Top five European producing countries are (based on 2016 production value): Germany (28%), the United Kingdom (20%), France (16%), Italy (10%) and Belgium (7%).

Overall, the EU is a net exporter of bricks and roof tiles. Major EU export destinations include Switzerland, Russia and Norway. EU imports come mainly from Serbia and, to a less extent, Turkey, China, Macedonia and Pakistan.

The analysis focusses on building brick and roof tile plants, which account for 96% of the sectoral output (flooring blocks and other clay construction products are marginal). These plants are homogeneous with similar production processes and products. A typical brick and roof tile plant in the analysis has a natural gas intensity of 0.31-0.86 MWh/tonne and an electricity intensity of 0.04-0.10 MWh/tonne. The sample for 2016-2017 includes 58 plants across Europe (11 in CEE region, 36 in NWE region and 11 in SE region), representing about 11% of total EU production. The sample for 2008-2015 includes 52 plants across Europe, representing 7-12% of the total EU production. In general, the CEE region tends to be slightly over-represented compared to the SE region and SMEs are under-represented in the sample.

A1.4.2 Electricity prices, costs and intensity

Key electricity indicators for bricks and roof tiles are presented in Table 17.

After recording a growing trend from 2008 to 2012, the electricity prices and costs (in EUR/MWh) borne by EU brick and roof tile producers decreased between 2012 and 2017.

EU average electricity prices rose from less than 80 EUR/MWh in 2008 to above 94 EUR/MWh in 2012 and then declined to 83 EUR/MWh in 2017. When looking at the price components (Figure 45), it appears that the energy component accounted for less than half (49%) of the price in 2017, which is comparatively lower than in any of the other sectors analysed. Conversely, the network component increased over time and represented 34% of the price in 2017. Larger consumers faced lower electricity prices (weighted average by purchased electricity is constantly below simple average), because they: i) benefitted from stronger bargaining power when negotiating electricity prices (lower energy component); and ii) paid relatively less for network costs and other non-recoverable taxes/levies (this was not the case for RES levies). Only a few plants relied on the wholesale market to purchase electricity and they did not necessarily coincide with the largest consumers.

EU average electricity costs in EUR/MWh (Figure 46) were largely aligned with electricity prices. After a peak in 2012, they sharply declined, from above 92 EUR/MWh in 2012 and 2013 to about 75 EUR/MWh in 2017. The very small difference between electricity prices and costs in EUR/MWh can be explained by the following factors: i) only a few plants participated in flexibility schemes (and the compensation they received is relatively small compared to their electricity costs); ii) only about 10% of the plants met part of their electricity demand via self-generation; and iii) whereas 20% of the

plants were reimbursed *ex post* for part of their electricity price, reimbursements were small and only given in some years. EU average electricity costs in EUR/tonne (Figure 47) increased between 2008 and 2013 from less than 6 EUR/tonne to above 7 EUR/tonne, and then declined again (6 EUR/tonne in 2017). Larger producers experienced lower electricity costs (weighted average by production output is below simple average); this result can be explained by a combination of three factors: i) better bargaining power of larger electricity consumers; ii) relatively lower network costs and other non-recoverable taxes/levies; and iii) economies of scale.

EU average electricity intensity of the bricks and roof tiles sector (Figure 48) increased slightly in the last decade, from 0.07 to 0.08 MWh/tonne. Larger plants are more electricity efficient than smaller ones (weighted average – by production output – electricity intensity is constantly below simple average one).

A1.4.3 Natural gas prices, costs and intensity

Key natural gas indicators for bricks and roof tiles are presented in Table 18.

EU average natural gas prices and costs for brick and roof tile producers peaked in 2013 and then recorded a downwards trend, driven by a decrease (in absolute value) in the energy component of the gas price.

After peaking in 2013 (32 EUR/MWh), the natural gas price decreased sharply down to about 23 EUR/MWh in 2017 (Figure 49). As shown in Figure 50, the natural gas price is made up mostly by the energy component (82% in 2017), though this share tends to decrease over time. Larger consumers faced lower natural gas prices (weighted average by purchased natural gas is below simple average); in fact, they seem to pay less for the network component but not necessarily for the energy and non-recoverable taxes/levies components. Only a few plants relied on the wholesale market to purchase natural gas. There is no difference in this sector between natural gas prices and costs in EUR/MWh for two reasons: i) self-generation of natural gas is not relevant; ii) whereas 11% of the sampled plants participated in interruptibility schemes, no revenues stemmed from such schemes in the period under observation.

EU average natural gas costs (in EUR/tonne) ranged between 21 EUR/tonne in 2008 and 14 EUR/tonne in 2017 (Figure 51). Larger plants incurred lower costs (weighted average by production output is below simple average). This may be due to: i) quantity discount for larger consumers of natural gas; ii) lower network costs; and iii) economies of scale.

EU average natural gas intensity (Figure 52) was quite stable between 2008 and 2017 (ranging between 0.6 MWh/tonne and 0.7 MWh/tonne). Larger plants tend to be more natural gas efficient than smaller ones (weighted average – by production output – natural gas intensity is generally below simple average one).

A1.4.4 Competitiveness

Between 2008 and 2017, natural gas and electricity costs represented on average 14-22% and 5-9% of total production costs, respectively (Table 19). The share of total energy (natural gas + electricity) costs in production costs decreased from 28% in 2008 to 24% in 2017. Economies of scale play here a key role, as energy and total production costs per output incurred by larger plants were much lower than those experienced by smaller ones (weighted average – by production output – energy and total production costs per output are well below simple average ones, in the order of magnitude of 20%).

EBITDA per tonne declined between 2008 and 2015 and then increased in the last two years (Figure 53). We can note that energy costs are always higher than EBITDA and show an opposite pattern compared to EBITDA, which is particularly visible in the most recent years (decrease in energy costs while increase in EBIDTA). This shows the importance of energy costs and the potential direct impact it can have on margins of brick and roof tile production.

A1.4.5 Tables and graphs

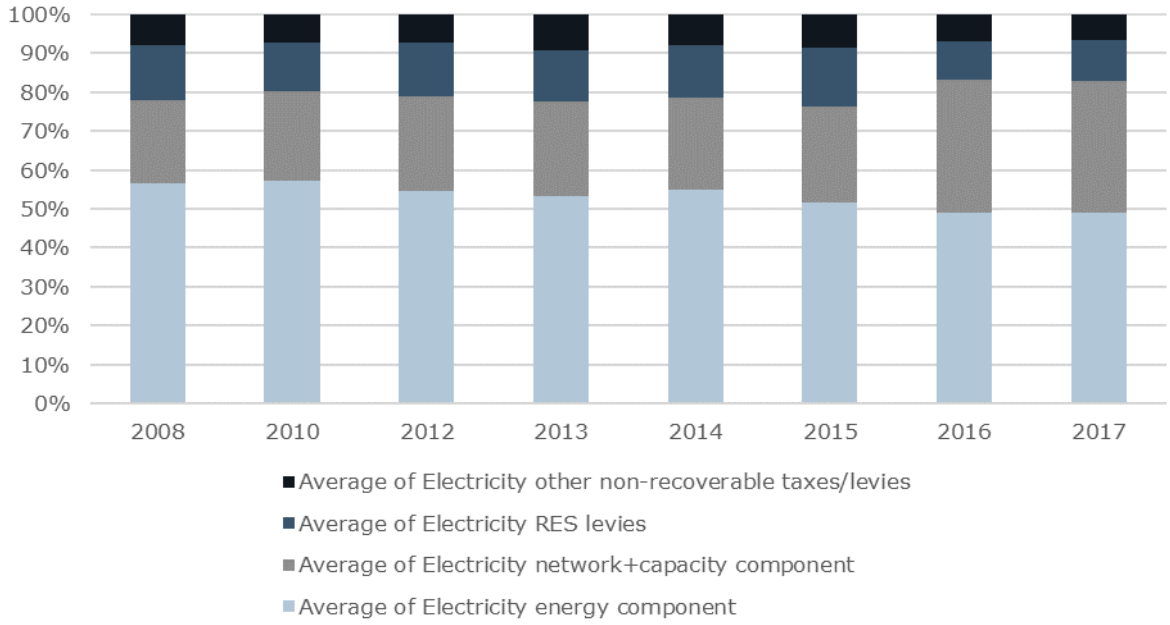
Electricity

Table 17. Key electricity indicators of brick and roof tile production (EU averages)

Indicator	2008	2010	2012	2013	2014	2015	2016	2017
Electricity price (€/MWh)	79.0	82.2	94.3	91.7	90.4	90.1	86.3	83.1
Electricity costs (€/MWh)	77.8	80.8	92.5	92.4	89.2	88.4	79.3	75.1
Electricity costs (€/tonne)	5.9	5.4	6.7	7.1	6.9	6.5	6.2	6.0
Electricity intensity (MWh/tonne)	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08

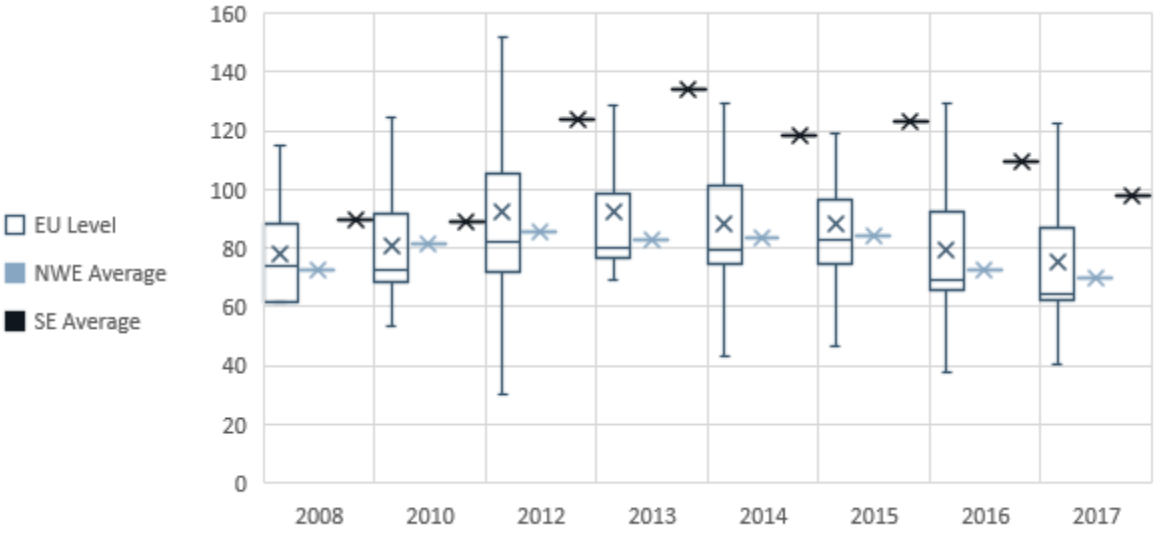
Source: CEPS/Ecofys.

Figure 45. Components of the EU average electricity price for brick and roof tile production (%)



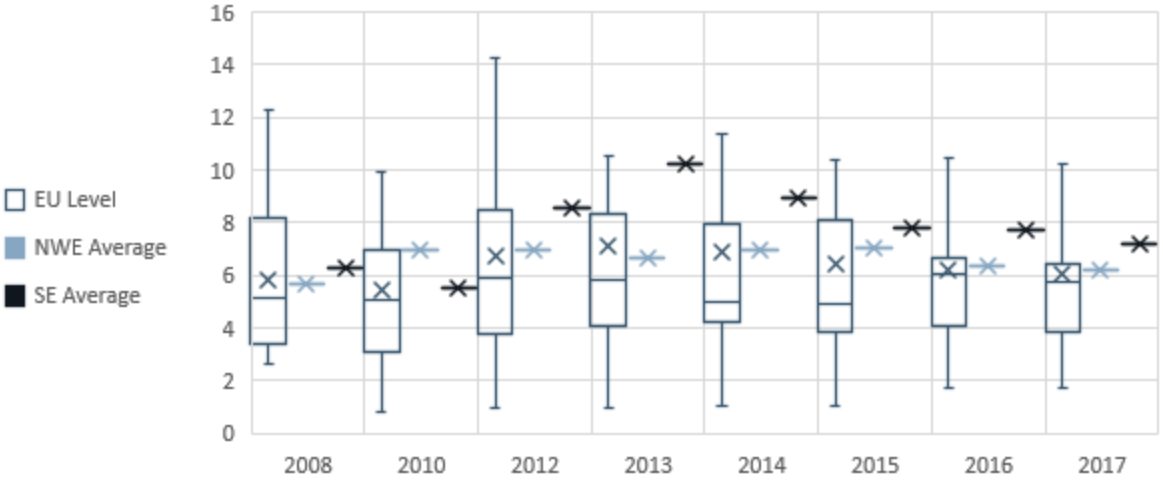
Source: CEPS/Ecofys.

Figure 46. Electricity costs of brick and roof tile production (€/MWh)



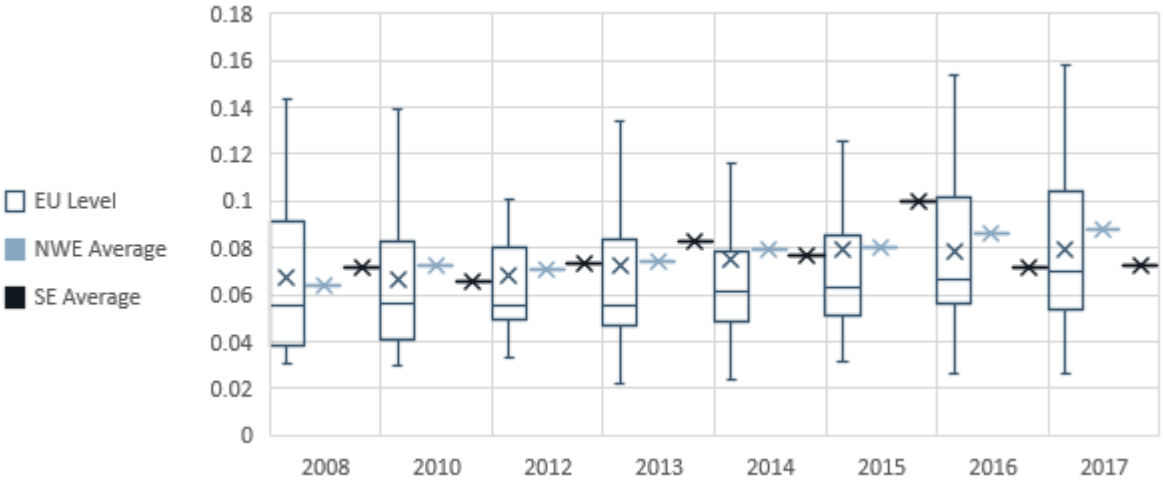
Source: CEPS/Ecofys.

Figure 47. Electricity costs of brick and roof tile production (€/tonne)



Source: CEPS/Ecofys.

Figure 48. Electricity intensity of brick and roof tile production (MWh/tonne)



Source: CEPS/Ecofys.

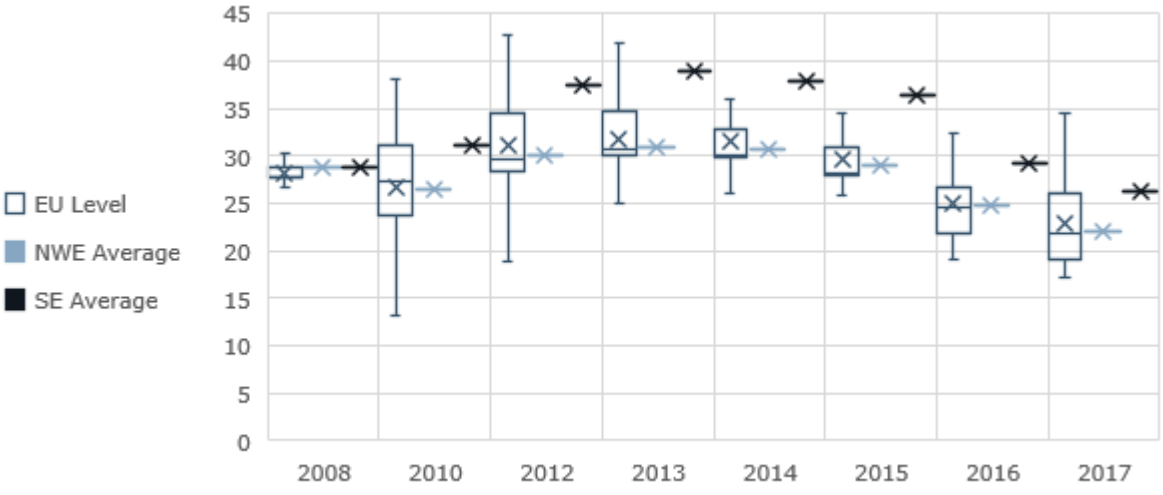
Natural gas

Table 18. Key natural gas indicators of brick and roof tile production (EU averages)

Indicator	2008	2010	2012	2013	2014	2015	2016	2017
Natural gas price (€/MWh)	28.2	26.8	31.1	31.8	31.6	29.6	25.1	22.9
Natural gas costs (€/tonne)	20.7	17.8	20.1	21.0	20.9	18.7	15.7	14.4
Natural gas intensity (MWh/tonne)	0.69	0.62	0.64	0.63	0.64	0.63	0.64	0.65

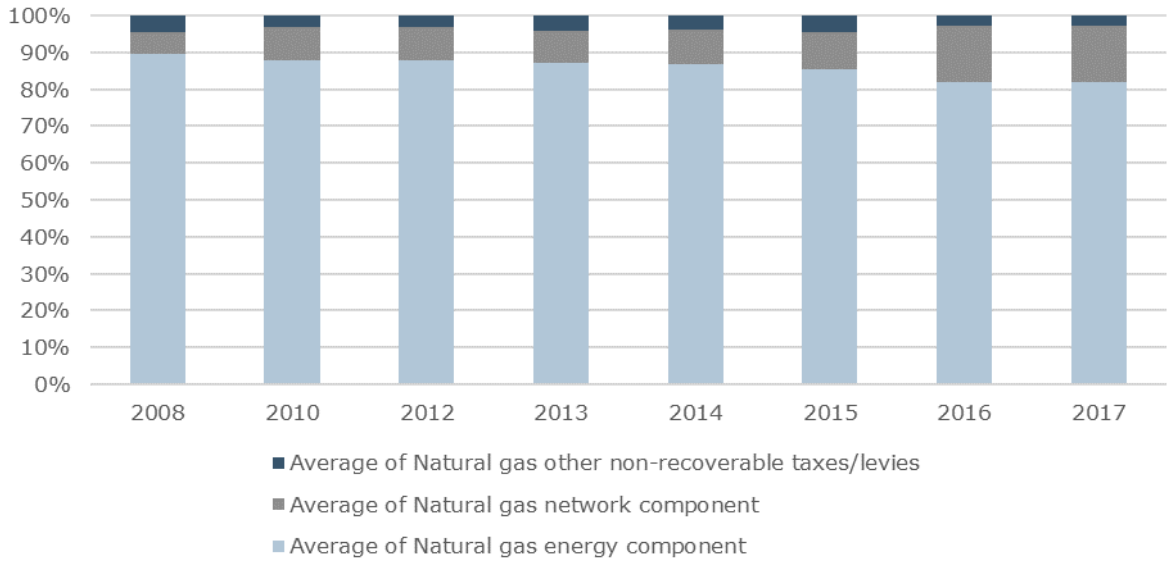
Source: CEPS/Ecofys.

Figure 49. Natural gas prices of brick and roof tile production (€/MWh)



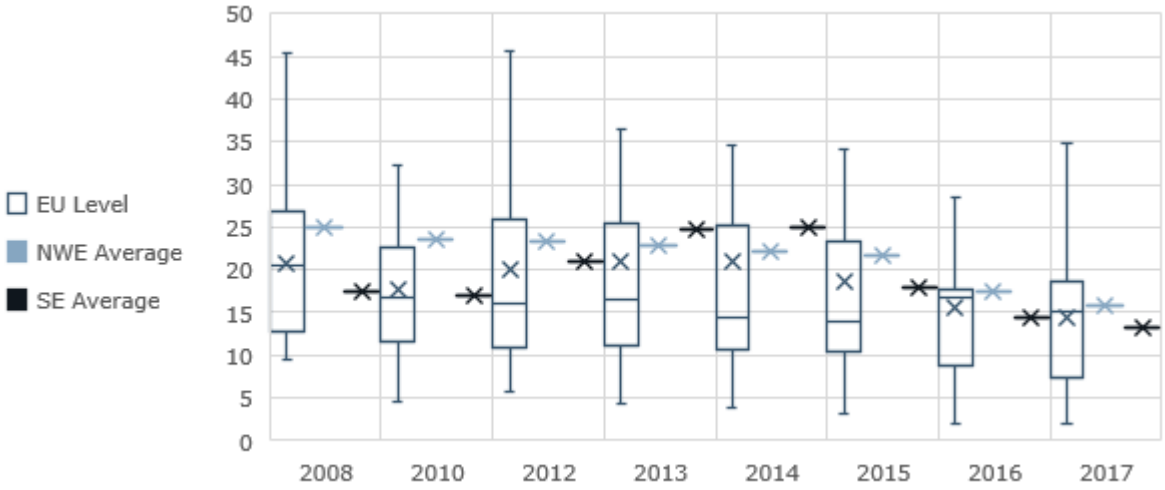
Source: CEPS/Ecofys.

Figure 50. Components of the EU average natural gas price for brick and roof tile production (%)



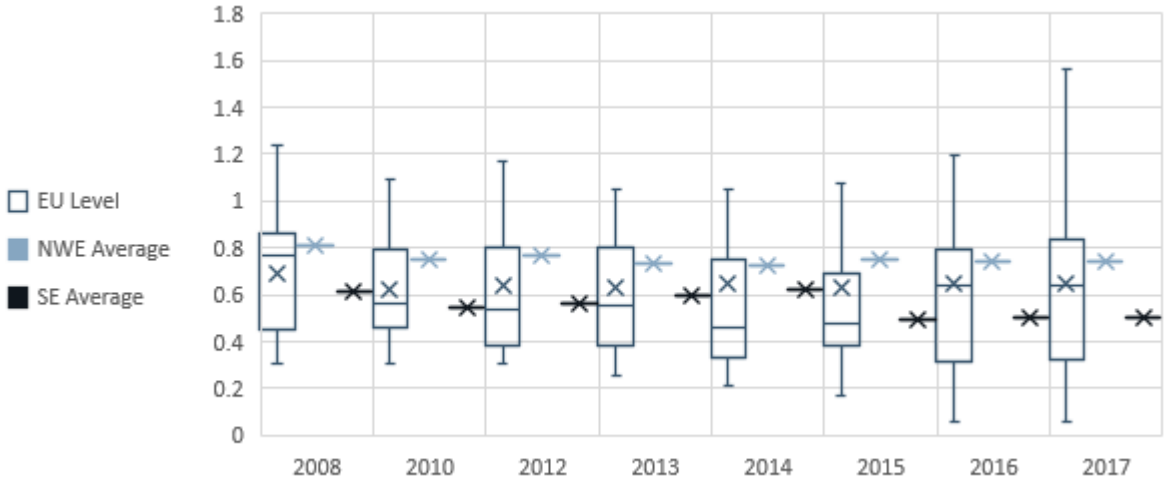
Source: CEPS/Ecofys.

Figure 51. Natural gas costs of brick and roof tile production (€/tonne)



Source: CEPS/Ecofys.

Figure 52. Natural gas intensity of brick and roof tile production (MWh/tonne)



Source: CEPS/Ecofys.

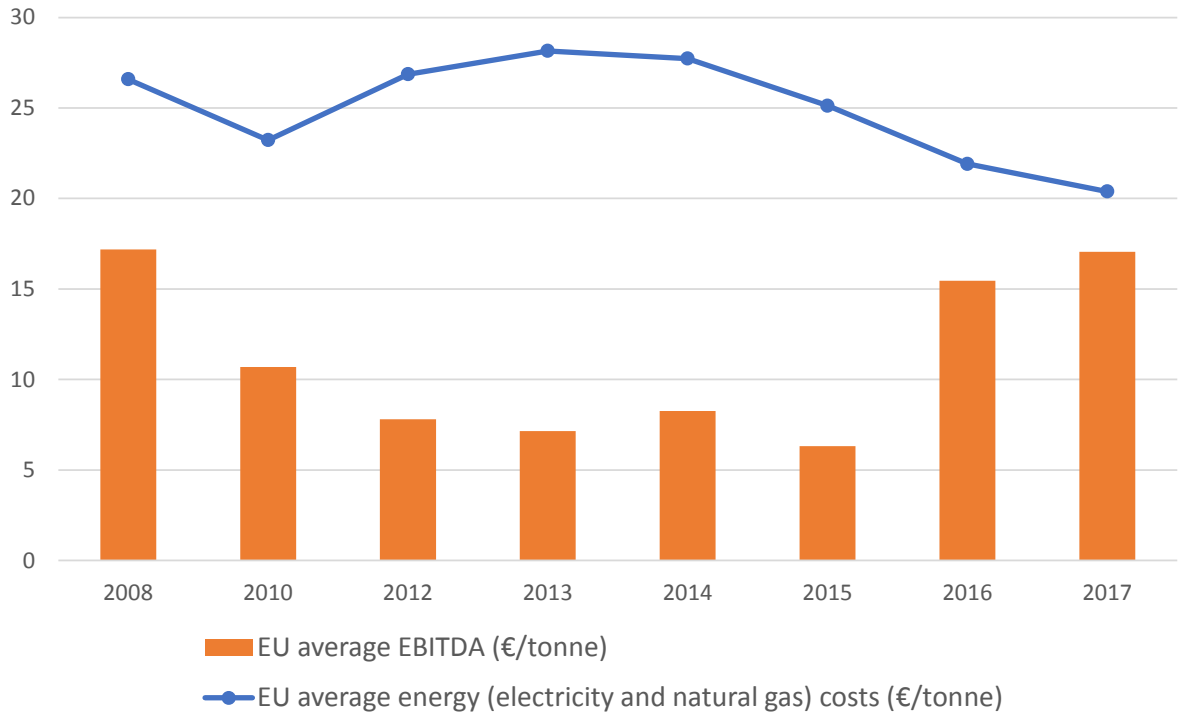
Competitiveness

Table 19. Key competitiveness indicators of brick and roof tile production (EU averages)

Indicator	2008	2010	2012	2013	2014	2015	2016	2017
Share of electricity costs in production costs (%)	6.2	6.5	7.9	9.1	7.8	6.1	5.4	7.1
Share of natural gas costs in production costs (%)	21.9	21.3	23.6	27.0	23.5	17.6	13.6	17.0
Share of total energy costs in production costs (%)	28.1	27.7	31.4	36.1	31.2	23.7	19.0	24.1
Total energy costs (€/tonne)	26.6	23.2	26.9	28.2	27.7	25.1	21.9	20.4
EBITDA (€/tonne)	17.2	10.7	7.8	7.2	8.3	6.3	15.5	17.1
Ratio of total energy costs to EBITDA	1.5	2.2	3.4	3.9	3.4	4.0	1.4	1.2

Source: CEPS/Ecofys.

Figure 53. Energy costs versus EBITDA of brick and roof tile production (€/tonne)



Source: CEPS/Ecofys.

A1.5 WALL AND FLOOR TILES

A1.5.1 General information and sample composition

The wall and floor tiles sector (sector 23.31 in NACE Rev. 2) includes manufacturers of ceramics tiles. The production is heterogeneous in terms of physical composition, dimension, weight, shape, surface and colour as well as use (covering and/or decorating both internal, e.g. kitchen and bathrooms, and external surfaces, e.g. swimming pools and public areas). Unlike bricks and roof tiles, wall and floor tiles are high value-added and highly tradable goods, more subject to international competition.

The most common energy source used in wall and floor tile production is natural gas. Electricity is used as a secondary energy source.

The sector, which closely follows the economic trend of the construction sector (its main customer), has been severely hit by the crisis. Its production value declined by about 23% between 2008 and 2015. In 2015, there were 1,225 wall and floor tile enterprises in the EU, mostly SMEs (the number of enterprises fell by almost 30% between 2008 and 2015). A notable difference with the bricks and roof tiles sector is that most EU wall and floor tile production concentrates in two Member States only (based on 2016 production value): Italy (42%) and Spain (39%). Poland completes the top three (9%).

Overall, the EU is a net exporter of wall and floor tiles. Major EU export destinations include the United States, Switzerland, Saudi Arabia and Russia. EU imports come mainly from Turkey and, to a less extent, China and the United Arab Emirates.

A typical wall and floor tile plant in the analysis has a natural gas intensity of 1.1-2.3 MWh/tonne and an electricity intensity of 0.1-0.3 MWh/tonne. The sample for 2016-2017 includes 22 plants across Europe (8 in CEE region, 4 in NWE region and 10 in SE region), representing about 12% of total EU production. The sample for 2008-2015 includes 18 plants across Europe, representing about 8% of the total EU production. In general, the SE region and SMEs are under-represented in the sample.

A1.5.2 Electricity prices, costs and intensity

Key electricity indicators for wall and floor tiles are presented in Table 20.

EU average electricity prices and costs (in EUR/MWh) remained quite stable between 2008 and 2017.

EU average electricity prices fluctuated between 90 and 100 EUR/MWh. When looking at the price components (Figure 54), it appears that the energy component accounted for just half (50%) of the price in 2017, which is comparatively lower than in the other sectors analysed (except brick and roof tile production). Conversely, the network component increased over time and represented 25% of the price in 2017. Larger consumers faced lower electricity prices (weighted average by purchased electricity is significantly below simple average), because they: i) benefitted from stronger bargaining power when negotiating electricity prices (lower energy component); and ii) paid relatively less for network costs and other non-recoverable taxes/levies (this was not the case for RES levies). Only a few plants relied on the wholesale market to purchase electricity and these did not coincide with the largest consumers.

EU average electricity costs in EUR/MWh (Figure 55) went from 96 EUR/MWh in 2008 to 86 EUR/MWh in 2017, with a peak in 2013 (105 EUR/MWh). The small difference between electricity prices and costs in EUR/MWh is due to: i) compensation received by two plants only for participating in flexibility schemes; ii) ex post reimbursements granted to two other sampled plants; and ii) self-generation of electricity by five plants. It also appears that larger consumers benefitted the most from flexibility schemes, self-generation and ex post reimbursement. EU average electricity costs in EUR/tonne (Figure 56) were equal to 21 EUR/tonne in 2008 and 19 EUR/tonne in 2017 and registered a peak in 2013 (22 EUR/tonne). Plants with higher production output registered slightly lower costs per tonne (weighted average by production output is slightly lower than simple average), mainly linked to better bargaining power when negotiating the energy component of the electricity price and relatively lower network costs and other non-recoverable taxes/levies.

EU average electricity intensity of the production process (Figure 57) was quite stable throughout the period under observation, ranging between 0.21 and 0.25 MWh/tonne. In addition, economies of scale play a limited role for electricity (difference between simple and weighted average – by production output – electricity intensity is very limited).

A1.5.3 Natural gas prices, costs and intensity

Key natural gas indicators for wall and floor tiles are presented in Table 21.

Natural gas prices and costs fluctuated throughout the period under observation, declining significantly in 2016 and 2017 owing to a decrease (in absolute value) in the energy component of the gas price.

After peaking in 2013 (33 EUR/MWh), EU average natural gas prices (Figure 58) decreased sharply down to about 22 EUR/MWh (in 2017). As shown in Figure 59, the natural gas price is made up mostly by the energy component (81% in 2017), though this share tends to decrease over time. Unlike in the bricks and roof tiles sector, larger consumers did not face lower natural gas prices. Only a few plants relied on the wholesale market to purchase natural gas. Given that there is no natural gas self-generation and only few plants participated in interruptibility schemes, with very limited compensation compared to total natural gas costs, it results that natural gas prices and costs in EUR/MWh are the same.

EU average natural gas costs (in EUR/tonne) ranged between 36 and 51 EUR/tonne between 2008 and 2017 (Figure 60). They decreased sharply to less than 40 EUR/tonne in 2016 and 2017. It should be noted that larger plants actually incurred higher costs (weighted average by production output is slightly above simple average), which indicates that natural gas costs were mostly affected by plant-specific features (e.g. the type of output produced) rather than by economies of scale and/or bargaining power of larger consumers.

EU average natural gas intensity in the wall and floor tiles sector (Figure 61) decreased over the 10 years, declining from 1.8 MWh/tonne in 2008 to 1.6 MWh/tonne in 2017 (apparent efficiency gain of 14% over 10 years). We do not observe any difference between smaller and larger producers in terms or natural gas intensity (no economies of scale linked to natural gas usage in this sector).

A1.5.4 Competitiveness

Between 2008 and 2017, natural gas and electricity costs represented 7-17% and 4-7% of total production costs, respectively (Table 22). The share of total energy (natural gas + electricity) costs in production costs decreased from 25% in 2008 to 11% in 2017. This sharp decrease results from the fact that in absolute terms production costs per output followed a rising trend (+77%) whereas energy costs per output decreased (-23%) over the period. One key feature of this sector is that economies of scale play a limited role. Indeed the size of the wall and floor tile producers does not influence their energy costs per output (simple and weighted – by production output – averages are the same), whereas larger producers actually incur higher total production costs per output (weighted average by production output is higher than simple average). The output produced is quite diverse in this sector, leading to plant specific costs, which at the end may explain this counterintuitive result.

It is not possible to draw conclusions on the impact of electricity and natural gas costs on profitability. We can observe a sharp increase in EBITDA in 2016 and 2017 (Figure 62), but this margin increase is partially influenced by the different composition of the sample in those years compared to the 2008-2015 period. It is worth emphasising that except between 2015-2017, energy costs were higher than EBITDA, which shows the importance of energy costs in this sector as regards competitiveness issues.

A1.5.5 Tables and graphs

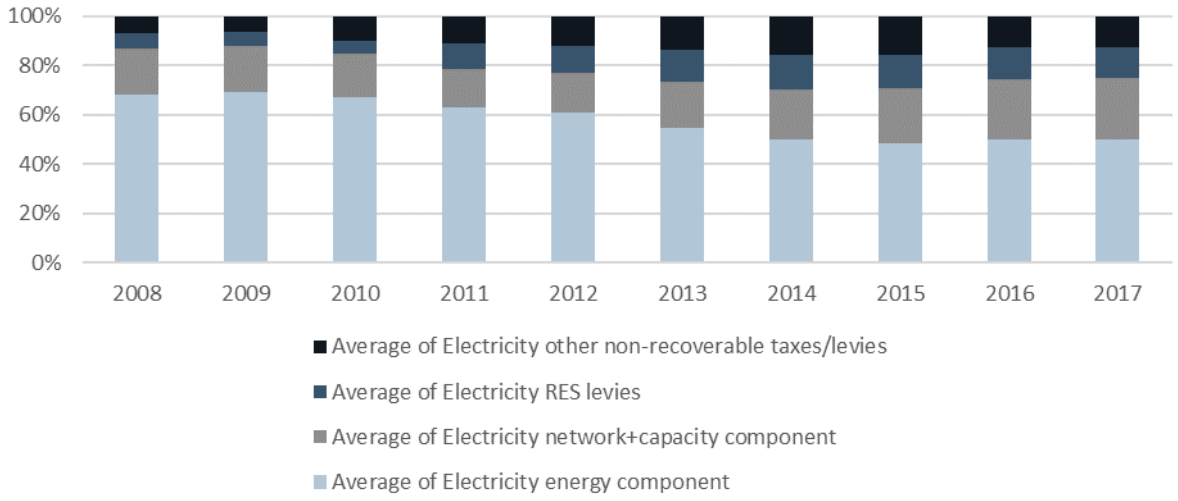
Electricity

Table 20. Key electricity indicators of wall and floor tile production (EU averages)

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity price (€/MWh)	67.4	68.9	67.9	91.7	83.1	77.1	69.7	72.0	66.5	69.3
Electricity costs (€/MWh)	64.0	67.9	66.3	73.4	70.0	75.0	65.2	64.7	60.3	65.2
Electricity costs (€/tonne)	12.0	12.1	11.1	12.3	11.8	13.4	11.3	11.0	11.4	10.7
Electricity intensity (MWh/tonne)	0.19	0.18	0.17	0.17	0.17	0.18	0.17	0.17	0.19	0.18

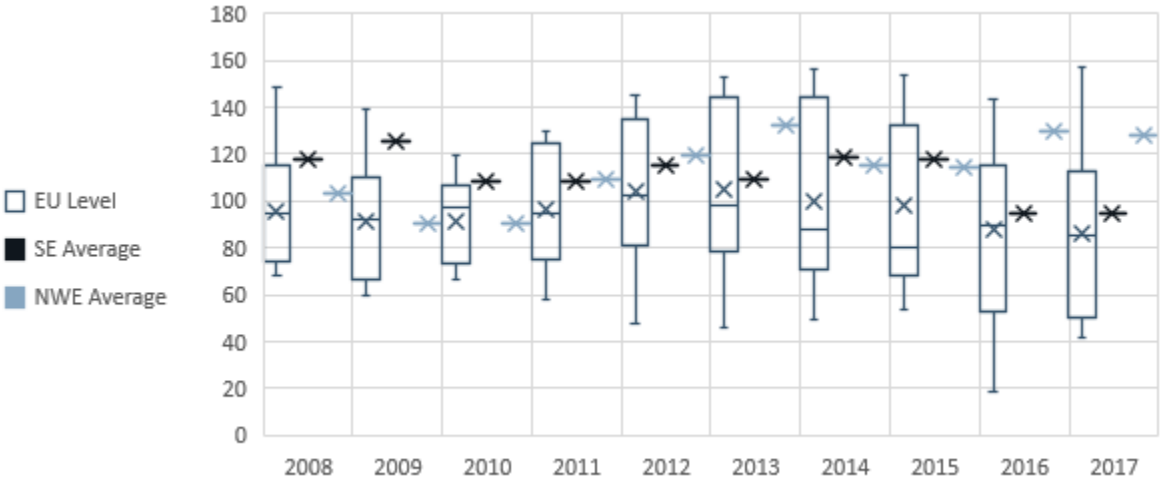
Source: CEPS/Ecofys.

Figure 54. Components of the EU average electricity price for wall and floor tile production (%)



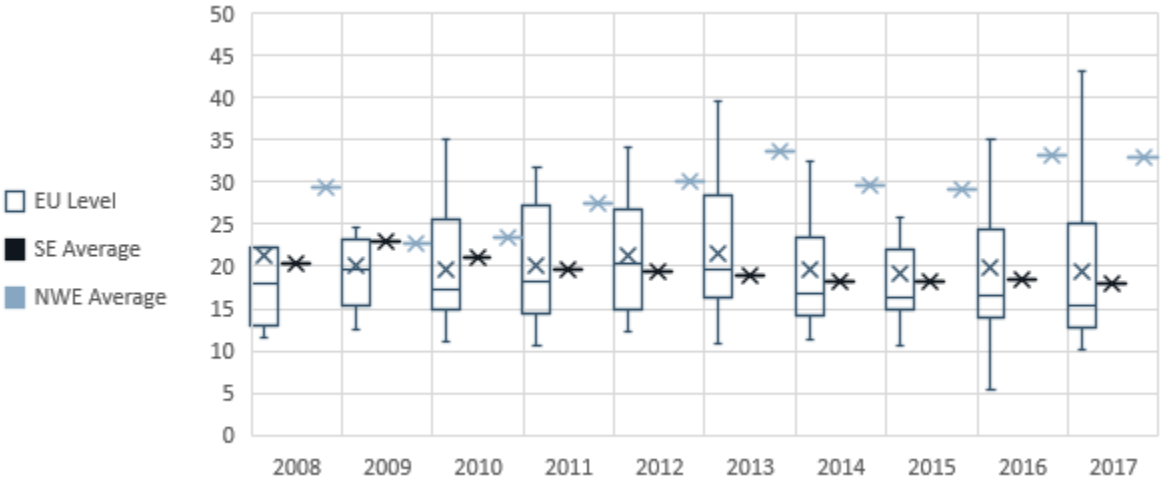
Source: CEPS/Ecofys.

Figure 55. Electricity costs of wall and floor tile production (€/MWh)



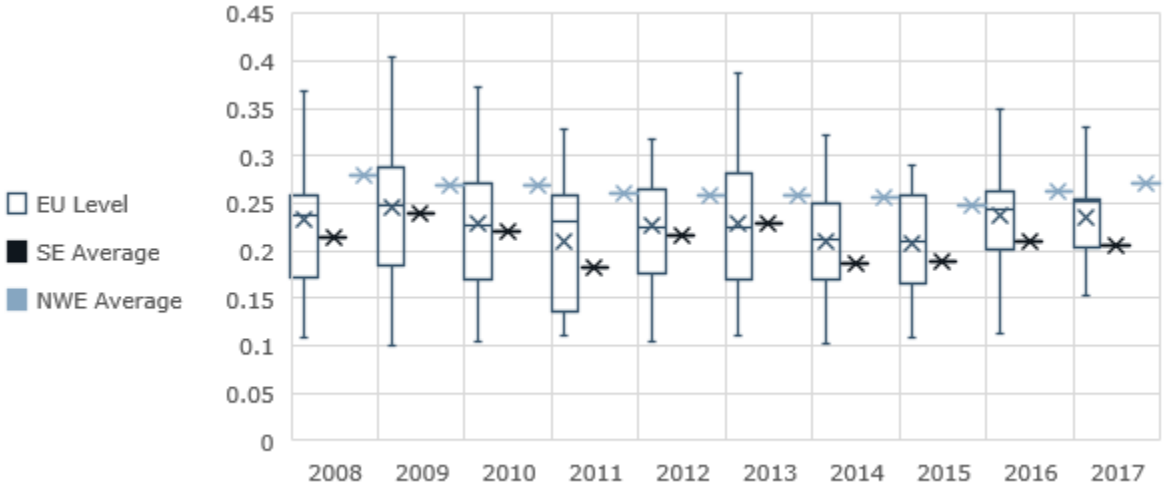
Source: CEPS/Ecofys.

Figure 56. Electricity costs of wall and floor tile production (€/tonne)



Source: CEPS/Ecofys.

Figure 57. Electricity intensity of wall and floor tile production (MWh/tonne)



Source: CEPS/Ecofys.

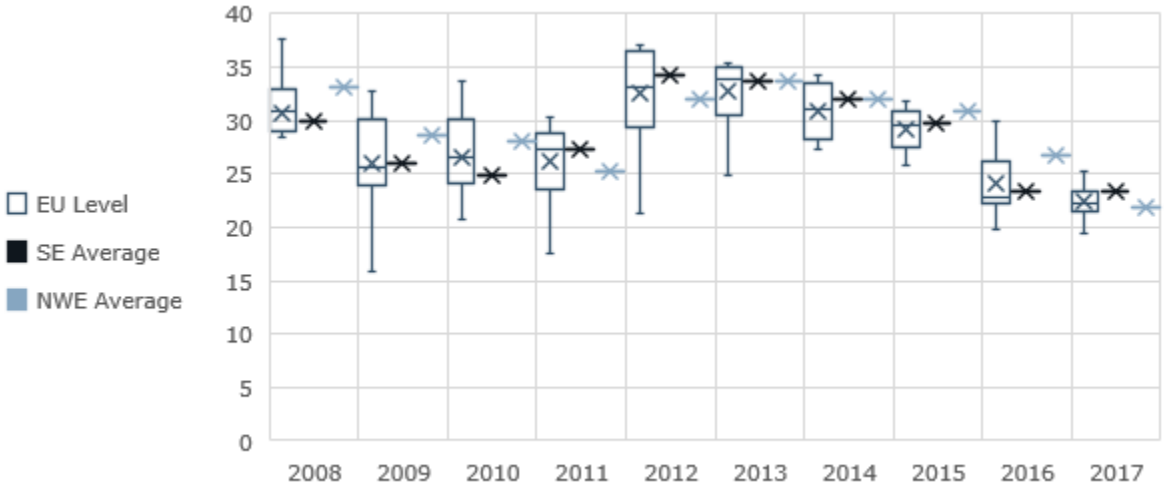
Natural gas

Table 21. Key natural gas indicators of wall and floor tile production (EU averages)

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas price (€/MWh)	30.7	26.1	26.5	26.1	32.5	32.7	30.9	29.2	24.1	22.4
Natural gas costs (€/tonne)	50.7	41.8	42.4	39.9	48.8	47.8	45.0	42.2	39.5	36.1
Natural gas intensity (MWh/tonne)	1.82	1.75	1.66	1.72	1.63	1.58	1.50	1.48	1.59	1.57

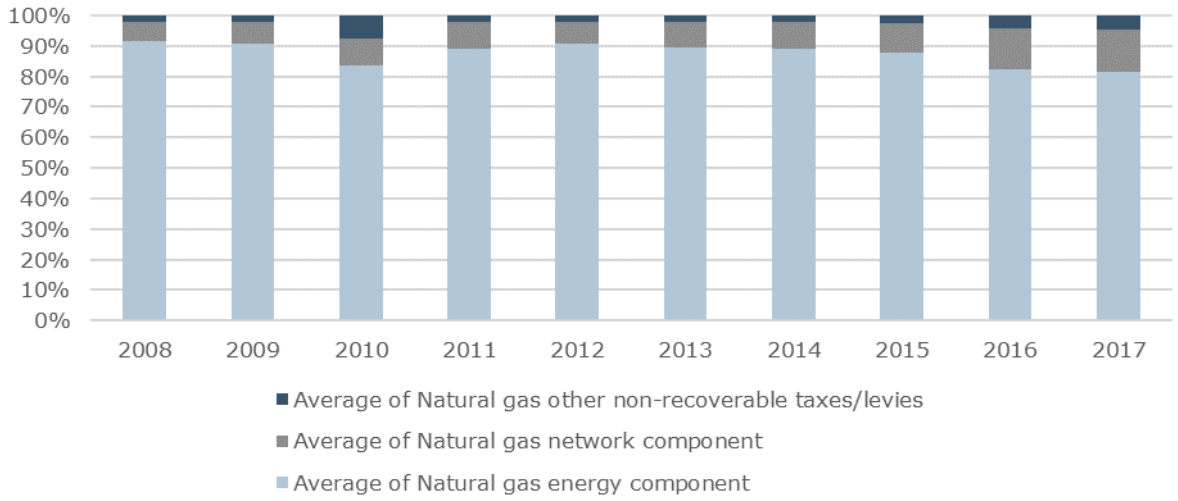
Source: CEPS/Ecofys.

Figure 58. Natural gas prices of wall and floor tile production (€/MWh)



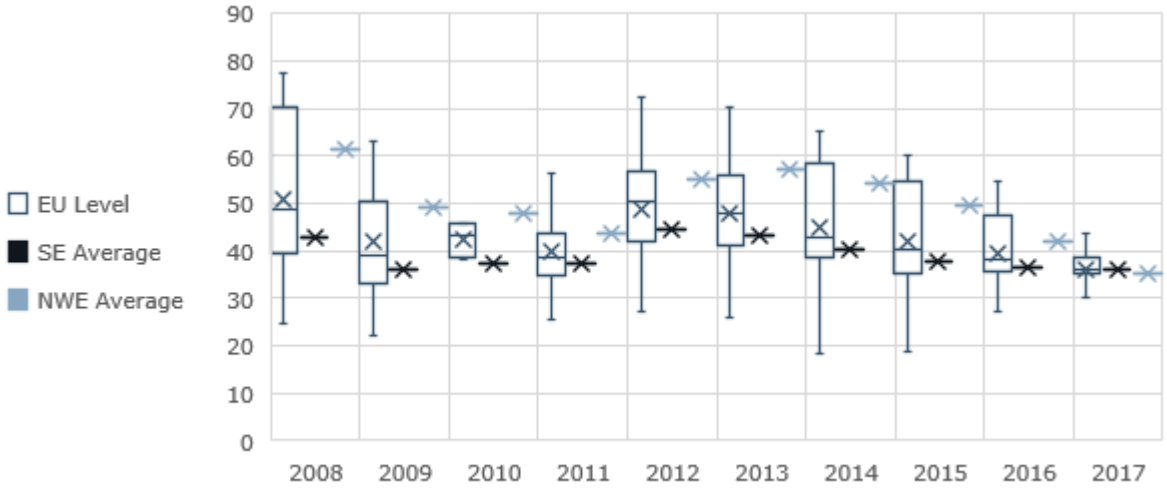
Source: CEPS/Ecofys.

Figure 59. Components of the EU average natural gas price for wall and floor tile production (%)



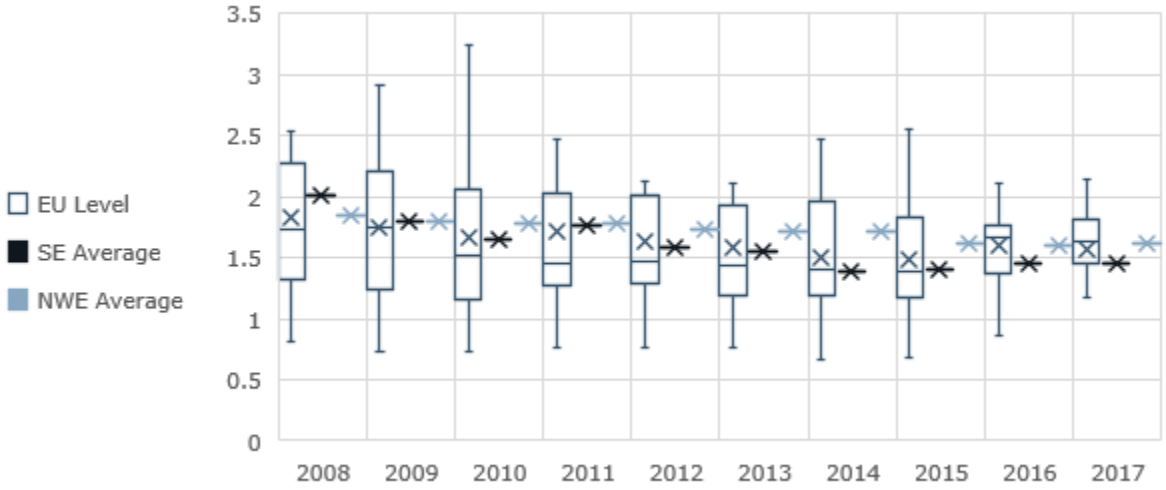
Source: CEPS/Ecofys.

Figure 60. Natural gas costs of wall and floor tile production (€/tonne)



Source: CEPS/Ecofys.

Figure 61. Natural gas intensity of wall and floor tile production (MWh/tonne)



Source: CEPS/Ecofys.

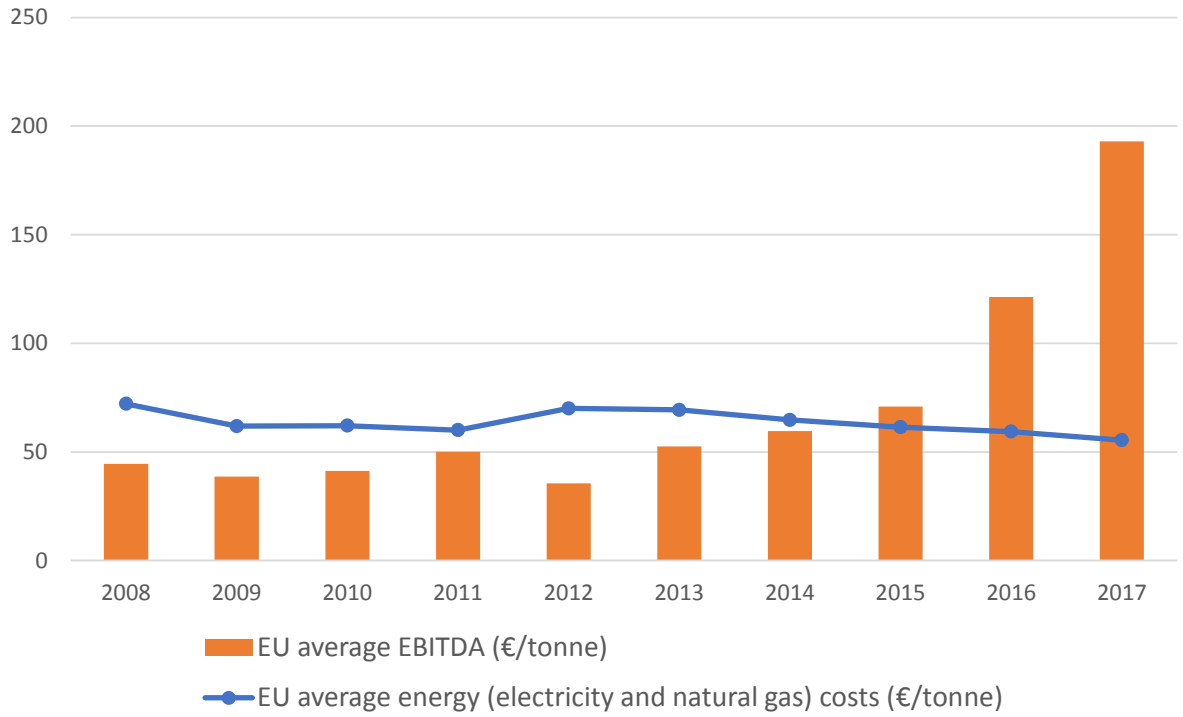
Competitiveness

Table 22. Key competitiveness indicators of wall and floor tile production (EU averages)

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Share of electricity costs in production costs (%)	7.3	5.4	6.9	6.3	6.4	7.0	6.3	6.1	5.2	3.8
Share of natural gas costs in production costs (%)	17.4	11.2	14.8	12.4	14.6	15.4	14.4	13.3	10.4	7.0
Share of total energy costs in production costs (%)	24.7	16.6	21.6	18.7	21.0	22.4	20.7	19.4	15.6	10.8
Total energy costs (€/tonne)	72.1	61.9	62.1	60.0	70.0	69.3	64.8	61.4	59.4	55.4
EBITDA (€/tonne)	44.5	38.7	41.2	50.1	35.5	52.6	59.7	70.8	121.4	192.9
Ratio of total energy costs to EBITDA	1.6	1.6	1.5	1.2	2.0	1.3	1.1	0.9	0.5	0.3

Source: CEPS/Ecofys.

Figure 62. Energy costs versus EBITDA of wall and floor tile production (€/tonne)



Source: CEPS/Ecofys.

A1.6 GLASS TABLEWARE

A1.6.1 General information and sample composition

Glass tableware, as packaging glass, is part of the hollow glass sector (sector 23.13 in NACE Rev. 2). Glass tableware production is quite heterogeneous: it includes a large variety of products (e.g. drinking glasses, pitchers, jugs, bowls, dishes, etc.), different qualities of products (e.g. champagne flute versus standard water glassware) and different types of production plants (small plants focusing on high value added products versus large plants focusing on mass production). It should be noted that glass tableware, in general, has a much higher value-to-weight ratio and is much more tradable than packaging glass.

The sector uses both electricity and natural gas as energy sources.

Unlike packaging glass, glass tableware production is still far from the pre-crisis level. After the 2009 crisis, it additionally registered a contraction between 2012 and 2015 and just started to partially recover in 2016. In 2015, there were 35 glass tableware plants, mostly part of large companies owning one or more production sites in the EU. Top five European producing countries are (based on 2016 production value): Italy (32%), France (17%), Poland (16%), Czech Republic (12%) and Spain (10%).

Overall, the EU is a net exporter of glass tableware. Major EU export destinations include the United States, Russia, China, Switzerland and Japan. EU imports come mostly from China and, to a less extent, Turkey.

A typical glass tableware plant in the analysis shows electricity and natural gas intensities in the range of 0.6-3.9 MWh/tonne and 3.4.-7.6 MWh/tonne, respectively. The sample includes 12 plants across Europe (two in CEE region, four in NWE region and six in SE region), representing more than 90% of total EU production (2016).

A1.6.2 Electricity prices, costs and intensity

Key electricity indicators for glass tableware are presented in Table 23.

Electricity prices and costs in EUR/MWh increased between 2008 and 2017, mainly due to a rise (in absolute value) in network costs and RES levies.

EU average electricity prices rose from 72 EUR/MWh in 2008 to 91 EUR/MWh in 2017, with a peak in 2013 (100 EUR/MWh). When looking at the price components (Figure 63), the energy component still represents the highest share of the price (59% in 2017), though this share has decreased over time. In contrast, network costs and RES levies significantly increased over the period, both in relative and absolute terms (they accounted in 2017 for 28% and 11% of the price, respectively). It is striking that in most recent years larger consumers faced much lower electricity prices (weighted average by purchased electricity is well below simple average) by: i) benefitting from stronger bargaining power when negotiating electricity prices (lower energy component); and ii) paying relatively less for network costs and non-recoverable taxes/levies, including RES levies. This gap between large consumers and small consumers increased recently, most likely because the former benefitted from larger exemptions on regulatory components than in previous years. Very few plants relied on the wholesale market to purchase electricity.

EU average electricity costs in EUR/MWh (Figure 64) increased from 69 EUR/MWh in 2008 to 85 EUR/MWh in 2017, with a peak in 2013 (99 EUR/MWh). The difference between electricity prices and costs in EUR/MWh can be explained by the following factors: i) a few plants participated in flexibility schemes (but the compensation is relatively small compared to their electricity costs); and ii) most of the plants were reimbursed ex post for some components of their electricity price (especially RES levies). There is not electricity self-generation in the sector. EU average electricity costs in EUR/tonne (Figure 65) halved over the last ten years, going from 205 EUR/tonne in 2008 to 108 EUR/tonne in 2017.

The sharp decrease in energy costs can be mainly explained by the significant reduction of electricity intensity (especially in smaller plants). EU average electricity intensity (Figure 66) fell from 2.1 MWh/tonne in 2008 to 1.3 MWh/tonne in 2017. It interesting to note that especially in this sector, besides facing lower electricity prices, larger producers were more electricity efficient (weighted average – by production output – electricity intensity is significantly below simple average one) by benefitting from economies of scale and not using electric heated/boosted furnaces (while smaller plants did).

A1.6.3 Natural gas prices, costs and intensity

Key natural gas indicators for glass tableware are presented in Table 24.

Natural gas prices and costs fluctuated between 2008 and 2015, before registering a sharp decline in 2016 and 2017, mainly due to a decrease (in absolute value) in the energy component of the gas price.

After peaking in 2013 (32 EUR/MWh), EU average natural gas prices (Figure 67) decreased sharply down to about 22 EUR/MWh (2017). As shown in Figure 68, the natural gas price is made up mostly by the energy component (90% in 2017), the remaining coming from the network component (non-recoverable taxes/levies play here a very minor role). Overall, larger plants tend to face lower natural gas prices (weighted average by purchased natural gas is generally below simple average), mostly because they paid relatively lower network costs and non-recoverable taxes/levies. But the natural gas price difference between larger and smaller plants is much less pronounced than in the case of electricity (quantity discounts and exemptions on regulatory components are less relevant for natural gas). Plants generally do not buy natural gas on the wholesale market. Natural gas costs in EUR/MWh are the same as prices (no natural gas self-generation and no plant taking part in interruptibility schemes).

EU average natural gas costs (in EUR/tonne) ranged between 144 and 170 EUR/tonne between 2008 and 2015 (Figure 69). They decreased in recent years, falling to around 130 EUR/tonne in 2016 and 2017. Larger plants incurred significant lower costs (weighted average by production output is well below simple average), which can be mainly due to economies of scale (quantity discounts and exemptions seem to play a minor role here).

EU average natural gas intensity (Figure 70) ranged between 5 and 6 MWh/tonne over the last ten years. We can see a growing trend from 2013 but this can be attributed to a switch from electricity to natural gas. When considering the overall energy (electricity + natural gas) consumption, the energy intensity of the production process actually decreased between 2008 and 2017, from about 8 MWh/tonne to about 7 MWh/tonne. It should also be noted that larger plants are more natural gas efficient (weighted average – by production output – natural gas intensity is below simple average one).

A1.6.4 Competitiveness

As shown in Table 25, over the period, the share of electricity costs in total production costs declined, from 9% (2008) to about 6% (2017), while the share of natural gas costs in total production costs increased from around 7% (2008) to about 8% (2017). Overall, the share of total energy (electricity + natural gas) costs in production costs slightly decreased from 16% in 2008 to 14% in 2017.

It is not possible to draw conclusions on the impact of electricity and natural gas costs on profitability. As shown in Figure 71, in absolute terms, EU average energy costs per tonne decreased significantly over the period, from 354 EUR/tonne (2008) to 235 EUR/tonne (2017), while EU average EBITDA per tonne was very volatile (range of 78-278 EUR/tonne), including some bad years (2009, 2015 and 2016) and better years (e.g. 2010 and 2011). It is still worth underlining that energy costs were always higher than EBITDA, which confirms the importance of energy costs in this sector as regards competitiveness issues.

A1.6.5 Tables and graphs

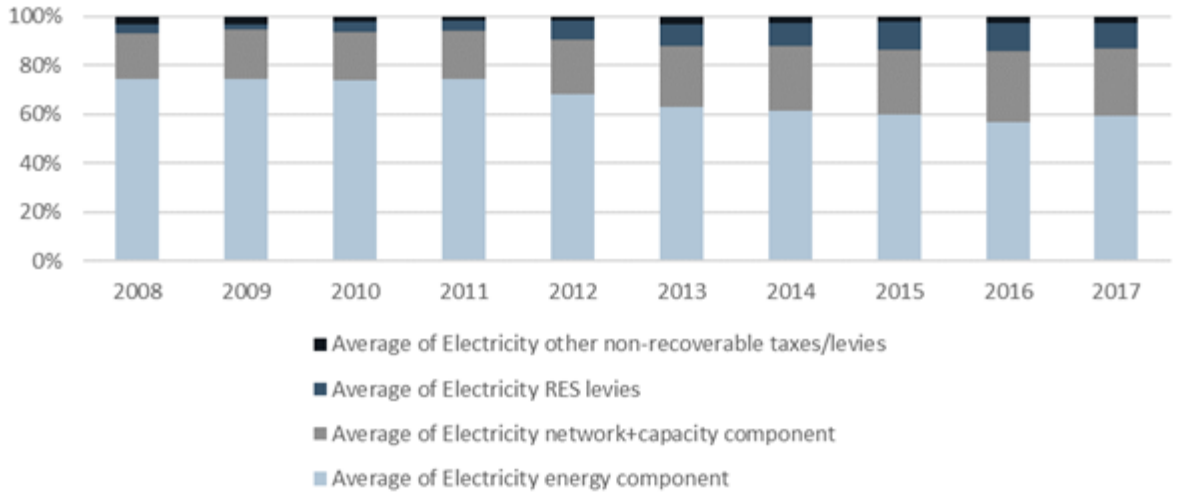
Electricity

Table 23. Key electricity indicators of glass tableware production (EU averages)

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity price (€/MWh)	71.5	77.7	79.3	83.1	94.4	100.1	97.4	96.6	92.4	91.3
Electricity costs (€/MWh)	69.2	76.2	77.7	81.8	93.2	98.9	92.6	90.1	85.8	85.1
Electricity costs (€/tonne)	204.8	203.2	140.8	140.9	161.4	152.3	119.4	120.4	108.5	107.7
Electricity intensity (MWh/tonne)	2.1	2.3	1.7	1.7	1.7	1.5	1.3	1.4	1.3	1.3

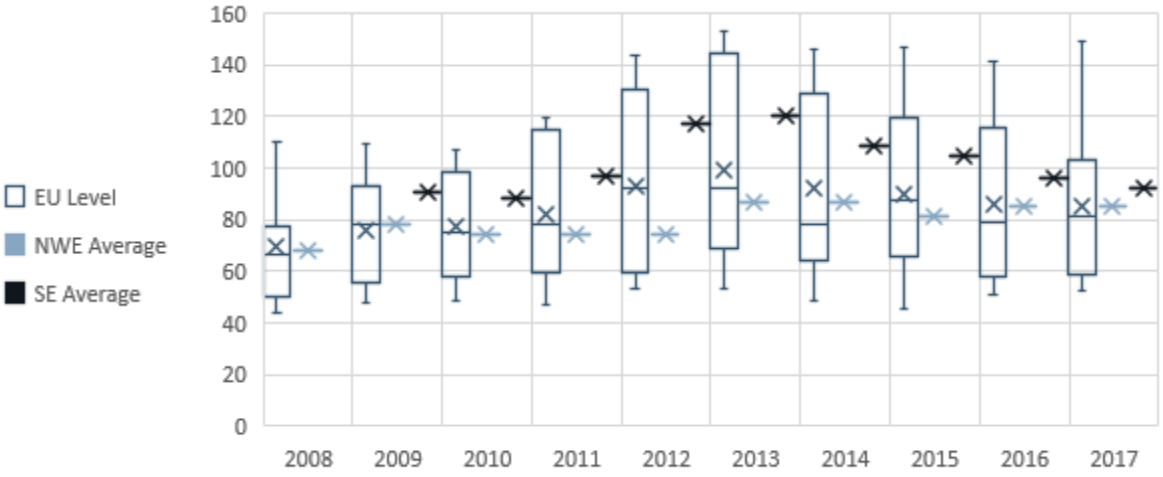
Source: CEPS/Ecofys.

Figure 63. Components of the EU average electricity price for glass tableware production (%)



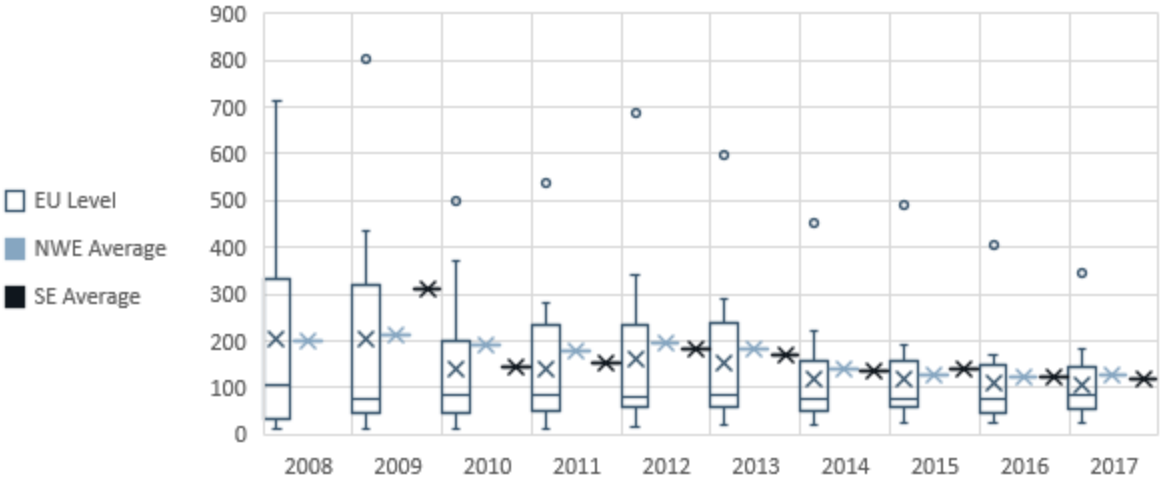
Source: CEPS/Ecofys.

Figure 64. Electricity costs of glass tableware production (€/MWh)



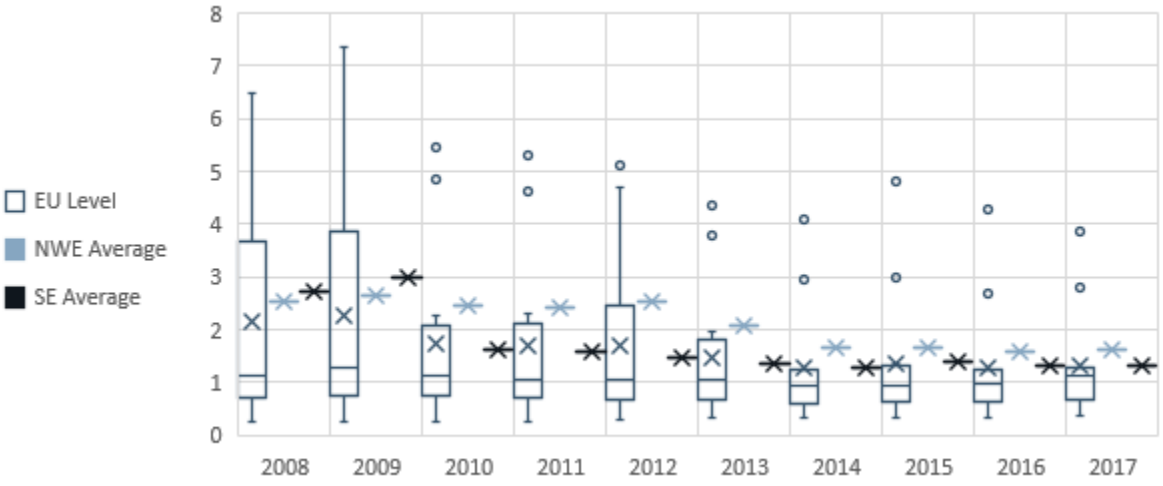
Source: CEPS/Ecofys.

Figure 65. Electricity costs of glass tableware production (€/tonne)



Source: CEPS/Ecofys.

Figure 66. Electricity intensity of glass tableware production (MWh/tonne)



Source: CEPS/Ecofys.

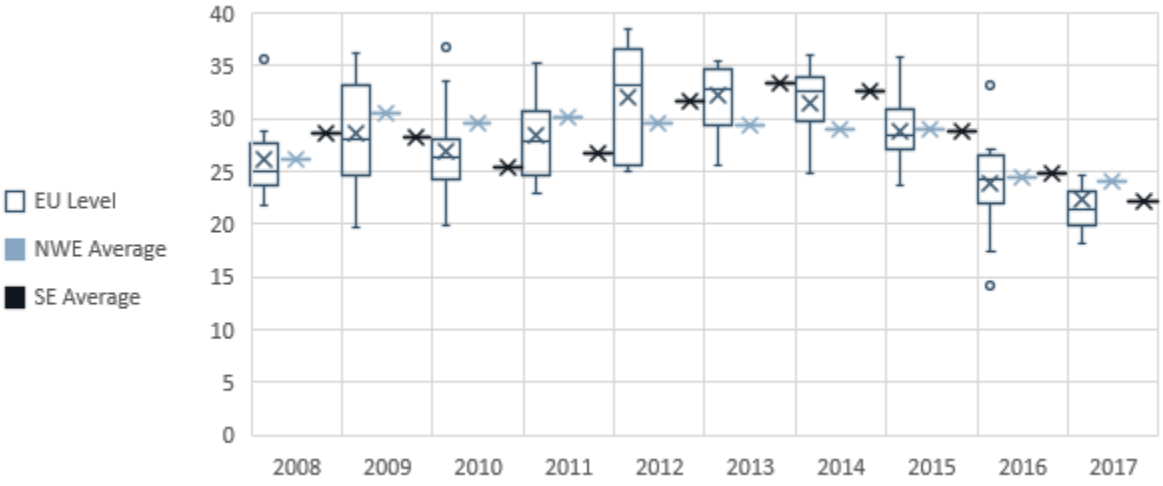
Natural gas

Table 24. Key natural gas indicators of glass tableware production (EU averages)

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas price (€/MWh)	26.2	28.6	26.9	28.4	32.0	32.2	31.5	28.7	23.8	22.3
Natural gas costs (€/tonne)	149.7	170.5	144.1	146.0	162.7	163.4	168.8	159.9	131.9	127.5
Natural gas intensity (MWh/tonne)	5.6	6.2	5.5	5.2	5.2	5.1	5.4	5.5	5.3	5.5

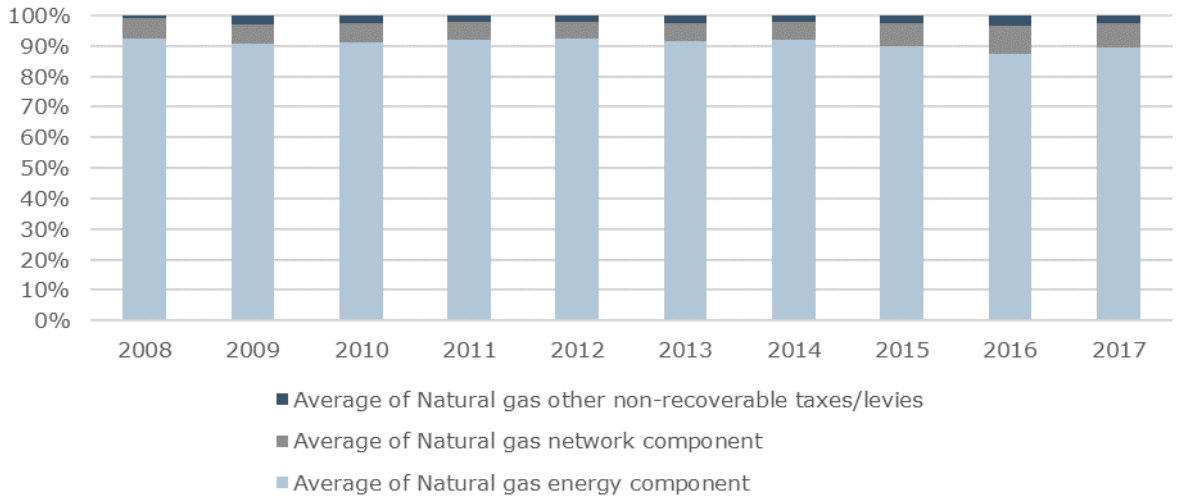
Source: CEPS/Ecofys.

Figure 67. Natural gas prices of glass tableware production (€/MWh)



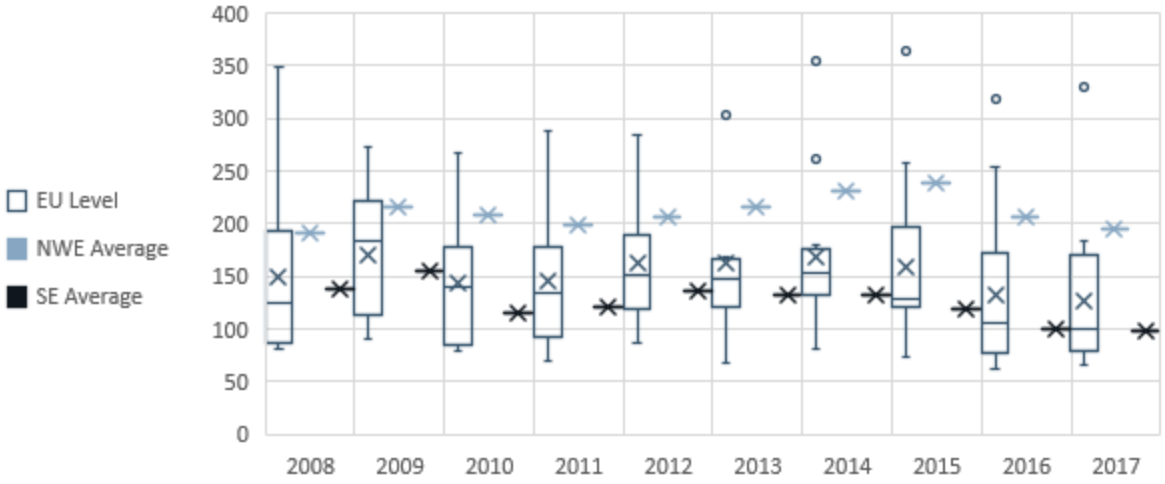
Source: CEPS/Ecofys.

Figure 68. Components of the EU average natural gas price for glass tableware production (%)



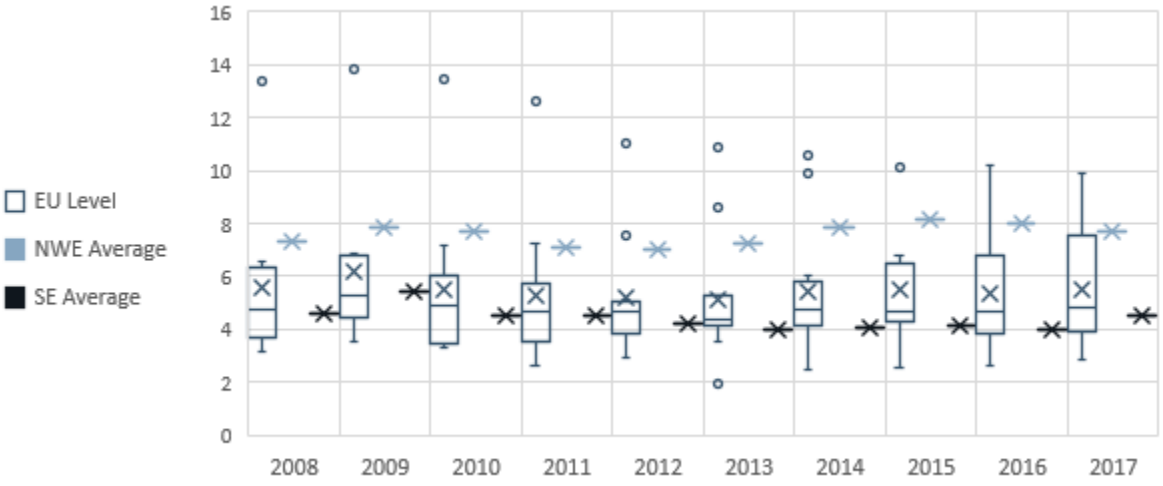
Source: CEPS/Ecofys.

Figure 69. Natural gas costs of glass tableware production (€/tonne)



Source: CEPS/Ecofys.

Figure 70. Natural gas intensity of glass tableware production (MWh/tonne)



Source: CEPS/Ecofys.

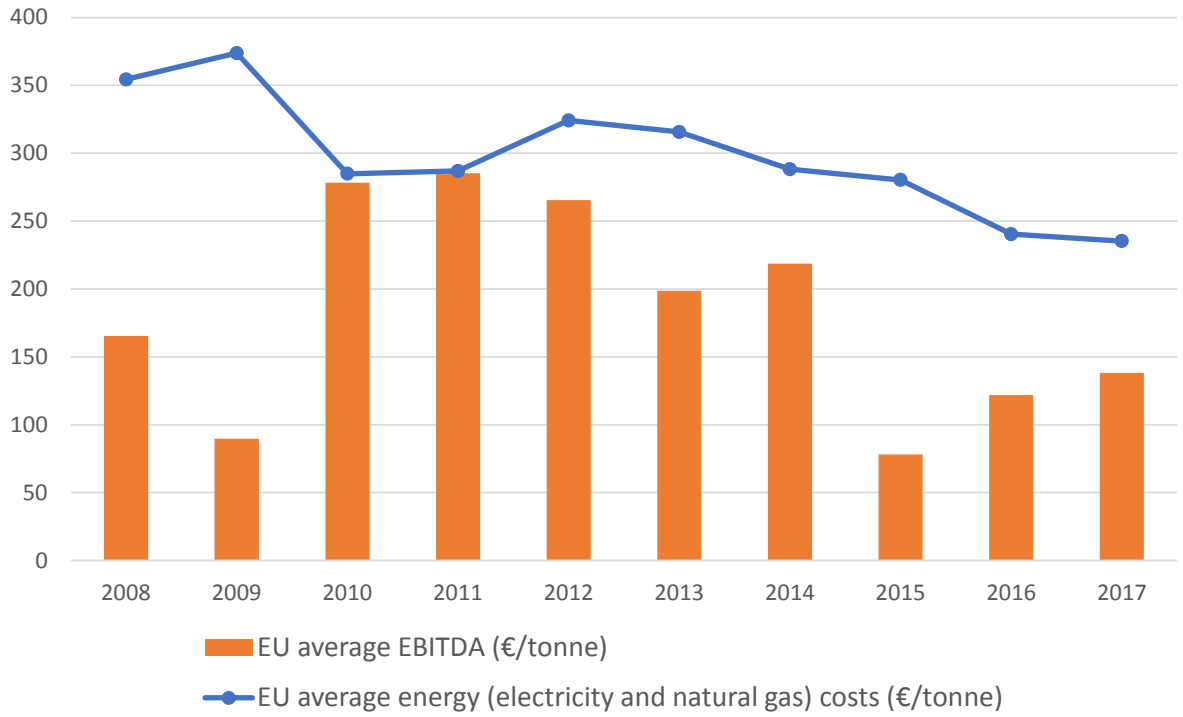
Competitiveness

Table 25. Key competitiveness indicators of glass tableware production (EU averages)

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Share of electricity costs in production costs (%)	9.3	8.6	6.2	6.8	7.2	7.8	6.7	6.4	6.2	6.5
Share of natural gas costs in production costs (%)	6.8	7.2	6.3	7.0	7.3	8.3	9.4	8.5	7.5	7.7
Share of total energy costs in production costs (%)	16.1	15.8	12.5	13.8	14.5	16.1	16.1	14.8	13.7	14.2
Total energy costs (€/tonne)	354.4	373.7	284.9	286.9	324.1	315.7	288.2	280.3	240.4	235.2
EBITDA (€/tonne)	165.4	89.8	278.2	285.2	265.6	198.6	218.6	78.2	121.8	138.2
Ratio of total energy costs to EBITDA	2.1	4.2	1.0	1.0	1.2	1.6	1.3	3.6	2.0	1.7

Source: CEPS/Ecofys.

Figure 71. Energy costs versus EBITDA of glass tableware production (€/tonne)



Source: CEPS/Ecofys.

A1.7 PACKAGING GLASS

A1.7.1 General information and sample composition

Packaging glass, as glass tableware, is part of the hollow glass sector (sector 23.13 in NACE Rev. 2). Packaging glass production includes bottles, jars and other containers, which come in different colours and shapes. Compared to glass tableware, packaging glass has low value-to-weight ratio and is less tradable.

The sector uses natural gas as main energy source and electricity as secondary source.

Unlike glass tableware, EU packaging glass production has recovered pre-crisis level. In 2016, there were a bit less than 200 plants in Europe, mostly composed of large companies owning multiple production sites in the EU and third countries. Top five European producing countries are (based on 2016 production value): Italy (21%), France (21%), Germany (19%), the United Kingdom (11%) and Spain (11%).

Overall, the EU is a net exporter of packaging glass. Major EU export destinations include the United States and Switzerland. EU imports come mainly from China and, to a less extent, Ukraine, Switzerland, India and the United Arab Emirates.

A typical packaging glass plant in the analysis has a natural gas intensity of 1.4-2.1 MWh/tonne and an electricity intensity of 0.3-0.4 MWh/tonne. The sample includes 24 plants across Europe (eight in each region), representing around 17% of total EU production.

A1.7.2 Electricity prices, costs and intensity

Key electricity indicators for packaging glass are presented in Table 26.

Electricity prices and costs in EUR/MWh saw a fluctuating trend between 2008 and 2015, before registering a decrease in 2016 and 2017, mainly due to a decline (in absolute value) in the energy component of the electricity price.

EU average electricity prices went from 77 EUR/MWh in 2008 to 75 EUR/MWh in 2017, with a peak in 2012 at 83 EUR/MWh. When looking at the price components (Figure 72), the energy component still represents the highest share of the price (56% in 2017), though this share has decreased over time. In contrast, network costs and RES levies significantly increased over the period, both in relative and absolute terms (they accounted in 2017 for 25% and 17% of the price, respectively). Larger consumers faced lower electricity prices (weighted average by purchased electricity is below simple average) by paying relatively less for network costs and RES levies (note that they did not pay less for the other price components, i.e. network costs and other non-recoverable taxes/levies). This gap between large consumers and small consumers increased recently, most likely because the former benefitted from larger exemptions on regulatory components than in previous years. No plant bought electricity directly on the wholesale market.

EU average electricity costs in EUR/MWh (Figure 73) increased from 75 EUR/MWh in 2008 to 79 EUR/MWh in 2012 and then decreased to 65 EUR/MWh in 2017. The increasing difference between electricity prices and costs (rising up to 10 EUR/MWh in 2017) can be explained by the participation of plants in flexibility schemes and ex post reimbursement for some components of their electricity price (mainly RES levies and other non-recoverable taxes/levies). Both compensation for flexibility schemes and ex post reimbursement grew in the most recent years. There is not electricity self-generation in the sector. EU average electricity costs in EUR/tonne (Figure 74) also increased from 24 EUR/tonne in 2008 to 26 EUR/tonne in 2012 and, subsequently, declined to 21 EUR/tonne in 2017.

EU average electricity intensity (Figure 75) remained stable over the 10-year period, ranging between 0.32-0.34 MWh/tonne. Larger producers benefitted from small economies of scale (weighted average – by production output – electricity intensity is slightly below simple average one).

A1.7.3 Natural gas prices, costs and intensity

Key natural gas indicators for packaging glass are presented in Table 27.

Natural gas prices and costs fluctuated between 2008 and 2015, before registering a sharp decline in 2016 and 2017, mainly due to a decrease (in absolute value) in the energy component of the gas price.

After peaking in 2012 (32 EUR/MWh), EU average natural gas prices (Figure 76) decreased sharply down to 21 EUR/MWh in 2017. As shown in Figure 77, the natural gas price is made up mostly by the energy component (88% in 2017), the remaining coming from the network component (note that non-recoverable taxes/levies are marginal, less than 1% in 2017). Large and small consumers paid the same price (weighted average by purchased natural gas and simple average are the same).

EU average natural gas costs (in EUR/tonne) ranged between 44 and 53 EUR/tonne between 2008 and 2015 (Figure 78). They decreased in recent years, falling to around 35 EUR/tonne in 2016 and 2017.

EU average natural gas intensity (Figure 79) recorded a decreasing trend from above 1.8 MWh/tonne (in 2008) to below 1.7 MWh/tonne (in 2017), indicating increased energy efficiency in the production process. Larger producers benefitted from small economies of scale (weighted average – by production output – natural gas intensity is slightly below simple average one).

A1.7.4 Competitiveness

As shown in Table 28, over the period, the share of electricity costs in total production costs declined, from 8% (2008) to about 7% (2017). The share of natural gas costs in total production costs ranged between 16% and 17% from 2008 to 2014, but decreased significantly thereafter, falling from 15% in 2015 to 11% in 2017. Overall, the share of total energy (natural gas + electricity) costs in production costs decreased from 25% in 2008 to 18% in 2017.

It is not possible to draw firm conclusions on the impact of electricity and natural gas costs on profitability. As shown in Figure 80, in absolute terms, EU average energy costs per tonne were in the range of 70-80 EUR/tonne until 2015 and then significantly decreased (56 EUR/tonne in 2017), while EU average EBITDA per tonne fluctuated over the period (between 63 and 78 EUR/tonne). We can still note that EBITDA and energy costs per tonne were always in the same order of magnitude (ratio of total energy costs to EBITDA close to 1) and in the most recent years, when energy costs significantly fell down, EBITDA improved. Energy costs are then an important element to be considered when looking at competitiveness issues in this sector.

A1.7.5 Tables and graphs

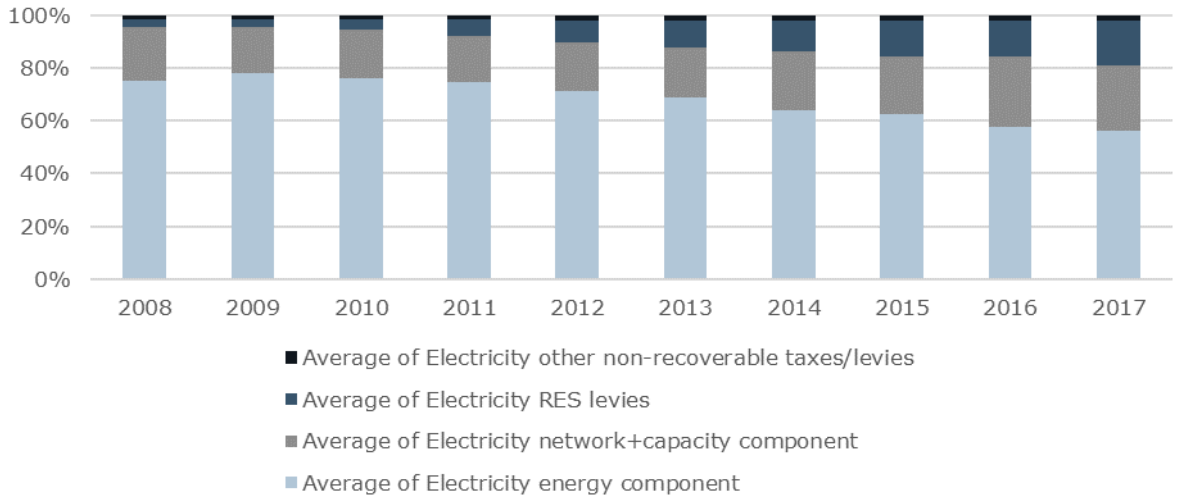
Electricity

Table 26. Key electricity indicators of packaging glass production (EU averages)

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity price (€/MWh)	77.0	79.0	75.8	77.7	83.3	82.5	80.3	82.6	75.4	75.0
Electricity costs (€/MWh)	75.3	77.3	74.1	73.5	79.1	77.0	73.1	76.0	68.9	64.8
Electricity costs (€/tonne)	24.3	26.0	24.5	24.2	26.2	25.6	23.2	24.5	22.1	20.6
Electricity intensity (MWh/tonne)	0.32	0.34	0.33	0.33	0.33	0.33	0.32	0.32	0.32	0.32

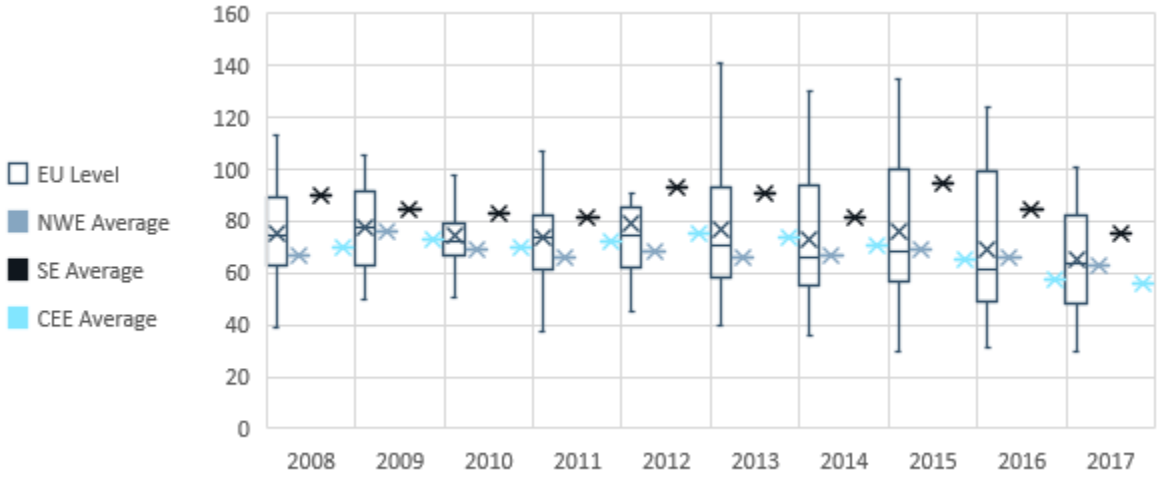
Source: CEPS/Ecofys.

Figure 72. Components of the EU average electricity price for packaging glass production (%)



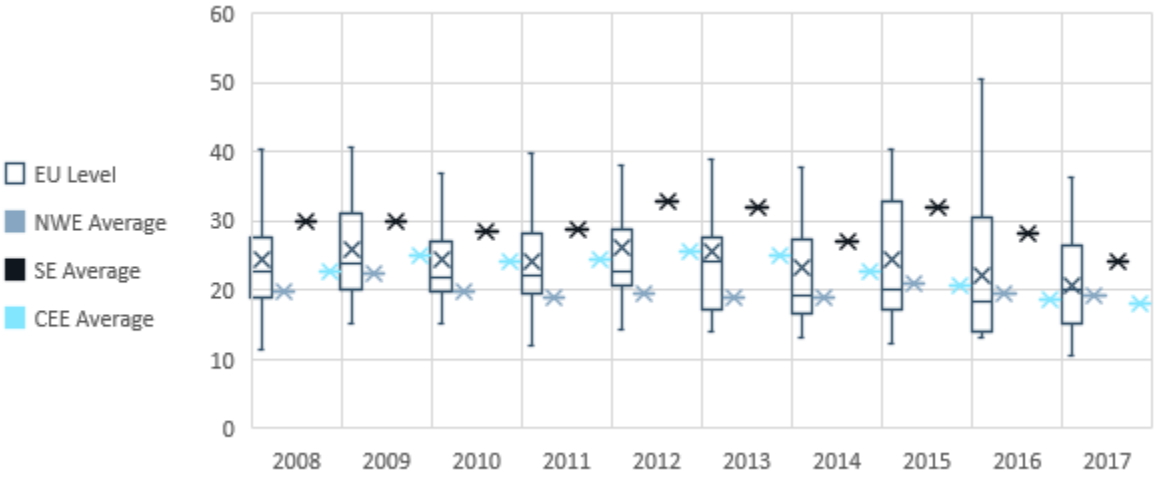
Source: CEPS/Ecofys.

Figure 73. Electricity costs of packaging glass production (€/MWh)



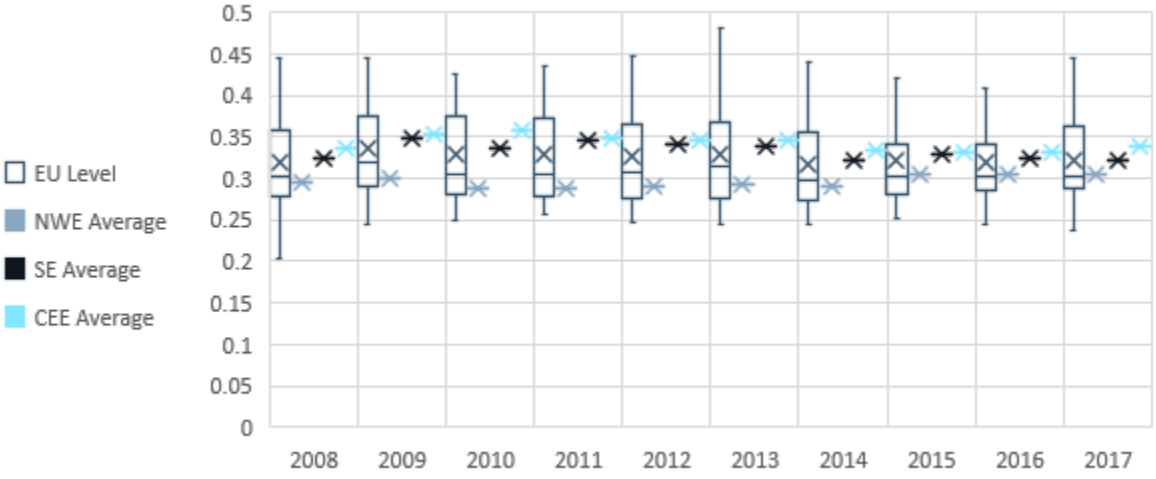
Source: CEPS/Ecofys.

Figure 74. Electricity costs of packaging glass production (€/tonne)



Source: CEPS/Ecofys.

Figure 75. Electricity intensity of packaging glass production (MWh/tonne)



Source: CEPS/Ecofys.

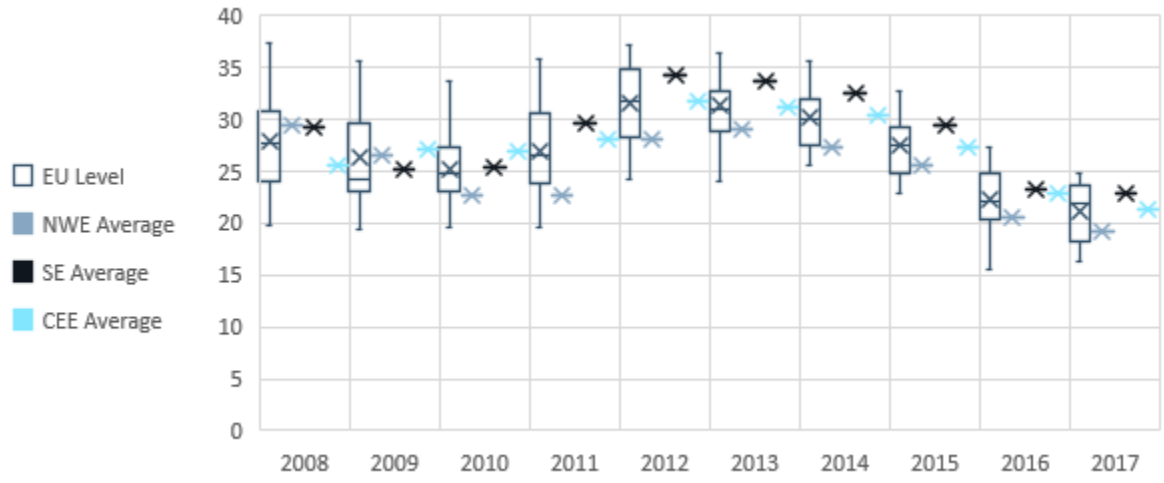
Natural gas

Table 27. Key natural gas indicators of packaging glass production (EU averages)

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas price (€/MWh)	27.8	26.3	25.1	26.9	31.5	31.3	30.1	27.5	22.3	21.2
Natural gas costs (€/tonne)	50.0	47.4	44.1	46.2	52.2	52.5	50.7	45.9	36.1	35.2
Natural gas intensity (MWh/tonne)	1.8	1.8	1.8	1.7	1.7	1.7	1.7	1.7	1.6	1.7

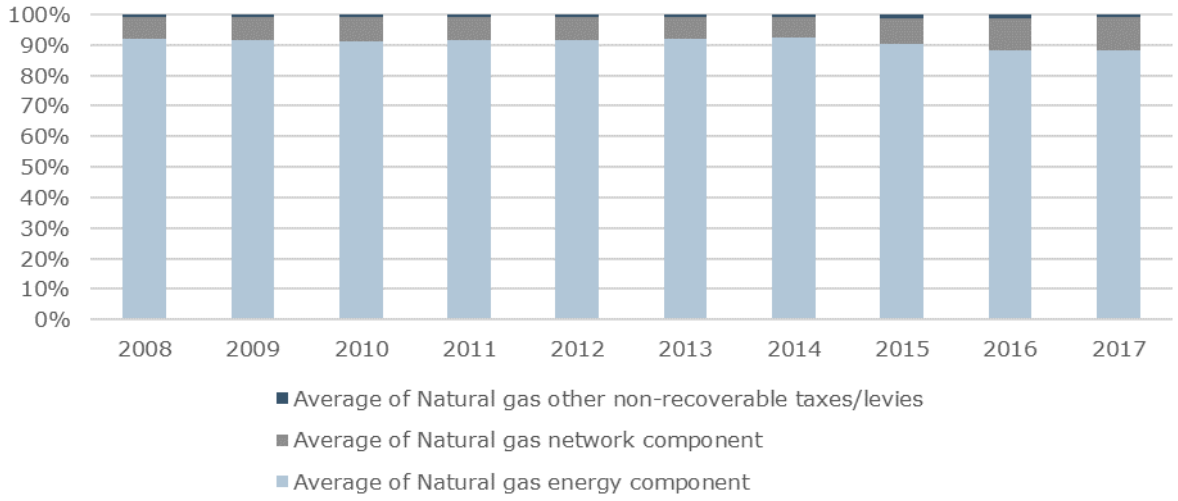
Source: CEPS/Ecofys.

Figure 76. Natural gas prices of packaging glass production (€/MWh)



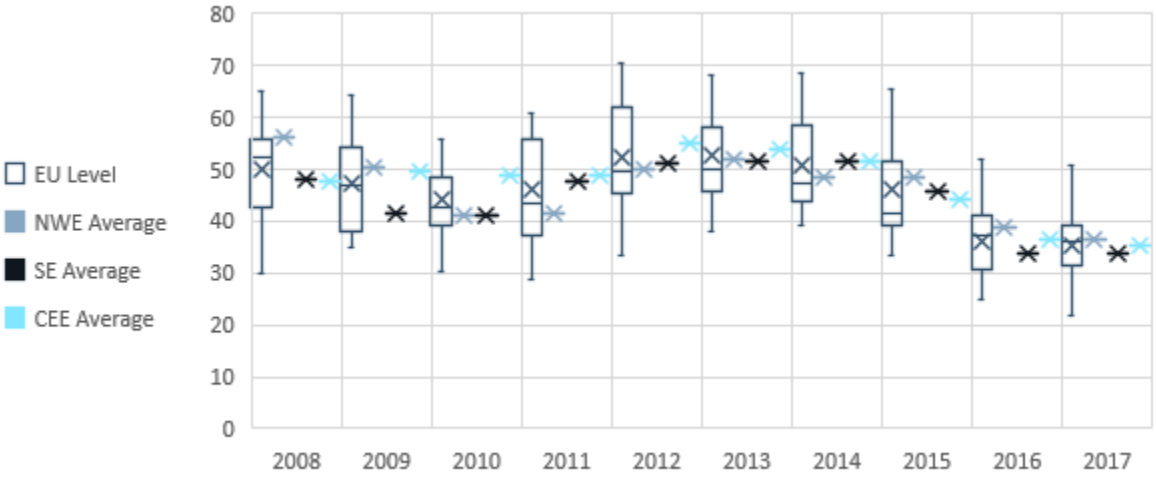
Source: CEPS/Ecofys.

Figure 77. Components of the EU average natural gas price for packaging glass production (%)



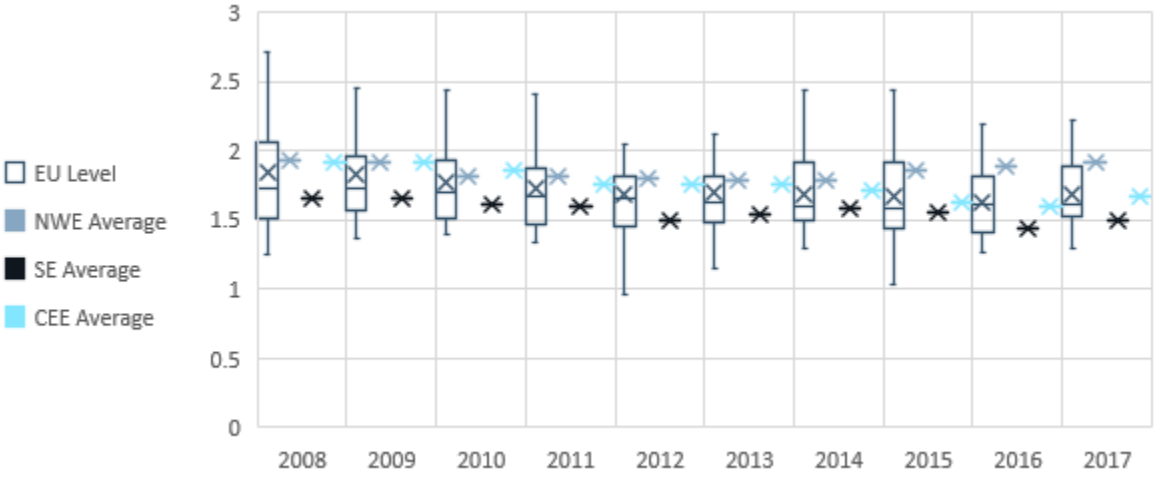
Source: CEPS/Ecofys.

Figure 78. Natural gas costs of packaging glass production (€/tonne)



Source: CEPS/Ecofys.

Figure 79. Natural gas intensity of packaging glass production (MWh/tonne)



Source: CEPS/Ecofys.

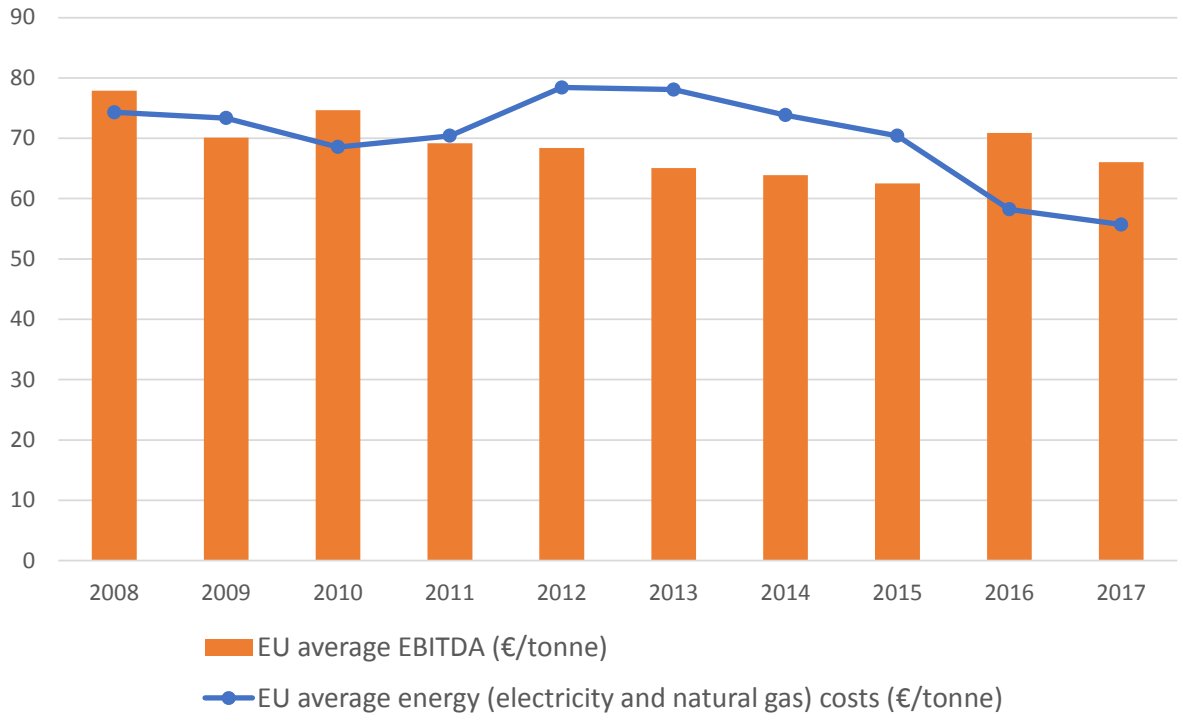
Competitiveness

Table 28. Key competitiveness indicators of packaging glass production (EU averages)

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Share of electricity costs in production costs (%)	8.3	8.7	8.8	8.2	8.3	7.9	7.4	7.9	7.5	6.6
Share of natural gas costs in production costs (%)	17.1	15.9	15.8	15.6	16.6	16.1	16.2	14.9	12.2	11.4
Share of total energy costs in production costs (%)	25.4	24.6	24.5	23.8	25.0	24.0	23.6	22.8	19.6	18.0
Total energy costs (€/tonne)	74.3	73.4	68.6	70.4	78.4	78.1	73.8	70.4	58.2	55.7
EBITDA (€/tonne)	77.9	70.1	74.7	69.2	68.4	65.1	63.9	62.5	70.9	66.0
Ratio of total energy costs to EBITDA	1.0	1.0	0.9	1.0	1.1	1.2	1.2	1.1	0.8	0.8

Source: CEPS/Ecofys.

Figure 80. Energy costs versus EBITDA of packaging glass production (€/tonne)



Source: CEPS/Ecofys.

A1.8 NITROGEN FERTILISERS

A1.8.1 General information and sample composition

Nitrogen fertilisers are part of sector 20.15 in NACE Rev.2.

For nitrogen fertilisers, ammonia production is the key building block, which requires by far the largest share of energy in the whole production process. The most common fuel used in ammonia production is natural gas, which mainly serves as a feedstock. In the nitrogen fertiliser sector, natural gas costs can represent around 60% of total production costs.

In the last few years, the European fertiliser industry has experienced a slowdown due to less demand of fertilisers from farmers. As farmers experience lower commodity prices (i.e. less revenue on their produce), they have tended to reduce fertiliser intake or purchase fertilisers from non-EU markets. The latter can offer cheaper fertilisers than those produced in the EU. Top five European producing countries are (based on 2017 capacity): Germany (16%), Poland (15%), the Netherlands (15%), France (8%) and the United Kingdom (6%).

Overall, the EU is a net importer of fertilisers and nitrogen compounds, importing most of it from Russia. The EU also exports some of its production, mostly to Brazil, Turkey and the United States.

The analysis focusses on ammonia plants. There are 47 ammonia plants in the EU, where a typical plant has an average capacity of 400 kilo tonnes/year, an average natural gas intensity of 10.8 MWh/tonne and an average electricity intensity of 0.18 MWh/tonne. The sample in the analysis includes eight EU plants (four in CEE region, one in NWE region and three in SE region), representing about 19% of total ammonia capacity in the EU.

A1.8.2 Electricity prices, costs and intensity

Key electricity indicators for nitrogen fertilisers are presented in Table 29.

EU average electricity price in 2017 was at a similar level as in 2008 (69 EUR/MWh). Price peaked in 2011 at 92 EUR/MWh and then continuously decreased again. As shown in Figure 81, in every year, the energy component accounted for the largest share in the electricity price (74% in 2008, 69% in 2017), followed by the network component (18% in 2008, 17% in 2017). Overall, large consumers faced lower electricity prices (weighted average by purchased electricity is generally below simple average) because they were able to negotiate more favourable deals on the energy component (note that they did not pay less for the regulatory components, including network costs, RES levies and other non-recoverable taxes/levies).

EU average electricity costs in EUR/MWh (Figure 82) were on a slightly upward trend from 2008 to 2013, followed by a decrease from 2013 to 2017. In 2017, the average electricity costs at the EU level were 65 EUR/MWh. The difference between electricity price and electricity costs in EUR/MWh is caused by plants that received some form of reimbursement (mainly tax reimbursements) and/or used self-generated electricity on site. The weighted average (by electricity consumption) for this indicator was lower than the simple average, confirming better bargaining power for larger electricity consumers. From 2008 to 2017, EU average electricity costs in EUR/tonne (Figure 83) decreased, ranging between 11 and 13 EUR/tonne. In 2017, the electricity costs per tonne were at their lowest level of 11 EUR/tonne.

EU average electricity intensity (Figure 84) ranged from 0.17 to 0.19 MWh/tonne, decreasing slightly from 2008 (0.19 MWh/tonne) to 2017 (0.18 MWh/tonne). There is no indication that larger plants are less electricity intensive than smaller plants.

A1.8.3 Natural gas prices, costs and intensity

Key natural gas indicators for nitrogen fertilisers are presented in Table 30.

EU average natural gas prices for ammonia plants (Figure 85) show a volatile trend between 2008 and 2017 (lowest value in 2009 and highest in 2013). Prices followed the international natural gas price developments. In 2017, the average price was 21 EUR/MWh. As shown in Figure 86, the energy component made up the lion's share of the natural gas price in every year (always above 85%). We can, however, observe that the share of the regulatory components (network costs + non-recoverable taxes/levies) increased between 2008 and 2017 (4% in 2008 vs. 11% in 2017). Larger consumers faced lower natural gas prices (weighted average by purchased natural gas is below simple average) and actually paid less for all the price components (energy, network costs and non-recoverable taxes/levies).

EU average natural gas costs (in EUR/tonne) followed a similar trend to the natural gas prices (Figure 87). The costs increased from 2009 to 2013 and decreased from 2013 to 2017. In 2017, they were at around 99 EUR/tonne, while in 2008 costs were around 133 EUR/tonne.

EU average natural gas intensity (Figure 88) ranged from 4.6 to 5.1 MWh/tonne, decreasing slightly from 2008 (5.1 MWh/tonne) to 2017 (5.0 MWh/tonne). Overall, efficiency thus increased slightly. There is no indication that larger plants are less natural gas intensive than smaller plants.

A1.8.4 Competitiveness

Over the period, natural gas and electricity costs accounted for 51–66% and 5–7% of total production costs, respectively (Table 31). The share of total energy (natural gas + electricity) costs in production costs increased from 67% in 2008 to 73% in 2017.

EBITDA per tonne underwent a volatile trend from 2008 to 2017 (Figure 89). Comparing 2008 and 2017, EBITDA per tonne decreased by almost 50% from 49 EUR/tonne in 2008 to 25 EUR/tonne in 2017. By looking at trends in costs and margins, it is not possible to draw conclusions about the impact of electricity and natural gas costs on profitability. Nevertheless, it should be emphasised that energy costs are always much higher than EBITDA (ratio of total energy costs to EBITDA ranges between 1.9 and 7.7), which shows the high importance of energy costs for the competitiveness of nitrogen fertiliser production.

A1.8.5 Tables and graphs

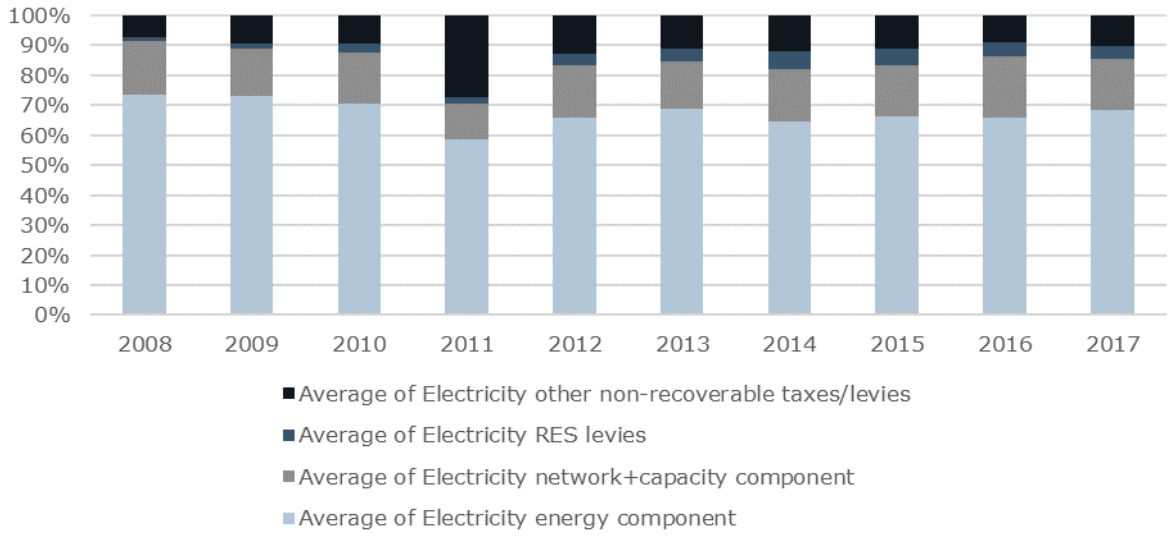
Electricity

Table 29. Key electricity indicators of nitrogen fertiliser production (EU averages)

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity price (€/MWh)	67.4	68.9	67.9	91.7	83.1	77.1	69.7	72.0	66.5	69.3
Electricity costs (€/MWh)	64.0	67.9	66.3	73.4	70.0	75.0	65.2	64.7	60.3	65.2
Electricity costs (€/tonne)	12.0	12.1	11.1	12.3	11.8	13.4	11.3	11.0	11.4	10.7
Electricity intensity (MWh/tonne)	0.19	0.18	0.17	0.17	0.17	0.18	0.17	0.17	0.19	0.18

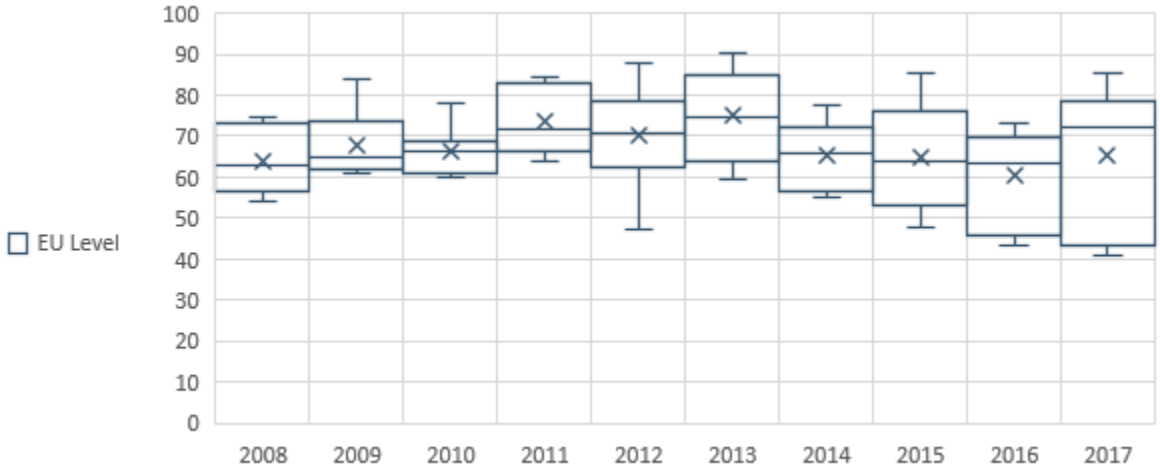
Source: CEPS/Ecofys.

Figure 81. Components of the EU average electricity price for nitrogen fertiliser production (%)



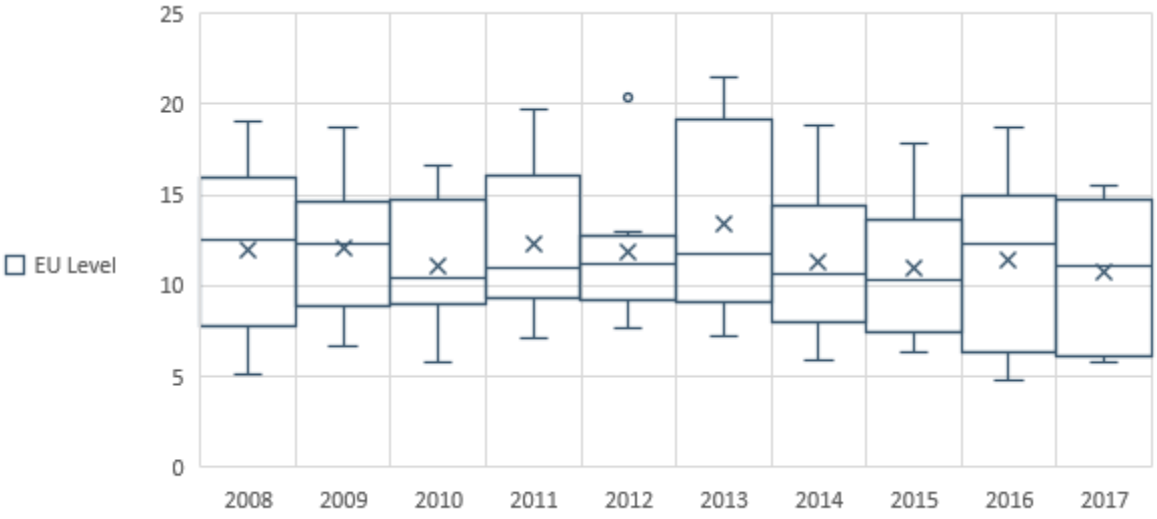
Source: CEPS/Ecofys.

Figure 82. Electricity costs of nitrogen fertiliser production (€/MWh)



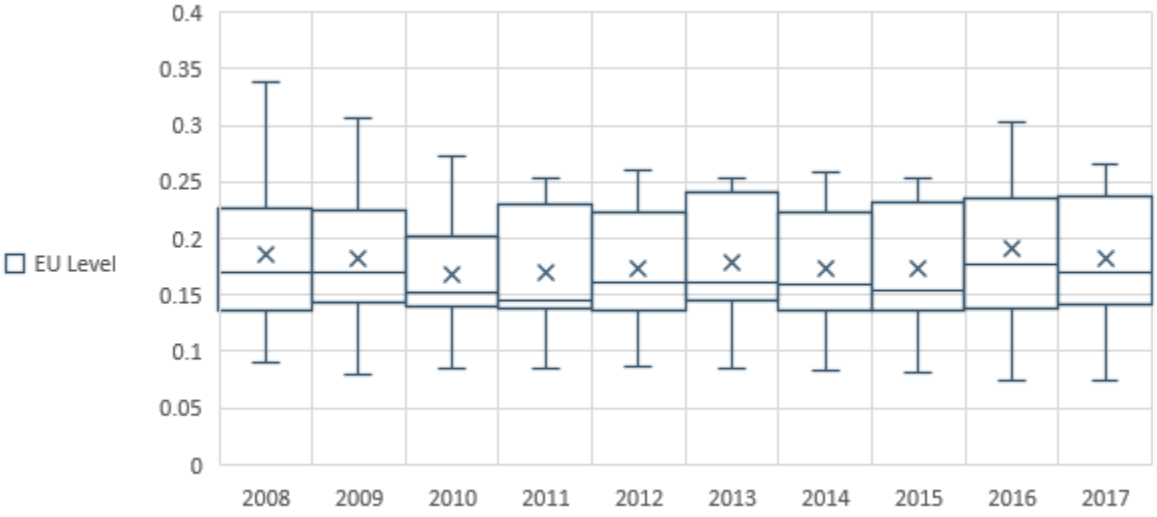
Source: CEPS/Ecofys.

Figure 83. Electricity costs of nitrogen fertiliser production (€/tonne)



Source: CEPS/Ecofys.

Figure 84. Electricity intensity of nitrogen fertiliser production (MWh/tonne)



Source: CEPS/Ecofys.

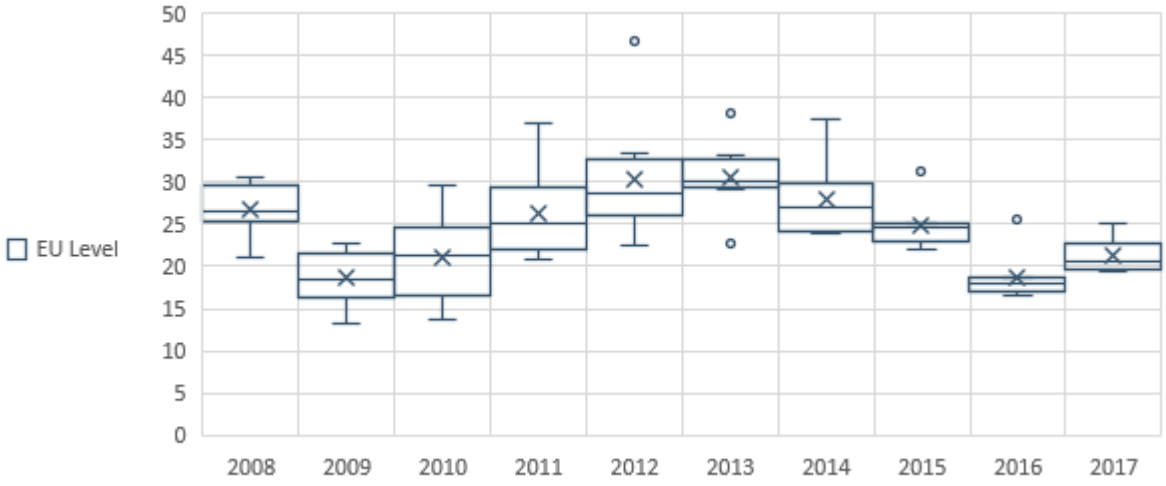
Natural gas

Table 30. Key natural gas indicators of nitrogen fertiliser production (EU averages)

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas price (€/MWh)	26.7	18.6	46.5	26.3	30.4	30.5	28.0	24.8	18.8	21.2
Natural gas costs (€/tonne)	132.9	84.7	90.1	124.5	144.5	146.6	134.2	119.2	89.8	99.2
Natural gas intensity (MWh/tonne)	5.1	4.8	4.6	5.0	5.0	4.9	5.0	4.9	5.0	5.0

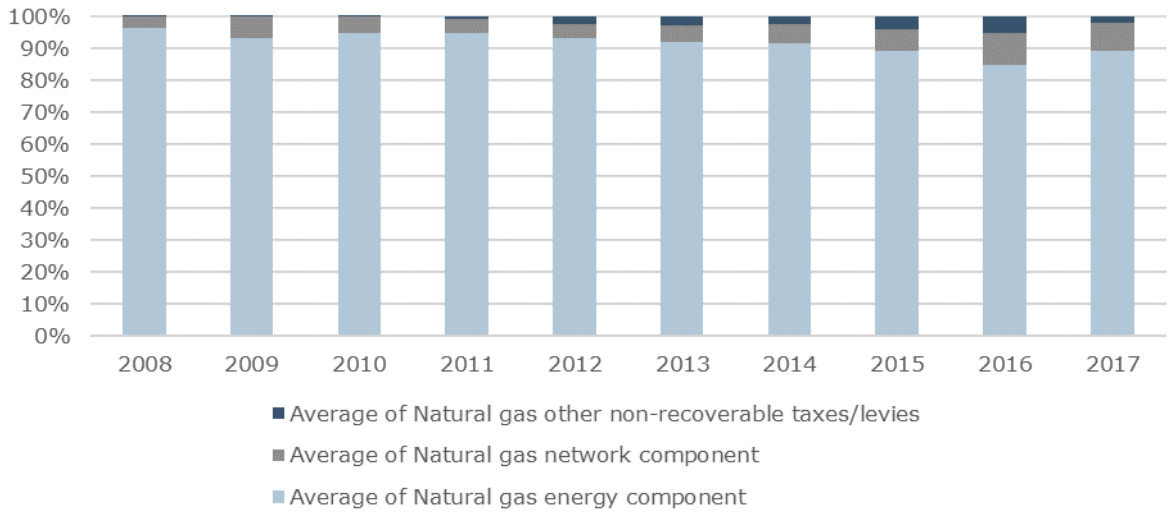
Source: CEPS/Ecofys.

Figure 85. Natural gas prices of nitrogen fertiliser production (€/MWh)



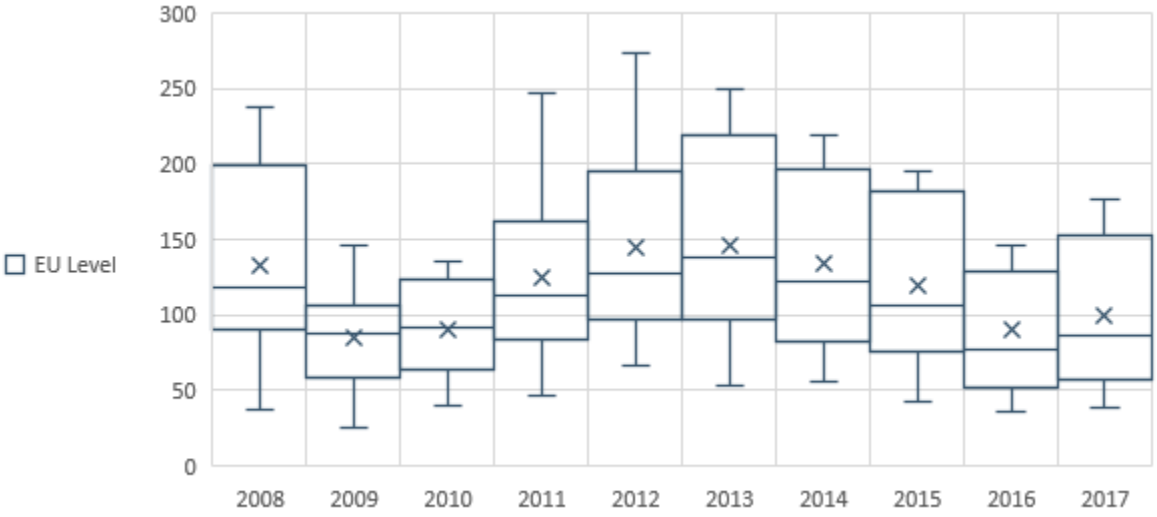
Source: CEPS/Ecofys.

Figure 86. Components of the EU average natural gas price for nitrogen fertiliser production (%)



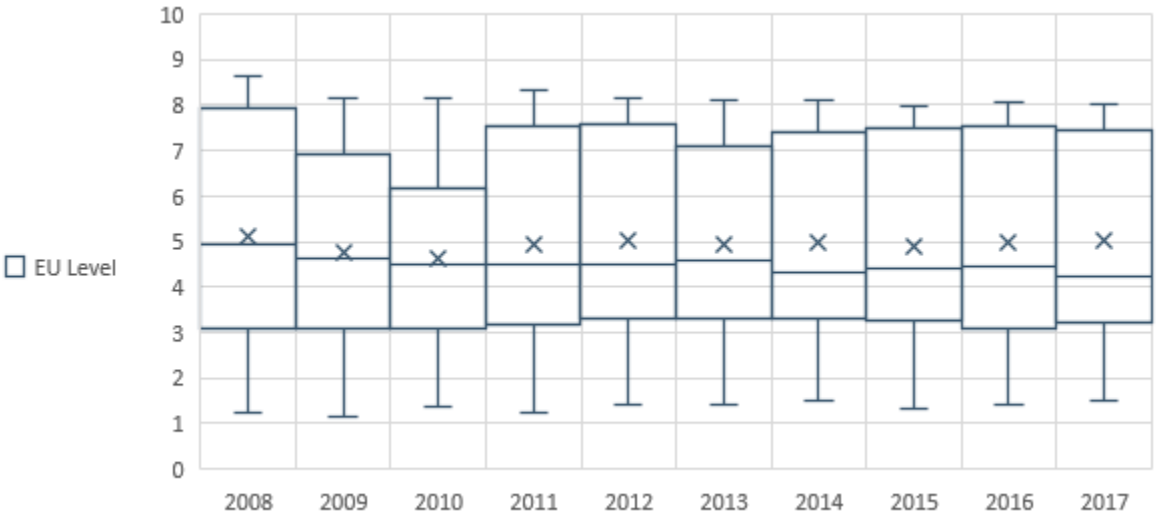
Source: CEPS/Ecofys.

Figure 87. Natural gas costs of nitrogen fertiliser production (€/tonne)



Source: CEPS/Ecofys.

Figure 88. Natural gas intensity of nitrogen fertiliser production (MWh/tonne)



Source: CEPS/Ecofys.

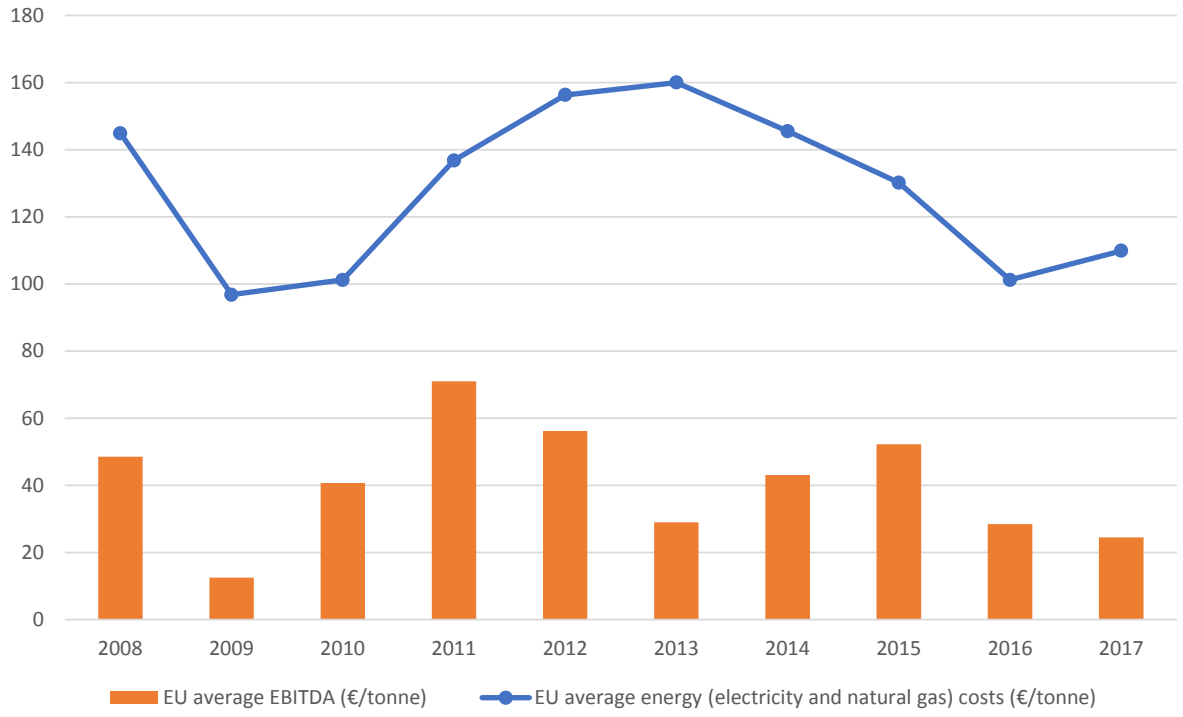
Competitiveness

Table 31. Key competitiveness indicators of nitrogen fertiliser production (EU averages)

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Share of electricity costs in production costs (%)	5.5	7.3	6.4	6.1	5.1	5.7	5.2	5.2	6.6	7.1
Share of natural gas costs in production costs (%)	61.2	51.1	51.6	61.3	63.0	62.2	61.6	55.8	52.1	66.2
Share of total energy costs in production costs (%)	66.7	58.4	58.0	67.4	68.1	67.9	66.8	61.0	58.7	73.3
Total energy costs (€/tonne)	144.9	96.8	101.2	136.8	156.3	160.0	145.5	130.2	101.2	109.9
EBITDA (€/tonne)	48.6	12.5	40.7	71.0	56.2	29.0	43.1	52.3	28.5	24.5
Ratio of total energy costs to EBITDA	3.0	7.7	2.5	1.9	2.8	5.5	3.4	2.5	3.6	4.5

Source: CEPS/Ecofys.

Figure 89. Energy costs versus EBITDA of nitrogen fertiliser production (€/tonne)



Source: CEPS/Ecofys.

A1.9 REFINERIES

A1.9.1 General information and sample composition

Refineries (sector 19.20 in NACE Rev.2) separate (distillate) and transform (convert and blend) crude oil to manufacture a wide variety of refined petroleum products, including transportation fuels, residual fuel oils and lubricants.

In the refinery sector crude oil – used as feedstock – represents, by far, the most prominent costs (more than 80% of total production costs). Electricity and natural gas costs play only a marginal role (they represent altogether around 2% of total production costs[6]).

Refineries in Europe have been going through a restructuring process. Several EU oil companies are divesting from refining capacity in Europe and expanding in other parts of the world, while non-European companies are emerging as potential investors. Nevertheless, the balance is negative and refining activity is decreasing in Europe. Most refineries are found in NWE or SE regions. Top five oil refining Member States are (based on 2017 capacity): Germany (14%), Italy (13%), the Spain (11%), the United Kingdom (10%) and France (10%).

Overall, the trade of refined petroleum products is fairly balanced for Europe (EU import and export are of the same order of magnitude). Europe exports mainly to the United States and, to a less extent, Turkey and imports mostly from Russia and, to a less extent, the United States and Saudi Arabia.

The analysis focusses on mainstream refineries (small petroleum oil sites producing specialised products such as bitumen and lube oil are excluded). There are 81 mainstream refineries in the EU. A typical refinery in the sample has an average capacity of around 6.5 Mt/year and covers oil distillation and conversion (through thermal or catalytic processes). The sample includes 13 plants across Europe (one in CEE region, eight in NWE region and four in SE region), representing around 20% of total EU capacity.

A1.9.2 Electricity prices, costs and intensity

Key electricity indicators for refineries are presented in Table 32.

EU average electricity prices decreased over the last decade (78 EUR/MWh in 2008 vs. 71 EUR/MWh in 2017). In most years, electricity prices in NWE were higher than in SE. In terms of price components (Figure 90), the energy component underwent a downward trend between 2008 and 2017 (both in absolute and relative terms) but still represents the lion's share of the electricity price (63% in 2017). Large consumers paid less for any of the price components, including energy but also network costs, RES levies and other non-recoverable taxes/levies (for each component, weighted average by purchased electricity is below simple average) and therefore faced significantly lower electricity prices.

Similarly, EU average electricity costs in EUR/MWh (Figure 91) were on a downward trend from 2008 (92 EUR/MWh) to 2017 (66 EUR/MWh). It should be underlined that there is a break in the time series between 2015 and 2016 due to sample composition variation (between 2008-2015 and 2016-2017). Except in the SE region, larger consumers benefited from better conditions for electricity costs (weighted average by electricity consumption is lower than simple average). In the same way, EU average electricity costs in EUR/tonne (Figure 92) decreased, from above 6 EUR/tonne in 2008 to below 4 EUR/tonne in 2017.

EU average electricity intensity (Figure 93) ranged from 0.06 to 0.08 MWh/tonne, decreasing slightly from 2008 (0.07 MWh/tonne) to 2017 (0.06 MWh/tonne). There is no indication that larger plants are less electricity intensive than smaller plants.

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[6] This ratio includes both operational and capital costs. It would be bigger if only operational productions costs were considered.

A1.9.3 Natural gas and total gas prices, costs and intensity

In the case of refineries, it is relevant to analyse the consumption of both natural gas and self-produced gases (i.e. refinery fuel gases). Table 33 presents key indicators for natural gas, refinery fuel gases and total gases (i.e. the sum of the two) in refineries.

EU average natural gas prices (Figure 94) show a general descending trend, with a sharp decrease between 2013 to 2016 when prices dropped from 30 to 20 EUR/MWh. In 2017, the price was, though, on the rise (22 EUR/MWh). Like for electricity, the energy component of natural gas prices (Figure 95) decreased between 2008 and 2017 (both in absolute and relative terms) but still represented 89% of the natural gas price in 2017. Larger consumers faced lower natural gas prices (weighted average by purchased natural gas is constantly below simple average); in fact, they do not necessarily pay less for the energy and network component but do pay relatively less for non-recoverable taxes/levies.

EU average natural gas costs in EUR/tonne (Figure 96) decreased by 52% from 2008 (11 EUR/tonne) to 2017 (5 EUR/tonne). Larger consumers experienced smaller natural gas costs per unit (weighted average by production output is below simple average) due to economies of scale and the lower natural gas prices they faced. However, when looking at the EU average total gas costs in EUR/tonne (Figure 97), i.e. including refinery fuel gases as well, the results then appear rather volatile throughout the 2008 to 2017 period without any clear trend (range between 11 and 20 EUR/tonne).

EU average natural gas intensity (Figure 98) decreased from 0.35 MWh/tonne in 2008 to 0.24 MWh/tonne in 2017. When including refinery fuel gases, EU average total gas intensity showed the same pattern and decreased from 0.77 MWh/tonne in 2008 to 0.68 MWh/tonne in 2017. There is no indication that larger plants are less gas intensive than smaller plants.

A1.9.4 Prices, costs and intensity of other fuels including feedstocks

In the case of refineries, other fuels (including feedstocks) than electricity and gas play a key role in their production costs. Some information could be gathered for 2016 and 2017 and is presented in Table 34.

Major input in refinery activity is crude oil used as feedstock. EU average crude oil price increased from about 24 EUR/MWh in 2016 to 29 EUR/MWh in 2017. In the same way, EU average crude oil costs in EUR/tonne rose from about 332 EUR/tonne in 2016 to 396 EUR/tonne in 2017. We can note that EU average crude oil intensity in refineries slightly decreased (around 1%) from 2016 to 2017 (from 13.76 to 13.62 MWh/tonne, respectively).

Fuel oil and petroleum coke follow the same pattern as crude oil. EU average price increased between 2016 and 2017, respectively, from about 15 to 20 EUR/MWh for fuel oil and from about 15 to 21 EUR/MWh for petroleum coke. In terms of costs in EUR/tonne, they rose between 2016 and 2017, respectively, from about 2.2 to 2.5 EUR/tonne for fuel oil and from 2.0 to 2.4 EUR/tonne for petroleum coke. In parallel, EU average petroleum coke intensity in refineries dropped by 8% (0.13 MWh/tonne in 2016 vs. 0.12 MWh/tonne in 2017) and more than 20% for fuel oil (0.14 MWh/tonne in 2016 vs. 0.11 MWh/tonne in 2017).

A1.9.5 Competitiveness

Table 35 presents the respective share of fuel costs and total energy (sum of electricity, natural gas, refinery fuel gases, crude oil, fuel oil and petroleum coke) costs in total production costs. Full data set is available for 2016 and 2017 only. The total energy costs amount between 84 and 86% in total production costs, mostly attributable to crude oil (crude oil makes up about 95% of total energy costs).

EBITDA per tonne (Figure 100) slightly increased between 2016 and 2017 (37 vs. 44 EUR/tonne, respectively). It is not possible to analyse the impact of total energy costs on profitability from a trend perspective, as data are available for two years only (2016 and 2017). Nevertheless, the ratio of total

energy costs to EBITDA still indicates that a 1 % reduction in total energy costs would potentially lead to an increase of 9.3% in EBITDA, which shows the extreme importance of energy costs and the huge potential impact they can have on margins of refineries.

A1.9.6 Tables and graphs

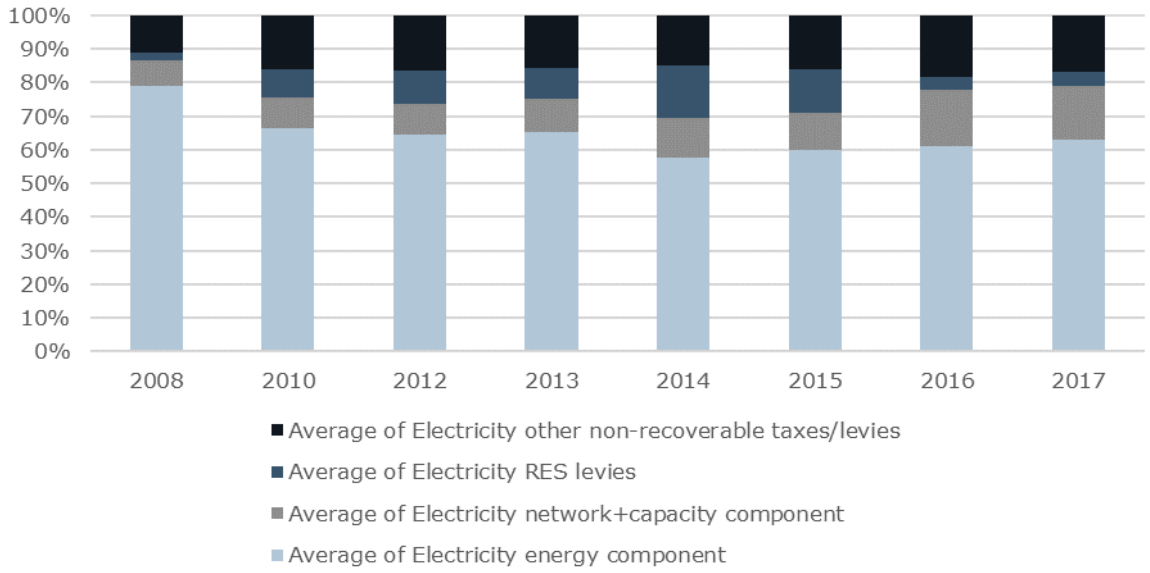
Electricity

Table 32. Key electricity indicators of refineries (EU averages)

Indicator	2008	2010	2012	2013	2014	2015	2016	2017
Electricity price (€/MWh)	77.6	69.2	75.5	72.4	76.9	73.6	69.0	70.5
Electricity costs (€/MWh)	92.4	89.2	92.0	92.6	89.2	83.6	62.9	65.9
Electricity costs (€/tonne)	6.2	6.7	6.9	6.8	7.1	6.1	3.5	3.8
Electricity intensity (MWh/tonne)	0.07	0.08	0.07	0.07	0.07	0.07	0.06	0.06

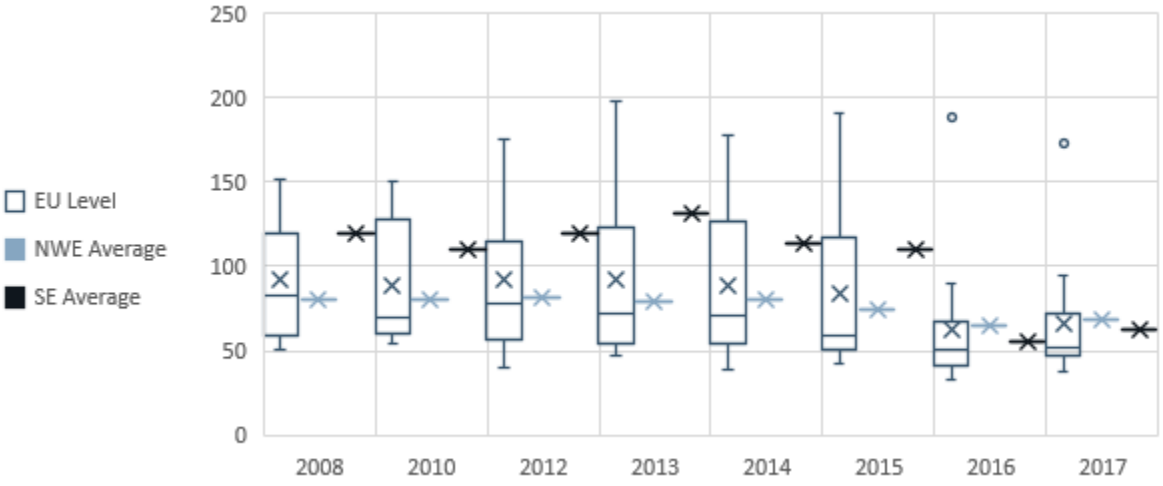
Source: CEPS/Ecofys.

Figure 90. Components of the EU average electricity price for refineries (%)



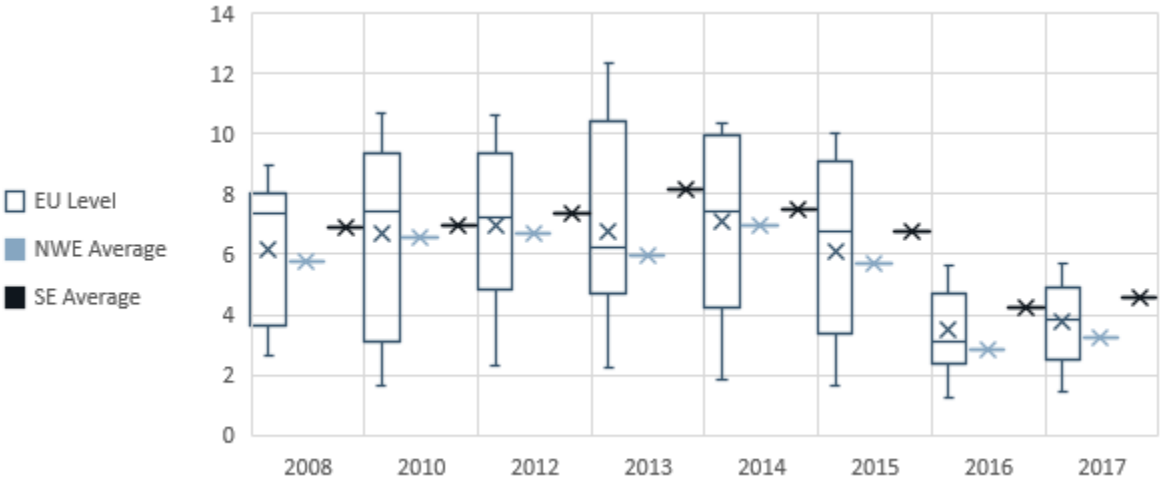
Source: CEPS/Ecofys.

Figure 91. Electricity costs of refineries (€/MWh)



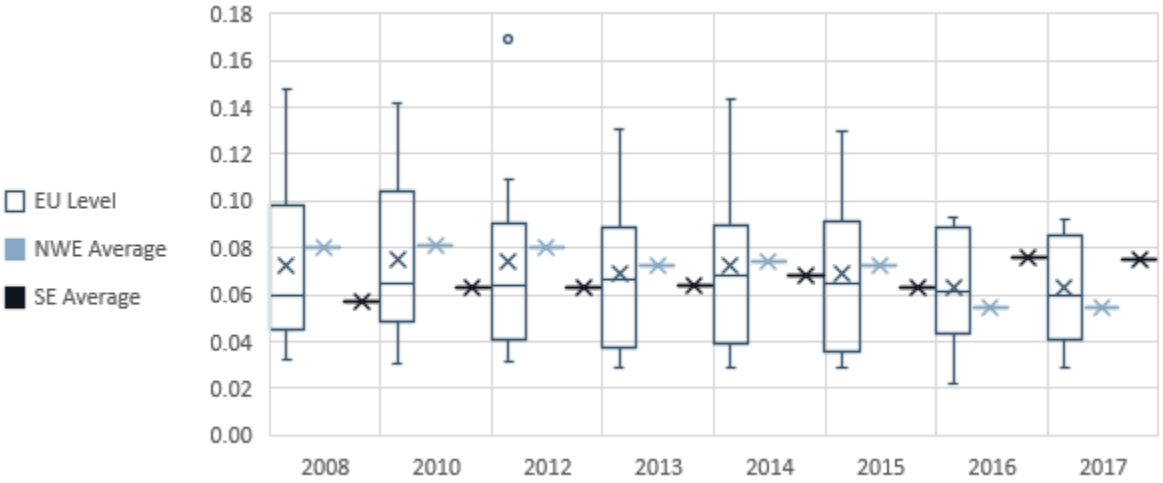
Source: CEPS/Ecofys.

Figure 92. Electricity costs of refineries (€/tonne)



Source: CEPS/Ecofys.

Figure 93. Electricity intensity of refineries (MWh/tonne)



Source: CEPS/Ecofys.

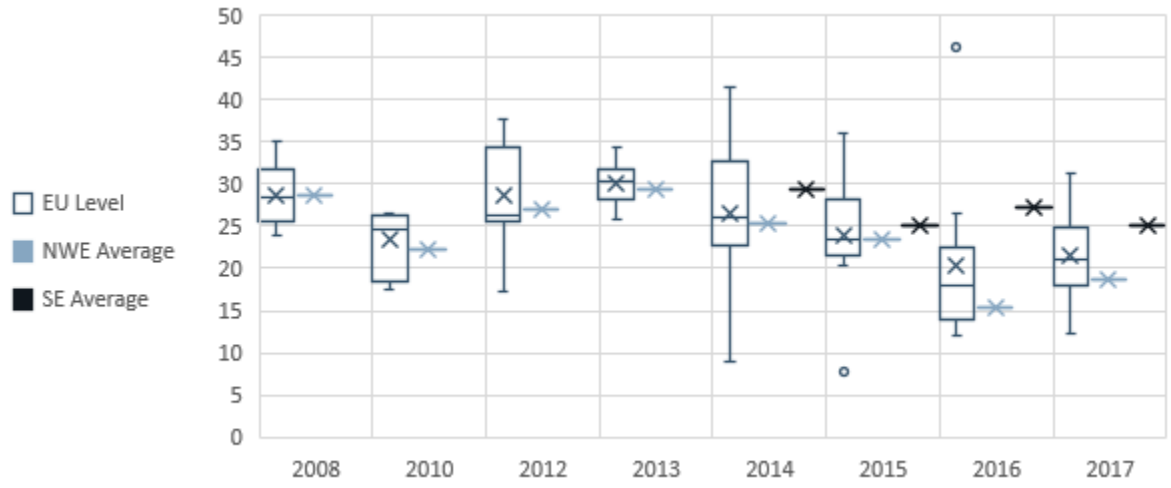
Natural gas and refinery fuel gases

Table 33. Key gas indicators of refineries (EU averages)

Indicator	2008	2010	2012	2013	2014	2015	2016	2017
Natural gas price (€/MWh)	28.6	23.4	28.6	30.1	26.4	23.8	20.3	21.6
Natural gas costs (€/tonne)	10.7	9.3	11.7	12.0	8.2	5.9	4.6	5.1
Refinery fuel gases costs (€/tonne)	2.4	4.4	7.9	6.5	6.1	4.6	7.3	9
Total gas costs (€/tonne)	**13.1**	**13.7**	**19.6**	**18.5**	**14.3**	**10.5**	**11.9**	**14.1**
Natural gas intensity (MWh/tonne)	0.35	0.34	0.36	0.38	0.31	0.26	0.24	0.24
Refinery fuel gases intensity (MWh/tonne)	0.5	0.5	0.48	0.46	0.55	0.57	0.45	0.44
Total gas intensity (MWh/tonne)	**0.77**	**0.83**	**0.89**	**0.88**	**0.91**	**0.86**	**0.69**	**0.68**

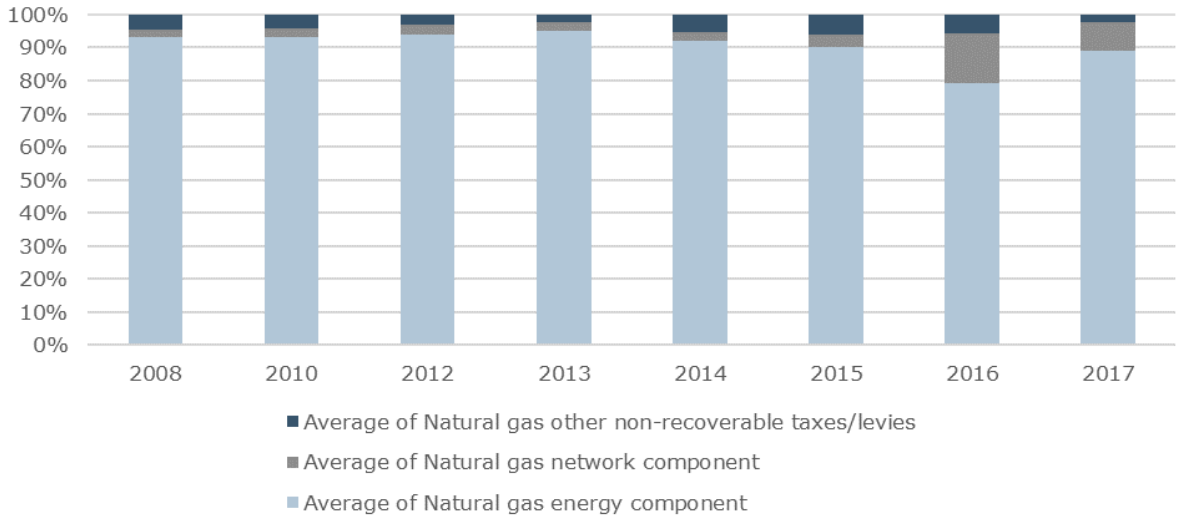
Source: CEPS/Ecofys.

Figure 94. Natural gas prices of refineries (€/MWh)



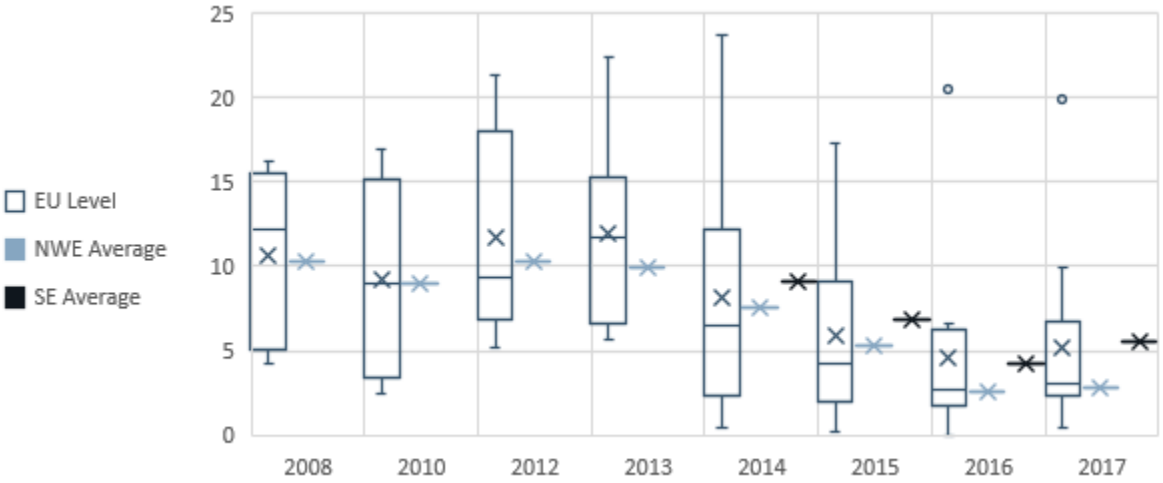
Source: CEPS/Ecofys.

Figure 95. Components of the EU average natural gas price for refineries (%)



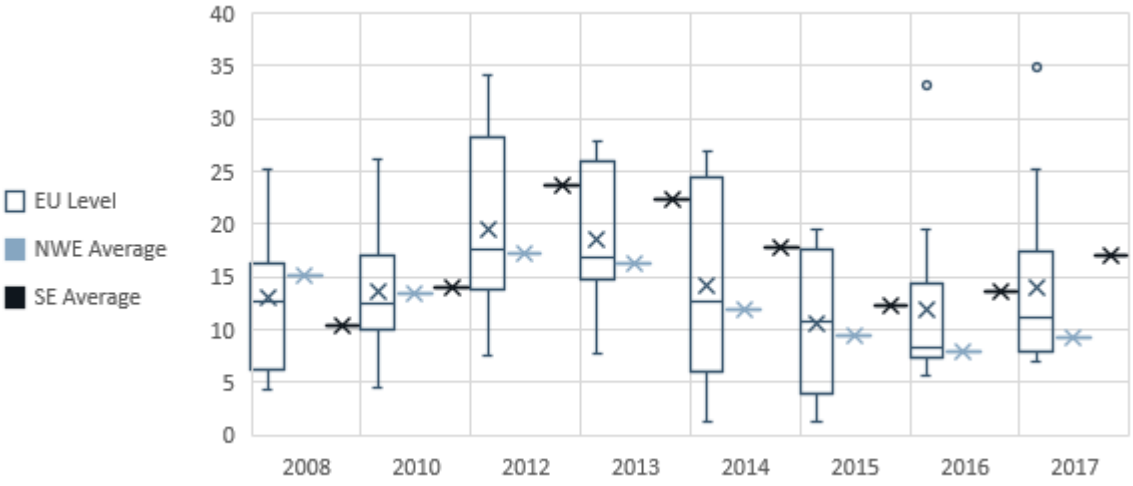
Source: CEPS/Ecofys.

Figure 96. Natural gas costs of refineries (€/tonne)



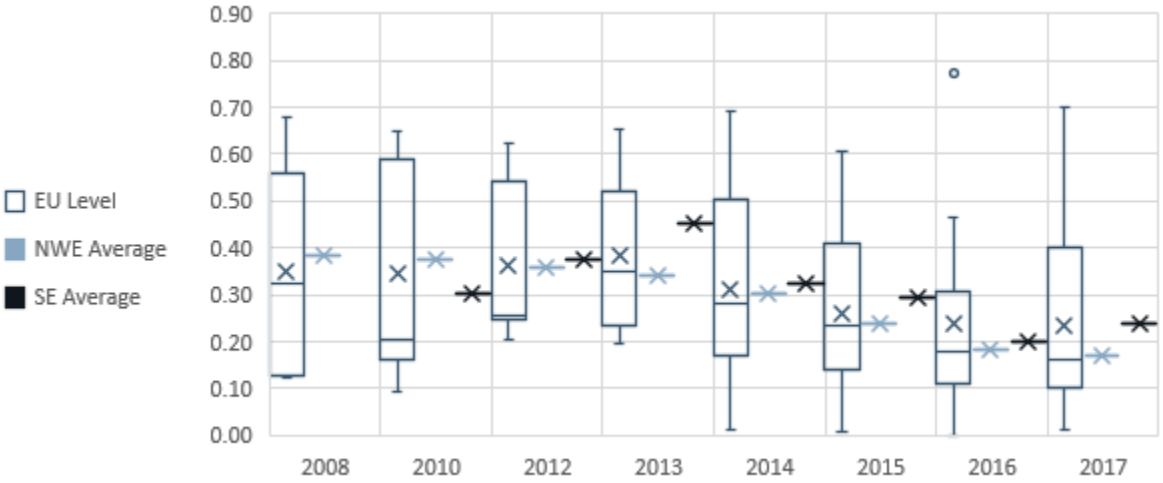
Source: CEPS/Ecofys.

Figure 97. Total gas costs of refineries (€/tonne)



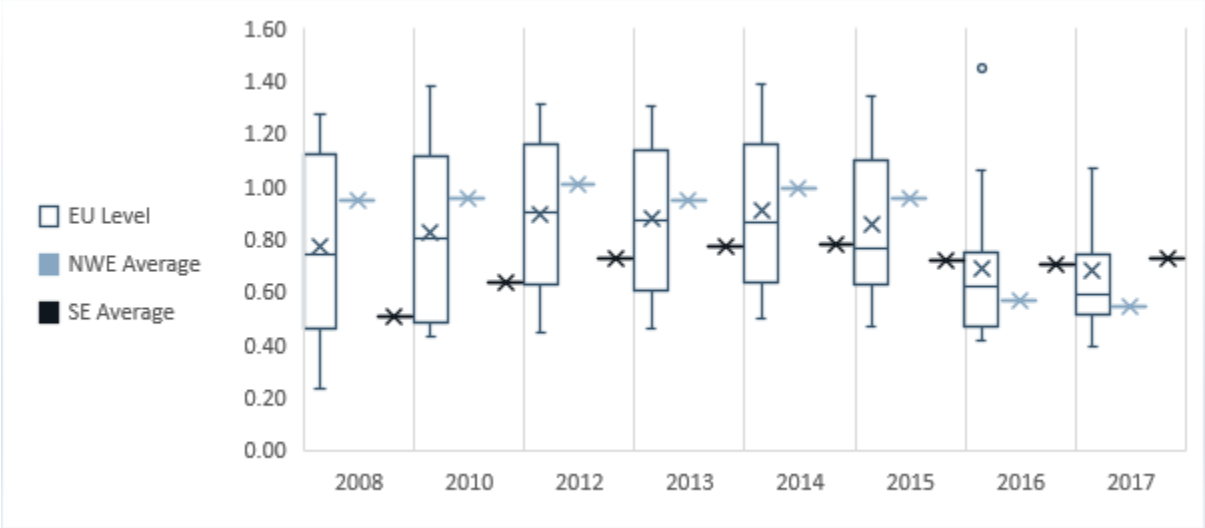
Source: CEPS/Ecofys.

Figure 98. Natural gas intensity of refineries (MWh/tonne)



Source: CEPS/Ecofys.

Figure 99. Total gas intensity of refineries (MWh/tonne)



Source: CEPS/Ecofys.

Other fuels including feedstocks

Table 34. Key other fuel indicators of refineries (EU averages)

Indicator	2016	2017
Crude oil price (€/MWh)	24.4	29.3
Crude oil costs (€/tonne)	331.5	395.8
Crude oil intensity (MWh/tonne)	13.76	13.62
Fuel oil price (€/MWh)	14.9	19.9
Fuel oil costs (€/tonne)	2.2	2.5
Fuel oil intensity (MWh/tonne)	0.14	0.11
Coke price (€/MWh)	15.3	20.7
Coke costs (€/tonne)	2.0	2.4
Coke intensity (MWh/tonne)	0.13	0.12

Source: CEPS/Ecofys.

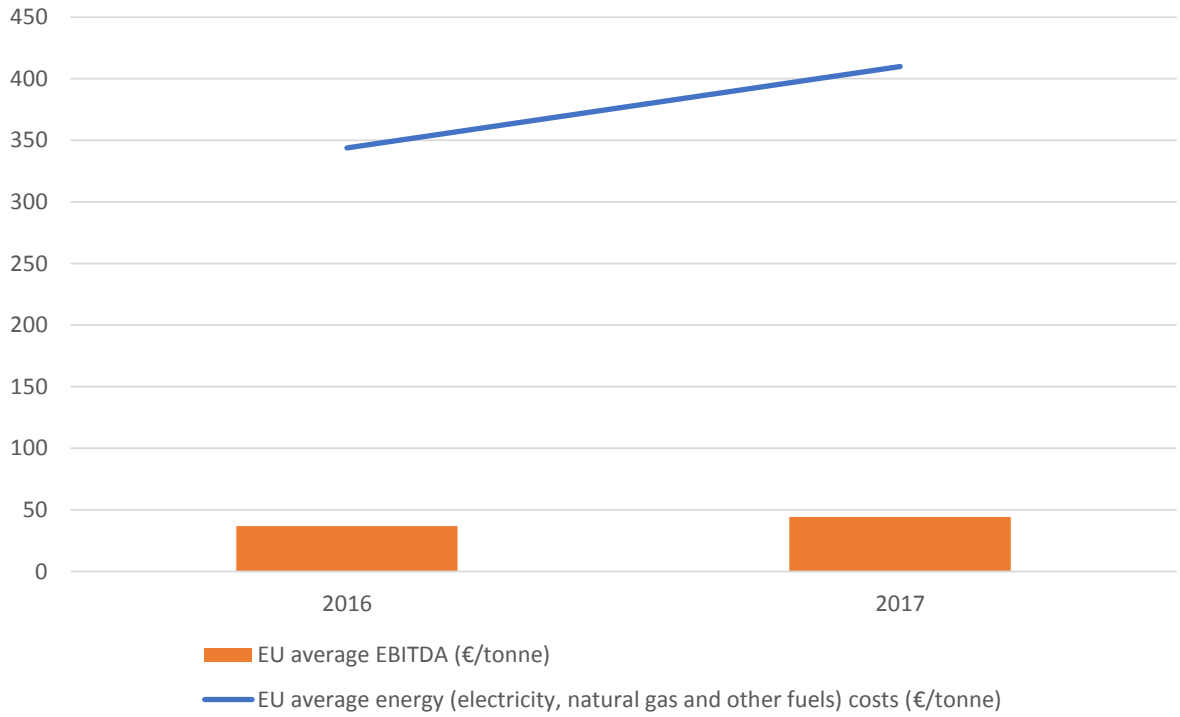
Competitiveness

Table 35. Key competitiveness indicators of refineries (EU averages)

Indicator	2016	2017
Share of electricity costs in production costs (%)	0.8	0.8
Share of natural gas costs in production costs (%)	1.1	1.1
Share of other gases costs in production costs (%)	1.7	1.7
Share of crude oil costs in production costs (%)	79.8	81.1
Share of fuel oil costs in production costs (%)	0.5	0.5
Share of petroleum coke costs in production costs (%)	0.5	0.5
Share of total energy costs in production costs (%)	84.4	85.6
Total energy costs (€/tonne)	343.9	409.8
EBITDA (€/tonne)	36.9	44.2
Ratio of total energy costs to EBITDA	9.3	9.3

Source: CEPS/Ecofys.

Figure 100. Energy costs versus EBITDA of refineries (€/tonne)



Source: CEPS/Ecofys.