Composition and Drivers of Energy Prices and Costs: Case Studies in Selected Energy Intensive Industries – 2018

Final Report

Written by:
CEPS and Ecofys
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Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs
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Unit C1 — Clean Technologies and Products

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Table of contents

List of acronyms and abbreviations ... 9
Glossary ... 10
Introduction ... 13
1 Methodology ... 14
1.1 Data collection ... 14
Sampling criteria ... 14
Sample selection ... 15
Data collection techniques ... 16
Pilot ... 17
Confidentiality agreement ... 17
Time span ... 18
Data cleansing and validation ... 18
Production costs and margins ... 19
International comparison ... 20
Data aggregation ... 20
Data visualisation ... 21
1.2 Indicators ... 22
2 Bricks and roof tiles ... 27
2.1 Composition of the sample ... 29
Sampling strategy ... 29
Sample statistics ... 30
2.2 Electricity ... 32
Electricity prices ... 32
Components of the electricity price ... 34
Electricity costs ... 37
Electricity intensity ... 39
Additional information ... 40
2.3 Natural gas ... 41
Natural gas prices ... 41
Components of the natural gas price ... 42
Natural gas costs ... 45
Natural gas intensity ... 46
Additional information ... 47
2.4 Competitiveness ... 48
Cost competitiveness ... 48
International competitiveness ... 59
3 Wall and floor tiles ... 64
3.1 Composition of the sample ... 66
Sampling strategy ... 66
Sample statistics ... 67
International comparison ... 68
3.2 Electricity ... 69
Electricity prices ... 69
Components of the electricity price ... 70
Electricity costs ... 73
Electricity intensity ... 75
Additional information ... 76
3.3 Natural gas ... 77

Natural gas prices 77
Components of the natural gas price 78
Natural gas costs 80
Natural gas intensity 81
Additional information 83
3.4 Competitiveness 83
Cost competitiveness 83
International competitiveness 91
4 Glass tableware 92
4.1 Composition of the sample 94
Sampling strategy 94
Sample statistics 96
International comparison 97
4.2 Electricity 97
Electricity prices 97
Components of the electricity price 98
Electricity costs 101
Electricity intensity 103
Additional information 104
4.3 Natural gas 104
Natural gas prices 105
Components of the natural gas price 106
Natural gas costs 108
Natural gas intensity 109
Additional information 110
4.4 Competitiveness 111
Cost competitiveness 111
5 Packaging glass 121
5.1 Composition of the sample 123
Sampling strategy 123
Sample statistics 124
International comparison 125
5.2 Electricity 125
Electricity prices 125
Components of the electricity price 126
Electricity costs 129
Electricity intensity 131
Additional information 132
5.3 Natural gas 133
Natural gas prices 133
Components of the natural gas price 134
Natural gas costs 137
Natural gas intensity 138
Additional information 139
5.4 Competitiveness 139
Cost competitiveness 139
6 Aluminium 150
6.1 Composition of the sample 153
Sampling strategy 153

Coverage and representativeness of the sample statistics 154
6.2 Electricity 155
Electricity prices 156
Components of the electricity price 159
Electricity costs 164
Electricity intensity 170
Additional information 173
6.3 Natural gas 174
Natural gas prices 175
Components of the natural gas price 177
Natural gas costs 181
Natural gas intensity 183
Additional information 186
6.4 Competitiveness 186
Cost competitiveness 186
International competitiveness 200
Energy prices: primary aluminium 200
International competitiveness: primary aluminium 201
7 Steel (EAF and BOF) 203
7.1 Composition of the sample 206
Sampling strategy 206
Sample statistics 208
7.2 Electricity 210
Electricity prices 211
Components of the electricity price 213
Electricity costs 217
Electricity intensity 221
Additional information 223
7.3 Natural gas 226
Natural gas prices 227
Components of the natural gas price 229
Natural gas costs 233
Natural gas intensity 235
Additional information 238
7.4 Competitiveness 239
Cost competitiveness 239
International competitiveness 259
8 Nitrogen fertilisers 265
8.1 Composition of the sample 266
Sampling strategy 266
Sample statistics 268
8.2 Electricity 269
Electricity prices 269
Components of the electricity price 270
Electricity costs 272
Electricity intensity 274
Additional information 275
8.3 Natural gas 277
Natural gas prices 277

Components of the natural gas price ... 278
Natural gas costs ... 280
Natural gas intensity ... 281
Additional information ... 281
8.4 Competitiveness ... 282
International competitiveness ... 292
9 Refineries ... 296
9.1 Composition of the sample ... 298
Sampling strategy ... 298
Sample statistics ... 299
9.2 Electricity ... 300
Electricity prices ... 301
Components of the electricity price ... 302
Electricity costs ... 304
Electricity intensity ... 307
Additional information ... 308
9.3 Natural gas ... 309
Natural gas prices ... 310
Components of the natural gas price ... 311
Natural gas costs ... 313
Natural gas intensity ... 315
Additional information ... 317
9.4 Other fuel ... 317
Other fuel prices (coke) ... 317
Other fuel prices (fuel oil) ... 318
Other fuel prices (crude oil) ... 319
Other fuel costs (coke) ... 320
Other fuel costs (fuel oil) ... 321
Other fuel costs (crude oil) ... 322
Other fuel intensity (coke) ... 323
Other fuel intensity (fuel oil) ... 324
Other fuel intensity (crude oil) ... 325
9.5 Competitiveness ... 326
Cost competitiveness ... 326
10 Cross-sectoral analysis ... 342
10.1 Introduction ... 344
10.2 Sample composition ... 344
10.3 Electricity ... 345
Electricity consumption and price analysis across sectors ... 345
Electricity consumption and price analysis across consumption bands ... 349
Electricity price component analysis across Member States ... 350
Exemptions ... 361
Visibility of price component costs ... 362
10.4 Natural gas ... 363
Gas consumption and price analysis across sectors ... 363
Natural gas consumption and price analysis across consumption bands ... 365
Gas price component analysis across Member States ... 366

List of acronyms and abbreviations

2016 EPC Study	CEPS, Ecofys and Economisti Associati (2016), Composition and drivers of energy prices and costs: case studies in selected energy intensive industries, European Commission.
Assignment	2018 edition of the Composition and Drivers of Energy Prices and Costs: Case Studies in Selected Energy Intensive Industries
BOF	Basic oxygen furnace
CAPEX	Capital expenditure
CEE	Central Eastern Europe/European
CHP	Combined heat and power
Conf.	Confidential data
EAF	Electric arc furnace
EBIT	Earnings before interest and taxes
EBITDA	Earnings before interest, taxes, depreciation and amortisation
EPC Study	Composition and Drivers of Energy Prices and Costs: Case Studies in Selected Energy Intensive Industries – 2018
EU	European Union
EUA	European Union Allowances prices
n.a.	Data not available
NR	Data not reported
NWE	North Western Europe/European
OPEX	Operating expenditure
PPA	Power purchase agreement
PSO	Public service obligation
RES	Renewable energy source
Research Team	Consortium composed of CEPS and Ecofys
SE	Southern Europe/European
SME	Small and medium-sized enterprise(s)
Technical Specifications	Technical Specifications for a Study on Composition and Drivers of Energy Prices and Costs: Case Studies in Selected Energy Intensive Industries – Follow up
Tender proposal	Proposal submitted by CEPS and Ecofys for a Study on Composition and Drivers of Energy Prices and Costs: Case Studies in Selected Energy Intensive Industries – Follow up
TSO	Transmission system operator
VAT	Value added tax

Glossary

Cost of the capacity market (electricity)	A capacity market is usually designed to ensure that the demand for electricity is met at all times. It remunerates generators to invest in new power capacity and keep existing capacity open. In some Member States, costs borne by energy suppliers to participate in this market can be charged in the electricity price.
Central Eastern Europe (CEE)	This region includes the following Member States: Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovak Republic and Slovenia
Components of the electricity price	They are classified in five groups: energy component, network costs, cost of the capacity market, RES levies, and other non-recoverable taxes. Costs of the capacity market are included in network costs in all those cases where only a limited number of plants disclosed costs for the capacity market.
Components of the natural gas price	They are classified in three groups: energy component, network costs, and other non-recoverable taxes.
Depreciation and amortisation	They refer to the annual depreciation and amortisation of assets related to the production process.
Earnings before interest and taxes (EBIT)	They represent the earnings of the companies after paying costs for production inputs, labour costs and annual depreciation and amortisation of all assets.
Earnings before interest, taxes, depreciation and amortisation (EBITDA)	They represent the earning of the companies after paying costs for production inputs and labour costs.
Electricity costs	Electricity costs are measured in both €/MWh and €/tonne. Electricity costs in €/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 €/tonne are computed by relying on the same formula but using as a denominator the total production output in tonnes.
Electricity prices	Electricity prices are measured in €/MWh. They are computed as total price paid to purchase electricity (net of recoverable taxes, such as VAT) divided by total amount of electricity purchased. Therefore, electricity prices are 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.
Flexibility schemes (electricity)	They include for instance: i) interruptibility schemes, which remunerate industrial plants in exchange for the possibility for the network operator to cut power supply, with a pre-determined notice, in view of ensuring the stability of the electrical network; ii) capacity remuneration mechanisms, which remunerate plants to reduce consumptions in peak time; iii)

	ancillary services, which remunerate plants to reduce consumption on request by the transmission system operator.
Natural gas costs	Natural gas costs are measured in €/tonne. They are computed as follows: (Total price paid to purchase natural gas – payment for flexibility schemes) / Total production output. Natural gas costs in €/MWh are not shown in the report, as payment for flexibility schemes are mostly irrelevant in the natural gas sectors and no significant difference between natural gas prices (see below) in €/MWh and natural gas costs in €/MWh was detected.
Natural gas prices	Natural gas prices are measured in €/MWh. They are 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 prices are 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.
Interruptibility schemes (gas)	They remunerate industrial plants (e.g. by reducing gas tariffs or providing a down payment) at a regulated rate in exchange for the possibility for the network operator to cut gas supply, with a pre-determined notice, in view of ensuring the stability of the gas supply.
Network costs	They are a component of the electricity (gas) price aiming to remunerate network operators for the costs to build, maintain and operate the electricity network (gas network).
North Western Europe (NWE)	This region includes the following Member States: Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Luxembourg, the Netherlands, Sweden and the UK.
Other planned outages	They are interruptions in the supply of electricity or gas that are not linked to flexibility/interruptibility schemes, but are notified in advance by the energy supplier.
Planned outages	They are interruptions in the supply of electricity or gas that are linked to flexibility/interruptibility schemes.
Production costs	They 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. Non-operating (e.g. interest expenses) and extraordinary cost items are not included.
Reimbursement (electricity price)	It is an *ex post* repayment for part of the billed price of electricity. It usually relates to one or more specific components of the price. It is different from exemptions, which instead apply *ex ante*. For instance, some plants are reimbursed (totally or partially) for RES levies; other types of reimbursement include: compensation for indirect costs of EU Emission Trading System and repayments for excise taxes on electricity.
Renewable Energy Sources (RES) levies (electricity)	They are a component of the electricity price aiming to fund support schemes for generation of renewable electricity.

Simple average	It is computed as the sum of the individual observations divided by the number of observations in the sample.
Southern Europe (SE)	This region includes the following Member States: Cyprus, Greece, Italy, Malta, Portugal and Spain.
Typical plant	A typical plant is a plant reflecting the average features of EU plants operating in a certain sector. In this respect, the main features of a typical plant are defined on a sector-by-sector basis. In some sectors, however, it is not possible to identify one single typical plant. For instance, in the steel sector the same production output can be obtained by adopting two very different production routes (EAF and BOF); or the aluminium sector includes very different plants operating at different links of the value chain (primary, secondary and downstream). In these cases, typical plants were identified in each subsector and, where possible, separate data on energy prices and costs are presented for each type of plant.
Turnover	It refers to revenues generated by normal business activities (e.g. the sale of goods to customers) and excludes revenues from non-core activities (e.g. dividend income, profits from financial investments). In case part of the production is transferred to other plants of the same company (e.g. for downstream processing), the value of deliveries to the company's other plants is also included.
Unplanned outages	They are unexpected interruptions in the supply of electricity or gas.
Weighted average	It is 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.

Introduction

The current report represents the final deliverable of the 2018 edition of the "Composition and Drivers of Energy Prices and Costs: Case Studies in Selected Energy Intensive Industries" (hereinafter "the Assignment").

The Assignment aimed to achieve two main objectives:

1. Providing well-grounded, bottom-up evidence of the composition and drivers of energy prices and energy costs faced by industrial operators in EU energy intensive sectors.
2. Assessing the impact of energy prices and costs and of their components on the cost competitiveness and, where possible, international competitiveness of EU energy intensive sectors.

In line with the Tender Proposal submitted by the Consortium led by CEPS (hereinafter "the Research Team") and the Technical Specification prepared by the European Commission, this Report includes analytical chapters for all sectors covered by the Assignment as well as a cross-sectoral analysis of data collected at the plant level. More specifically, the remainder is structured as follows:

- Chapter 1 details key methodological aspects.
- Chapters 2 to 9 analyse and discuss data collected from plants operating in the following sectors:
  - Bricks and tiles
  - Wall and floor tiles
  - Glass tableware
  - Packaging glass
  - Aluminium
  - Steel
  - Fertilisers
  - Refineries.
- Chapter 10 presents the cross-sectoral analysis.

It is worth stressing that the selection of sectors aimed to ensure wide coverage of a broad range of features of energy intensive industries in the EU. For instance, the study examines gas-intensive sectors (e.g. bricks and roof tiles and packaging glass) and electricity intensive sectors (e.g. primary aluminium and EAF steel); sectors relying on solid fuels, such as coking coal (e.g. BOF steel) and sectors using crude oil (e.g. refineries); sectors concentrated in a limited number of Member States (e.g. ceramic tiles and primary aluminium) and geographically dispersed sectors (e.g. packaging glass, secondary and downstream aluminium); sectors dominated by large companies (e.g. primary aluminium and glass tableware) and sectors including more SME (e.g. bricks and roof tiles and ceramic tiles); net importers (e.g. aluminium and steel), net exporters (e.g. ceramic tiles and glass tableware), and sectors that are relatively less exposed to international competition (e.g. bricks and tiles and packaging glass). Further details on the main features of the sectors covered by this Assignment are provided in Annex A.

Annex B provides a preliminary econometric analysis and decomposition analysis of cross-sectoral data.

1 Methodology

This Chapter discusses the main methodological aspects related to the collection, validation and analysis of data provided by EU plants operating in the eight energy intensive sectors covered by the EPC Study. It also details the key indicators measured and presented in each sectoral chapter.

1.1 Data collection

In principle, the analysis of the composition and drivers of energy prices and costs in EU energy intensive sectors can be performed by adopting either a top-down or a bottom-up approach. A top-down approach implies that costs are assessed on the entire sector by using aggregate data, retrieved from secondary sources. By contrast, a bottom-up approach requires collecting data from a sample of 'typical' plants/companies. More specifically, in a bottom-up approach, the analysis is based on disaggregated data, ideally collected at the plant level.[1]

As requested by the Technical Specifications and in line with the consolidated methodological approach adopted in the previous editions of the EPC Study, the current Assignment relies on a bottom-up approach. Hence, the composition and drivers of energy prices and costs are assessed by collecting primary data from manufacturers based in EU Member States. More specifically, data collection was carried out at the plant level; hence, the sampling units are expressed in terms of production sites rather than companies.

The following items, which are relevant to data collection strategy, are discussed in this Section of the Study:

- Sampling criteria
- Sample selection
- Data collection techniques
- Pilot
- Confidentiality
- Time span.

<u>Sampling criteria</u>

Once the bottom-up approach is opted for, to ensure the general validity of the Assignment, establishing a sample of typical plants[2] for the sectors covered by the case studies becomes a key factor. In general terms, a good sample reflects the diversity of the companies and plants within the sector. Against this background, for the purpose of this Assignment, the following sampling criteria have been considered:

- Sectors. Due to the differences between sectors in terms of e.g. product range, production technologies and configuration of the value chain, data for the Assignment needed to be collected and analysed (at least) at a NACE 4-digit level. Therefore, each sector under analysis is subject to a separate case study. For instance, it is not possible to aggregate data from producers of ceramic (wall and floor) tiles and bricks and roof tiles as the energy intensity and consumption of the two ceramics sectors are quite different.
- Geographical distribution. Based on the results of the previous editions of the EPC Study, variations in the magnitude of energy prices and costs can be explained to

[1] When not available, company level data can also be appropriately used.

[2] A typical plant is expected to reflect the average features of EU plants operating in a certain sector. In this respect, the main features of a typical plant are defined on a sector-by-sector basis. In some sectors, however, it is not possible to identify one single typical plant. For instance, in the steel sector the same production output can be obtained by adopting two very different production routes (EAF and BOF); or the aluminium sector includes very different plants operating at different links of the value chain (primary, secondary and downstream). In these cases, more than one typical plant was identified in a given sector and, where possible, separate data on energy prices and costs are presented for each typical plant.

some extent by the plant location. In fact, data are likely to be more homogenous within a given country. Nonetheless, as the production of several sectors is often concentrated in a limited number of Member States, to ensure the broadest geographical coverage while respecting confidentiality, data will be aggregated at a regional level. This prevents disclosing identifiable information on specific plants in case of too few respondents from a certain Member State. In line with previous Cumulative Cost Assessments reports published by the Commission,[3] the following classification to identify regions homogeneously across sectors is adopted:

  - 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.

- Company features: size/ownership. Although the analysis remains plant-based, company size/ownership may have an impact on energy prices and costs as well as on overall production costs and margins, as larger companies may be able to benefit from e.g. economies of scope, economy of scale, better bargaining power *vis-à-vis* suppliers. As a result, samples are divided (where relevant) in two main groups: i) large enterprises; and ii) small and medium-sized enterprises (SME).
- Plant features: configuration of the value chain. The configuration of the value chain is another important feature to be taken into account. In this respect, it is worth stressing that, to the extent possible, the Assignment focuses on the same number and typology of activities, i.e. value chain links, in all the sampled plants within a given sector.
- Plant features: capacity. The composition and drivers of energy prices and costs is likely to be affected by plant capacity. In fact, production capacity usually affects the energy intensity of the production process as well as production costs and margins, especially for homogenous products manufactured in large quantities where economies of scale do matter.
- Plant features: production technology/product range. Production technology and product range are two additional plant features that may be relevant to partition the population of EU companies into homogenous groups. For instance, steel can be produced by relying on two main technologies (Basic Oxygen Furnace-BOF and Electric Arc Furnace-EAF), which have profound differences in terms of energy consumption; in the same vein, the aluminium industry includes players who produce very different products (primary aluminium, secondary aluminium, semi-finished products) with different energy consumption profiles. Therefore, differences in products and production technologies are taken into account when devising the sampling strategies for specific sectors.

As information about most of these sampling criteria cannot be retrieved from secondary sources, the Research Team included ad hoc questions on the sampling criteria in the questionnaire for data collection. Where relevant, the impact of such criteria on energy prices and costs is assessed *ex post* by analysing data collected at the plant level.

Sample selection

Collecting data on the composition and drivers of energy prices and costs required plants to fill in a very detailed questionnaire, which entailed major efforts by plant staff to retrieve relevant information. The data required, and the complexity of the collection prevented relying on a statistical representative sample. In fact, a statistically representative sample would include a too large number of companies (especially in those sectors dominated by SME such

[3] See for instance CEPS et al. (2017), *Cumulative Cost Assessment of the EU ceramics industry*, European Commission and CEPS et al. (2017), *Cumulative Cost Assessment of the EU glass industry*, European Commission.

as ceramic tiles, bricks and tiles and downstream transformation of aluminium) and data collection might not be feasible.

Against this background, the Research Team applied the 'principle of a proportionate analysis' to set the minimum number of plants required to carry out the Assignment. In this respect, the Better Regulation Toolbox[4] endorses the need to respect the principle of a proportionate analysis and make transparent compromises about data quality, including limiting fieldwork to a sample of Member States or population segments.[5] In the case of this Assignment, the trade-off between data granularity and population coverage cannot be entirely resolved in favour of the latter. As acknowledged by the OECD, "statistically valid surveys may be expensive and time consuming to administer, both for government and for stakeholders, and may therefore not be appropriate or feasible […] however, small-scale surveys can provide broad indications of the scale of" the issue under investigation.[6] The resulting estimates are then complemented by consulting industry associations and other representative bodies and validating data, e.g. via secondary sources.

International best practices recommend conducting at least five interviews for each item under investigation, and then, if necessary, to follow up with additional interviews in case of discrepancies.[7] While in principle correct, this approach is too reductionist for the task at hand, which aimed to collect data on energy prices and costs. Experience with previous exercises has shown that the variance of energy prices and cost items is too high to be tackled with only five data points. In particular, based on experience in previous editions of the EPC Study and Cumulative Cost Assessments, discrepancies may emerge based on the geographic region where the plants operate and the features of each sector. Therefore, a relatively larger number of observations was required in those sectors characterised by elements of heterogeneity. For instance, the aluminium sector includes players operating at different links of the value chain (i.e. smelters, refiners/remelters and downstream producers). In the same vein, the steel sector covers two very different production technologies (i.e. BOF and EAF).

In light of the above, data on energy prices and costs were collected from a sample of 'typical' plants, selected on the basis of sampling criteria presented above. Nonetheless, the representativeness of each sample was then assessed *ex post* by measuring the share of EU sectoral turnover (or capacity) represented by respondent companies in each sector.

On the grounds of the proposed sampling criteria and composition of the sample, the Research Team prepared two different lists of companies contacted during the data collection phase:

- A 'main list', including randomly selected companies from a list of EU firms comprising members of the relevant EU and national associations. These companies were contacted for the data collection exercise and requested to provide data at the plant level.
- A 'mirror list', including only plants suggested by the relevant EU industry associations, based on their availability and willingness to participate in the Assignment. In order to avoid any bias in the sample selection, the Research Team resorted to this list only in case the response rate from players included in the 'main list' did not allow for collecting the required number of data points.

Data collection techniques

The Research Team relied on a mix of surveys via email and phone interviews. More specifically, the surveys were based on digital questionnaires (MsExcel®) aiming to collect the bulk of data necessary to perform the Assignment. The Research Team circulated two different types of questionnaire:

[4] Commission Staff Working Paper, *Better Regulation Guidelines*, SWD(2017)350.

[5] *Better Regulation Toolbox complementing Better Regulation Guidelines* (SWD(2017)350), at p. 468.

[6] OECD (2014), *OECD Regulatory Compliance Cost Assessment Guidance*, OECD Publishing, p. 35.

[7] *International SCM Manual*, also quoted in the Better Regulation 'Toolbox', at p.368-369.

- A questionnaire to collect primary data from EU sampled plants. This questionnaire included an introduction clarifying the aim and scope of the Assignment and was divided into five sections (general information, electricity, natural gas, other energy sources,[8] key performance indicators) covering the different topics relevant to this Assignment, i.e. energy prices and costs (with a breakdown by price components), energy supply conditions (e.g. type and duration of the contract, on-site generation, quality of the service), reimbursement, key performance and competitiveness indicators. The questionnaire also included a question aiming to collect information about the supporting evidence (e.g. natural gas and electricity bills, balance sheets) that respondents were willing to share.
- A questionnaire to collect primary data from plants managed by EU companies and based in third countries. The questionnaire for the international comparison was a simplified version of the questionnaire for collecting data from plants based in the EU, focusing only on one year and on selected indicators.

Follow-up interviews on the phone were arranged with a limited number of respondents to the survey to review and validate data gathered and collect more qualitative evidence useful to interpret trends in energy prices and costs.[9] Interview guidelines were tailored to the specific interviewee and circulated via email prior to the interview.

Pilot

Before launching the full-scale data collection, a pilot experiment was carried out in order to test the questionnaire for collecting plant level data and avoid time and resources being wasted on an inadequately drafted questionnaire. This activity aimed, *inter alia,* to ascertain that:

- Questions were easily understandable;
- Data requested were available at a plant level;
- A reasonable amount of time was needed to complete the entire questionnaire.

The pilot experiment was conducted on a small sample of companies that reflected:

- Differences in company dimensions, to account for different availability of skills and expertise as well as of sophisticated accounting systems between large companies and SME;
- Different geographic localisation, to account for linguistic bias as well as divergences in company culture.

The pilot experiment was completed by one plant per sector, with one single exception where the pilot was completed by the EU sectoral association on behalf of its members.

Confidentiality agreement

Given the sensitiveness of the topics at stake and the information/data to be used, the Research Team carried out this Assignment in strict compliance with confidentiality rules and competition rules including– but not limited to – the:

- Data collection, storage, handling and retention;
- Discussions on data and the Assignment;
- Presentation of the data to be included in the Assignment;

[8] This section was shared only with plants operating in sectors where sources other than electricity and natural gas are used.

[9] Follow-up interviews focused on: i) plants which appeared to be outliers, for data validation purposes; ii) plants putting forward additional information (the questionnaire allowed the provision of additional information in each part) that was not directly covered by the questions included in the questionnaire and had an impact on energy prices and costs; and iii) plants for which additional information was needed to complete the analysis.

- Drafting of the Assignment and its communication.

Against this background, the Research Team signed a confidentiality statement, which was shared with all respondents to the survey. In a limited number of occasions, an ad hoc confidentiality agreement was drafted by the sampled company and signed by the Research Team (this option required a longer time, as the process to draft and agree on the relevant terms took several weeks). At any rate, the Research Team committed to treat anonymously any primary data collected in the context of this Assignment and to aggregate and/or anonymise such data before being published or circulated. Confidential data will be passed neither to the Commission nor to any other third party.

In addition, to preserve data confidentiality, averages are presented only when based on observations from at least three independent companies. Box plots are presented only when figures were provided by at least six plants belonging to three independent companies.

Time span

For most of the indicators, the current report presents data over a 10-year period going from 2008 to 2017. However, in line with the Technical Specifications, whereas data for fertilisers, glass tableware and packaging glass were collected for the entire period under investigation, data for aluminium, bricks and roof tiles, refineries, steel and wall and floor tiles (the so-called 'old sectors') were collected only for 2016 and 2017. In the latter sectors, which were already covered up to 2015 by the 2016 EPC Study, time series were completed by relying on the data that the Research Team collected when performing the previous edition of the Study.[10]

In this respect, two caveats are required. First, in the 2016 EPC Study, data for 2009 and 2011 were not collected; this explains missing data for those two years in the 'old sectors'. Second, in some sectors, the current sample for the period 2008-2015 may differ from the sample on which the 2016 EPC Study is based; this is due to two main reasons: i) some plants participating in the 2016 EPC Study did not authorise the use of their data for the present Assignment; ii) some plants operating in 'old sectors' and participating only in the present Assignment voluntarily also provided data from the period 2008-2015.

Data cleansing and validation

All questionnaires received were carefully inspected by the Research Team and prepared for data processing. First, an internal consistency check was performed. More specifically, the Research Team checked that:

- Questionnaires were completed in all relevant parts;
- All data related to outputs were in tonnes, all monetary values in euros, all electricity and natural gas quantities in MWh. Where data were reported in a different unit, they were converted;
- The installed production capacity was always higher than annual production outputs;
- The sum of the electricity (natural gas) components was always equal to the total price paid for electricity (natural gas);
- Average electricity (natural gas) prices were in a plausible range. For instance, prices in the area of e.g. €1/MWh or €1,000/MWh were flagged;
- EBIT was always smaller than EBITDA;
- Where KPIs were reported at the company level, company level outputs were also provided by sampled plants.

Data were then compared with available supporting evidence. In this respect, random checks were performed to ascertain that data provided in the questionnaire were aligned with

[10] With regard to the wall and floor tiles sector, time series were completed by relying on energy data collected during the CEPS et al. (2016) Cumulative Cost Assessment of the EU Ceramics Industry. In fact, in the 2016 EPC Study the production output of the wall and floor tiles sector was expressed in square metres; by contrast, in the current Assignment and the Cumulative Cost Assessment, the production output is expressed in tonnes, thus ensuring full comparison with other sectoral data.

documentary evidence (if any) shared with the Research Team (mainly electricity and natural gas bills).

After these two rounds of checks, the Research Team sent requests for clarification to most of the respondents, in order to improve the quality of the data received. All requests were accompanied by short comments explaining the nature of the request and the relevance of the missing/inadequate information for the success of the ECP Study. Phone interviews were arranged in case the plant contact person asked for some guidance to retrieve the requested information.

Then, for each sector, all data were collated in an MsExcel® database, thus making it possible to compare data provided by different plants and identifying outliers.

- The Research Team contacted all outlier plants and asked to double check the information provided. Based on feedback from respondents, the following two categories of outlier were identified.
  - Plants that are outliers because they are not typical plants. Most of these outliers were removed from the sample. Nevertheless, this was not the case when, given the small number of respondents, removing outliers would have made it impossible to show data for a certain sector due to confidentiality reasons.
  - Plants that are outliers because they are more (or less) efficient than others or because they struck worse (or better) deals with energy providers. This was assessed on a case-by-case basis, taking into account the specificities of each sector. For instance, production output is more homogenous in the packaging glass sector than in the glass tableware sector, where the variance of e.g. energy intensity, production costs and margins was expected to be larger.

Finally, intermediate findings were presented to all relevant EU sectoral associations[11] in two ad hoc stakeholder workshops; feedback provided by these associations contributed to the data validation process.

<u>Production costs and margins</u>

All indicators presented in this report are based on plant level data collected by the Research Team, unless otherwise specified. The same applies to production costs, turnover and margins, which are measured on primary data provided by plants responding to the survey. For this purpose, a section of the questionnaire included a set of relevant questions to be filled in by the respondent companies. More specifically, the following information was requested from sampled companies at the plant level:

- Quantity produced (e.g. tonnes, or square metres)
- Turnover
- Total production costs
- Depreciation and amortisation
- EBITDA
- EBIT.

Some companies did not provide the requested information; however, they provided data on quantity produced at a company level. In this circumstance, the Research Team estimated production costs and margins per unit of output by relying on company balance sheets and profit and loss accounts retrieved from the Orbis Europe database.[12] This approach was limited by the coverage of the database, which does not include the entire population of EU companies (especially in some Member States and when it comes to SME). In addition, the approach did not work with conglomerate companies operating in a diverse range of sectors, as it was not possible to estimate the company performance in the specific sector covered by the Assignment.

[11] Cerame-Unie, Concawe, EDG, Eurofer, European Aluminium, Fertilizers Europe, FEVE, FuelsEurope.

[12] For further details see: https://www.bvdinfo.com/en-us/our-products/company-information/international-products/orbis

All sectoral samples include 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.

International comparison

In order to perform an international comparison, an estimate of energy prices and costs as well as production costs and margins incurred by international competitors is required. As data cannot be directly collected from extra-EU companies, the Research Team attempted to collect relevant data via EU companies operating production facilities outside the EU via a simplified version of the questionnaire completed by plants located in the EU. The response rate, however, was inadequate and did not allow collected data to be shown due to confidentiality reasons. The only exception is represented by the bricks and roof tiles and wall and floor tiles sectors, where the few producers that shared international data provided special authorisation to show such data in anonymised form, without aggregation (see below). Against this background, in the aluminium, fertiliser and steel sectors the international comparison was performed by relying on data provided by CRU[13]. In the remaining sectors, this analysis is missing.

Data aggregation

Once plant-level indicators were calculated, the Research Team measured average values at the EU and, where possible, regional level:

- Regional averages were computed by averaging data provided by plants located in a certain region;
- EU averages were computed by averaging data provided by all sampled plants.

Whereas all figures and graphs included in this report present simple averages, tables underneath each figure/graph show both simple and weighted averages. Different weighing factors were used for different indicators in order to allow for a meaningful comparison between simple and weighted averages:

- Total electricity purchased in MWh is the weighting factor for electricity prices and components of the electricity price. This allows testing of whether larger buyers of electricity are able to use their bargaining power to obtain quantity discounts and strike a better deal with their providers; or whether they are partially exempted from paying some of the components of the price.
- Total electricity consumed in MWh is the weighting factor for electricity costs in €/MWh.[14] The logic is the same as above; however, for this indicator it is necessary to account for the overall consumption of electricity as electricity costs in €/MWh are also affected by self-generation.
- Total natural gas purchased in MWh is the weighting factor for natural gas prices and components of the natural gas price. This allows testing of whether larger buyers of natural gas are able to use their bargaining power to obtain quantity discount and strike a better deal with their providers; or whether they are partially exempted from paying some of the components of the price.
- Total fuel purchased in MWh is the weighting factor for prices of other fuel. This allows testing of whether larger buyers of other fuel are able to use their bargaining power to obtain quantity discount and strike a better deal with their providers.

[13] For further details see: https://www.crugroup.com/

[14] Electricity prices in €/MWh are defined as follows: Total price paid to purchase electricity/Total electricity purchased. Electricity costs in €/MWh are defined 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).

- Production output in tonnes[15] is the weighting factor for the following variables: electricity costs in €/tonne, electricity intensity, natural gas costs, natural gas intensity, total gas costs, total gas intensity, other fuel intensity, production costs, turnover, EBITDA, EBIT. These are all variables expressed in €/tonne of output; therefore, the weighting factor allows testing of whether plants producing larger quantity of output benefit from economies of scale, thus recording lower costs, higher energy efficiency and better margins.

To preserve confidentiality, averages are presented only when based on observations from at least three independent companies; box plots (see 'data visualisation' below) are shown only when data from more than five plants belonging to at least three independent companies are available.

Data visualisation

Sectoral chapters mainly rely on 'standard' charts (such as bar graphs, line charts, pie charts, etc.), which are self-explanatory. Ranges are, however, displayed via box plots (Figure 1). More specifically, the main box is divided into two parts with a horizontal line, which indicates the median[16] of the sample. The upper and lower boundary lines of the box represent the first and third quartile of the data set, meaning that the box contains 50% of the sample. The lower border of the box represents the first (lower) quartile of the sample. It separates the lowest 25% of the data sample from the highest 75%. Correspondingly, the upper border of the box indicates the third (upper) quartile of the sample, thus separating the highest 25% of data from the lowest 75%. The whiskers below and above the box represent respectively the minimum[17] and maximum[18] value of the sample. Values outside this range are considered outliers and are represented by dots; this is a statistical definition of outliers that should not be confused with the operational definition detailed above. Unless relevant to discuss data trends, statistical outliers are hidden to limit data disclosure. Finally, the cross in each box represents the simple average.

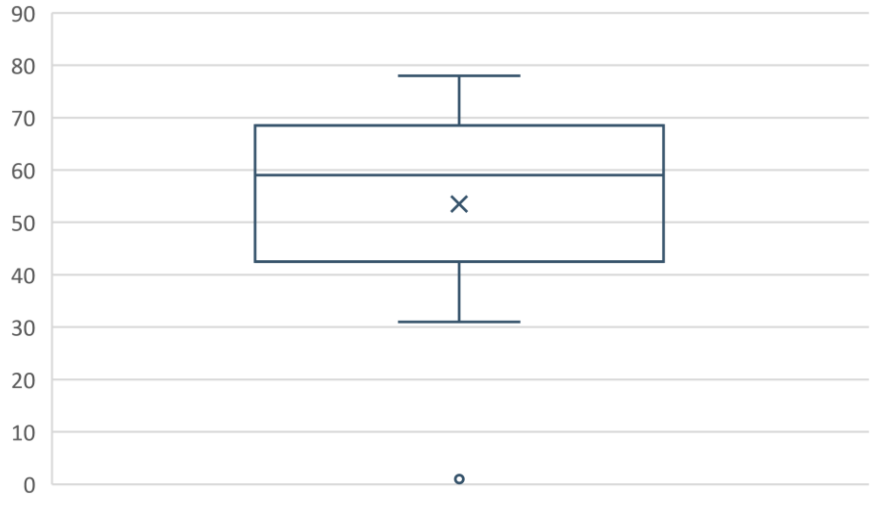
[15] This weighting factor makes it possible to provide a more accurate picture of average energy costs, production costs and margins registered to produce one tonne of output in a given sector. In fact, while simple averages attribute the same weight to each plant, averages weighted by production output attribute the same weight to each tonne produced. This is the same approach adopted in the Cumulative Cost Assessments (CCA) of the aluminium, ceramics, glass and steel industries published by the European Commission. It is worth remarking that it is not advisable to use the production value as a weighting factor. In fact, the production value depends on two variables, namely the quantity produced in tonnes and the selling price in €/tonne, and it is not possible to interpret which of the two variables would explain the difference between simple and weighted averages.

[16] Exclusive median: the median is excluded from the calculation if N (the number of values in the data) is odd.

[17] Smallest data element that is not smaller than the first quartile minus 1.5 times the interquartile range.

[18] Largest data element that is not larger than the third quartile plus 1.5 times the interquartile range.

Figure 1 Example of box plot



Source: Authors' elaboration

1.2 Indicators

Table 1 lists and defines all the indicators based on primary data that are presented in the sectoral chapters. Additional definitions to interpret such indicators are provided in the glossary presented at the beginning of this report.

Table 1 Indicators based on primary data

Variable	Definition	Unit	Relevant sectors
Electricity prices	• Total price paid to purchase electricity/Total electricity purchased The price is net of any *ex ante* exemption and recoverable taxes.	€/MWh	All
Components of the electricity price	• Total price paid for each component of the electricity price/Total electricity purchased	€/MWh and % out of total price paid to purchase electricity	All
Electricity costs in €/MWh	• (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)	€/MWh	All
Electricity costs in €/tonne	• (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 production output	€/tonnes	All
Electricity intensity	• (Total electricity purchased + total self-generated electricity – total self-generated electricity sold to the grid)/ Total production output	MWh/tonnes	All

Variable	Definition	Unit	Relevant sectors
Type of electricity contract	• Share of respondents purchasing electricity via wholesale market, purchase power agreements or energy suppliers. Some respondents may resort to a mix of the above-mentioned options.	%	All
Duration of electricity contracts	• Share of respondents purchasing electricity via contracts of indeterminate duration, contract up to five years or contracts above five years. Some respondents may resort to a mix of the above-mentioned contractual options.	%	All
Flexibility schemes for electricity	• Share of respondents taking part in flexibility/interruptibility schemes	%	All
Continuity of electricity supply	• Average number and duration of outages experienced by respondents	# and minutes	All
Self-generation of electricity	• Share of respondents self-generating (at least part of the required) electricity	%	All
Self-generated electricity sold on the market	• Share of respondents selling (at least part of) self-generated electricity on the market	%	All
Natural gas prices	• Total price paid to purchase natural gas/Total natural gas purchased The price is net of any *ex ante* exemption and recoverable taxes.	€/MWh	All
Components of the natural gas price	• Total price paid for each component of the natural gas price/ Total natural gas purchased	€/MWh and % out of total price paid to purchase natural gas	All
Natural gas costs	• (Total price paid to purchase natural gas – payment for flexibility schemes) / Total production output	€/tonnes	All
Total gas costs	• (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	€/tonnes	Fertiliser, refineries, steel
Natural gas intensity	• Total natural gas purchased / Total production output	MWh/tonnes	All
Total gas intensity	• (Total natural gas purchased + total self-produced gas – self-produced gas sold to the grid)/ Total production output	MWh/tonnes	Fertiliser, refineries, steel
Type of natural gas contract	• Share of respondents purchasing natural gas via wholesale market or energy suppliers. Some respondents may resort to a mix of the above-mentioned options.	%	All

Variable	Definition	Unit	Relevant sectors
Duration of natural gas contracts	• Share of respondents purchasing electricity via contracts of indeterminate duration, contract up to five years, contracts above five years. Some respondents may resort to a mix of the above-mentioned contractual options.	%	All
Interruptibility schemes for natural gas	• Share of respondents taking part in flexibility/interruptibility schemes	%	All
Continuity of natural gas supply	• Average number and duration of outages experienced by respondents	# and minutes	All
Self-production of gas	• Share of respondents self-producing (at least part of the required) gas	%	Fertiliser, refineries, steel
Self-production of gas sold on the market	• Share of respondents selling (at least part of) self-produced gas on the market	%	Fertiliser, refineries, steel
Price of other fuels (e.g. solid fuel, crude oil, petroleum products)	• Total price paid for other fuels/ Total consumption of other fuels	€/MWh	Depending on the type of fuel
Other fuels intensity (e.g. solid fuel, crude oil, petroleum products)	• Total consumption of other fuels/ Total production output	€/MWh	Depending on the type of fuel
Electricity costs vs production costs	The two following variables are compared: • For electricity costs see Electricity costs in €/tonne above • Production costs: Total production costs/total production output	€/tonne and %	All
Electricity costs vs production costs net of depreciation and amortisation	The two following variables are compared: • For electricity costs see Electricity costs in €/tonne above • Production costs net of depreciation and amortisation: (Total production costs – total depreciation and amortisation)/total production output	€/tonne and %	All
Electricity costs vs turnover	The two following variables are compared: • For electricity costs see Electricity costs in €/tonne above • Turnover: Total turnover/total production output	€/tonne and %	All

Variable	Definition	Unit	Relevant sectors
Electricity costs vs EBITDA	The two following variables are compared: • For electricity costs see Electricity costs in €/tonne above • EBITDA: Total EBITDA/total production output	€/tonne	All
Electricity costs vs EBIT	The two following variables are compared: • For electricity costs see Electricity costs in €/tonne above • EBIT: Total EBIT/total production output	€/tonne	All
Natural gas costs vs production costs	The two following variables are compared: • For natural gas costs see Natural gas costs above • Production costs: Total production costs/total production output	€/tonne and %	All
Natural gas costs vs production costs net of depreciation and amortisation	The two following variables are compared: • For natural gas costs see Natural gas costs above • Production costs net of depreciation and amortisation: (Total production costs – total depreciation and amortisation)/total production output	€/tonne and %	All
Natural gas costs vs turnover	The two following variables are compared: • For natural gas costs see Natural gas costs above • Turnover: Total turnover/total production output	€/tonne and %	All
Natural gas costs vs EBITDA	The two following variables are compared: • For natural gas costs see Natural gas costs above • EBITDA: Total EBITDA/total production output	€/tonne	All
Natural gas costs vs EBIT	The two following variables are compared: • For natural gas costs see Natural gas costs above • EBIT: Total EBIT/total production output	€/tonne	All

Note: for a limited number of plants, production costs, turnover, EBITDA and EBIT are estimated on Orbis Europe data.
Source: Authors' elaboration

In addition to the indicators listed in Table 1, the following indicators based on secondary sources (e.g. Eurostat SBS, Eurostat PRODCOM, Eurostat COMEXT, reports published by sectoral associations) are presented (where available) in Annex A detailing the main characteristics of the sectors under investigation[19]:

- Indicators of structural business conditions including, *inter alia*, production value and volumes, number of enterprises, employment size and trends.
- Indicators of geographical distribution within the EU covering, for instance, the geographical distribution of sold volumes by country and geographical distribution of major plants.
- Trade indicators focusing, *inter alia*, on trade flow and main trade partners.

[19] These indicators are summarised in a box at the beginning of each sectoral chapter.

2 Bricks and roof tiles

Box 1 Highlights – Bricks and roof tiles

In the EU bricks and roof tiles sector, while electricity costs represented on average 7% of total production costs (simple average) between 2008 and 2017, natural gas represented on average 21% of total production costs (simple average).

Electricity

- After recording a growing trend from 2008 to 2012, the electricity prices and costs (in €/MWh) borne by EU bricks and roof tiles producers decreased between 2012 and 2017.
- **Electricity prices** (simple average) rose from less than €80/MWh in 2008 to above €94/MWh in 2012 and then declined to €83/MWh in 2017. At EU level, the simple average for this indicator exceeded the weighted average (by purchased electricity). In fact, when looking at the components of the electricity price, it is apparent that larger consumers: i) benefitted from stronger bargaining power when negotiating electricity prices (lower energy component); and ii) paid relatively less for network costs and non-recoverable taxes/levies (excluding RES levies). Only a few plants relied on the wholesale market to purchase electricity and they did not necessarily coincide with the largest consumers.
- Average **electricity costs in €/MWh** were largely aligned with electricity prices in €/MWh. The very small difference between these two indicators 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.
- At the EU level, after a peak in 2012, **electricity costs** (simple average) sharply declined, from above €92/MWh in 2012 and 2013 to about €75/MWh in 2017. The weighted average (by electricity consumption) for this indicator was lower than the simple average, confirming better conditions for larger consumers. When looking at differences between weighted and simple averages for electricity prices and electricity costs in €/MWh, it is apparent that flexibility schemes, self-generation and *ex post* reimbursement had a similar impact on both large and small consumers.
- **Electricity costs in €/tonne** (simple average) increased between 2008 and 2013 from less than €6/tonne to above €7/tonne, and then declined again (€6/tonne in 2017). Larger producers experienced lower electricity costs (the weighted average by production output for this indicator was below the 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 taxes/levies; and iii) economies of scale.
- The overall **electricity intensity** (simple average) of the bricks and roof tiles sector increased slightly in the last decade, from 0.07 to 0.08 MWh/tonne. The weighted average (by production output) for this indicator was constantly below the simple average, indicating that larger plants were more efficient than smaller ones when it comes to electricity.

Natural gas

- Natural gas prices and costs 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/MWh), the **natural gas price** (simple average) decreased sharply to about €23/MWh in 2017. The EU weighted average (by purchased gas) was generally below the simple average: larger consumers were

able to strike better deals with gas suppliers (lower energy component) and paid lower network costs. 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 €/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.

- **Natural gas costs** (simple average) ranged between €21/tonne in 2008 and €14/tonne in 2017, with a peak in 2013 (€21/tonne). The EU weighted average (by production output) for this indicator was below the simple average, indicating that larger plants incurred lower costs than smaller ones; this may be due to: i) quantity discount for larger consumers of natural gas; ii) lower network costs; and iii) economies of scale.
- The average **natural gas intensity** (simple average) was quite stable between 2008 and 2017 (ranging between 0.6 MWh/tonne and 0.7 MWh/tonne). The weighted average is generally below the simple average; this may indicate that larger plants are more efficient than smaller ones.

Competitiveness

- Between 2008 and 2017, **electricity costs** represented on average 7% of **total production costs** (simple average), rising from 5% in 2016 to 9% in 2013. Whereas electricity costs in €/tonne registered an inverted U-shaped trend with a peak in 2013, production costs decreased after the crisis and then increased between 2013 and 2016. Production costs dropped between 2016 (€115/tonne) and 2017 (€85/tonne); however, this contraction may be affected by changes in the composition of the sample.
- By comparing weighted and simple averages, it is evident that **economies of scale** play a key role, as production costs in €/tonne incurred by larger plants were much lower than those experienced by smaller ones.
- **Natural gas costs** make up a larger share of **total production costs** than electricity costs. In the 10 years under analysis, they represented on average 21% of total production costs (simple average), ranging between almost 22% in 2008 and 14% in 2016.
- The share of electricity costs relative to **turnover** increased between 2008 and 2013 (from 4% to 7%) and returned to 4% in the last year under observation. Natural gas costs were between 10% (2017) and 20% (2013) of average sectoral turnover. The weighted average (by production output) for turnover was below the simple average; this may indicate that larger plants relied on their cost advantage to apply lower prices.
- With regard to profitability, it is not possible to draw conclusions on the impact of electricity costs on margins (more details on this point are provided in Annex B to this Study). **EBITDA** declined between 2008 and 2015 and then increased in the last two years. Negative values for **EBIT** were recorded up to 2015, and only recently was the negative trend reverted. By contrast, when compared to margins, electricity costs have been quite stable for the whole period under observation. On average, to obtain an idea of the importance of natural gas costs with respect to profit indicators, natural gas costs are higher than EBITDA (simple average) in all years except for 2016 and 2017; they are higher than EBIT in all years under observation.

Sample and limitations

- The **sample** for 2016 and 2017 included 58 plants across the EU, representing no less than **11% of the total production sold** by EU bricks and roof tiles producers (in value). The sample for previous years included 52 plants, representing between 7% (in 2008) and over 12% (in 2015) of the total production value in the EU. About 60% of the sample is composed of plants based in the NWE region, the remaining 40% of plants was equally distributed between the SE and CEE regions; this sample largely reflected the distribution of production value across the EU, even if the CEE region is slightly over-represented compared to the SE region. SME operating in the sector are under-represented.

- 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.
- For some indicators, the number of available observations varies between years; the trends may therefore be affected by **changes in the sample size**. More details about the number of observations are provided beneath each figure and table.
- **Averages for the CEE region cannot be shown** for confidentiality reasons. However, data provided by CEE plants are included in the EU averages.

2.1 Composition of the sample

Sampling strategy

Dividing EU manufacturers of bricks and roof tiles (NACE rev.2 23.32) into homogenous groups requires considering the following sampling criteria:

- Geographical distribution
- Company size/ownership.

First, the sample aims to cover three geographical regions (Southern Europe, Central Eastern Europe and North-Western Europe) to account for differences in energy prices and costs generated by the plant location.

Based on Eurostat data, in the manufacturing of clay building materials (NACE rev.2 23.3), most of the turnover is generated by large companies (above 50%) and medium-sized companies (35%). However, according to industry associations, SME may play a role in the manufacturing of bricks and roof tiles. Therefore, company size can be considered a relevant sampling variable.

Plant features are not a relevant variable for the bricks and roof tiles sector. Although the sector includes very heterogeneous products (in terms of physical composition, dimension, weight, shape, surface and colour), it is fairly homogenous when it comes to the production process as well as energy prices and costs. This was confirmed by the previous edition of the EPC Study, with the sole exception of some minor differences in the energy intensity of the production of bricks *vis-à-vis* the production of roof tiles.

The configuration of the value chain is quite straightforward and does not entail downstream processing activities performed by different companies. Nevertheless, there is room for different levels of vertical integration (e.g. some plants quarry raw materials) that may have some impact on energy costs.

Against this background and keeping in mind the methodology for the selection of the sample discussed in Chapter 1, a minimum number of 30 plants were expected to be surveyed in the bricks and roof tiles sector (Table 2).

Table 2 Minimum number of plants to be surveyed

Geographical regions	Bricks and roof tiles	
	Large	SME
Southern Europe	5	5
Central Eastern Europe	5	5
North-Western Europe	5	5
Total	**15**	**15**

Source: Authors' elaboration.

Box 2 Key features of the bricks and roof tiles sector

- Key statistics pertaining to the bricks and roof tiles sector (NACE 23.32) are presented as follows:
  - Production value (2015): €6,200 million
  - Number of enterprises in absolute value (2015): 1,810
  - Top five European bricks and roof tiles producers (2016, production value): Germany (28%), United Kingdom (20%), France (16%), Italy (10%), and Belgium (7%).
  - Intra-EU vs extra-EU trade (2016): intra-EU trade accounts for almost 85% of the total trade value. With regard to international trade, the EU is a net exporter of bricks and roof tiles.
  - The main importers of European bricks and roof tiles (2016) are Switzerland, Russia and Norway.
  - The main exporters to the EU of bricks and roof tiles (2016) are Serbia, Turkey and China.
- The bricks and roof tiles sector consists of a roughly equal number of large producers and regionally settled SME. Plants tend to be spread throughout Europe, depending on the availability of raw materials and requirements of the production process, which entails the following phases:
  - Preparation of raw materials
  - Shaping
  - Drying
  - Firing.
- Across the period under observation, most of the plants included in this study tend to fall in the following ranges (first quartile – third quartile range) for the indicators presented:
  - Electricity consumption: 3,500 MWh to 10,400 MWh per year
  - Electricity intensity: 0.04 MWh/tonne and 0.10 MWh/tonne
  - Natural gas consumption: 24,500 MWh to 88,000 MWh per year
  - Natural gas intensity: 0.31 MWh/tonne and 0.86 MWh/tonne.
- For additional details pertaining to the production process of a 'typical plant' and sector information, please refer to Annex A.

Source: Authors' elaboration on Eurostat and other sources.

Sample statistics

In the context of the current Assignment, the Research Team contacted 98 plants across the EU: 65 in the NWE region, 15 in the CEE region and 18 in the SE region (Table 3). The questionnaire was eventually completed by 58 plants[20] (nine belonging to SME)[21]. For data validation purposes, 31 plants provided supporting evidence, such as electricity and gas bills. However, plants based in the CEE region belong to fewer than three independent companies; therefore, data for this region cannot be presented in this report due to confidentiality reasons.

Table 3 Plants participating in the survey

Geographical regions	Bricks and roof tiles		
	Plants contacted	Questionnaires collected	Number of plants sharing supporting evidence
Southern Europe	18	11	7
Central-Eastern Europe	15	11	11
North-Western Europe	65	36	13
Total	**98**	**58**	**31**

Source: Authors' elaboration

Between 2014 and 2016, the turnover generated by sampled plants represented no less than 11% of the overall sectoral turnover at the EU level (Table 4). However, it is worth stressing that several plants included in the sample did not disclose their turnover; therefore, the sample certainly represents a larger share of the total value of production sold by EU producers of bricks and roof tiles.

Table 4 Turnover of sampled plants out of total value of production sold by EU producers (%)

Bricks and roof tiles	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Turnover %	7.1	n.a.	7.3	n.a.	8.9	9.4	11.6	12.5	11.0	n.a.
Number of plants disclosing their turnover	40	n.a.	44	n.a.	47	48	47	51	41	41
Total number of sampled plants	52	n.a.	52	n.a.	52	52	52	52	58	58

Note: PRODCOM values for 2017 are not available.
Source: Authors' elaboration on data collected at the plant level and PRODCOM.

It is worth mentioning that, in order to increase the response rate, the Research Team relied on several mitigation measures, including:

- Sending several rounds of reminders via email to all contacted companies
- Calling companies wherever the phone number was available

[20] It is worth mentioning that samples for the period 2008-2015 and for 2016-2017 are different. More specifically, for 2008-2015, the sample includes: i) plants not participating in the current Study, which, however, gave their consent to use data they provided for the 2016 EPC Study; ii) companies participating in both the current and 2016 edition of the EPC Study, which gave their consent to use also data they provided for the 2016 EPC Study; and iii) a few companies participating only in the current Study, which voluntarily also provided data for the period 2008-2015.

[21] Due to the small number of observations collected from plants belonging to SME, it is not possible to provide a separate analysis for energy prices and costs borne by SME.

- Inviting additional companies randomly selected via lists available on the websites of national associations
- Arranging a webinar to which companies and national associations as well as the Commission were invited to participate
- Arranging bilateral meetings with companies to explain how to complete the questionnaire.

In addition, the Research Team worked in close cooperation with Cerame-Unie (the relevant sectoral association at the EU level) and with national associations (e.g. Confindustria Ceramica, British Ceramic Confederation, Hyspalyt, etc.) to build trust across stakeholders.

2.2 Electricity

As shown in Table 5, electricity prices and costs in €/MWh borne by EU bricks and roof tiles producers were characterised by an inverted U-shaped trend in the period under investigation. In fact, after increasing between 2008 and 2012, prices and costs of electricity decreased between 2012 and 2017. With regard to electricity costs in €/tonne, between 2008 and 2017 a very small increase was recorded, which is partially due to 2017 electricity prices being above 2008 prices and partially to an increase in the electricity intensity of the production process.

Table 5 Electricity: summary table (EU, simple averages)

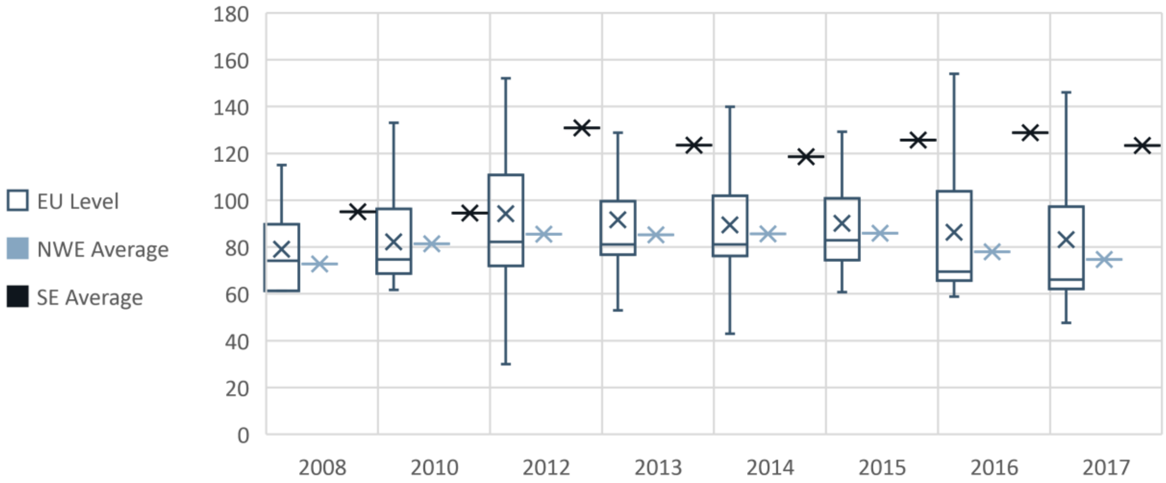
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity prices (€/MWh)	79.0	n.a.	82.2	n.a.	94.3	91.7	90.4	90.1	86.3	83.1
Electricity costs (€/MWh)	77.8	n.a.	80.8	n.a.	92.5	92.4	89.2	88.4	79.3	75.1
Electricity costs (€/tonne)	5.9	n.a.	5.4	n.a.	6.7	7.1	6.9	6.5	6.2	6.0
Electricity intensity (MWh/tonne)	0.07	n.a.	0.07	n.a.	0.07	0.07	0.07	0.08	0.08	0.08

Source: Authors' elaboration

Electricity prices

The EU average price (simple average) for electricity paid by bricks and roof tiles manufacturers recorded an upward trend between 2008 (less than €80/MWh) and 2012 (above €94/MWh; Figure 2). From 2013 onwards, the prices dropped towards pre-crisis levels (€83/MWh in 2017). At the regional level, on average, SE manufacturers of bricks and roof tiles paid more than NWE manufacturers. In fact, whereas electricity prices for NWE manufacturers closely follow the EU average prices in the whole period under observation, the average energy price paid by SE producers recorded an increasing trend. At EU level, the simple average for this indicator exceeded the weighted average (by purchased electricity; Table 6). In fact, when looking at the components of the electricity price (see below), it is apparent that larger consumers i) benefitted from stronger bargaining power when negotiating electricity prices (lower energy component); and ii) paid relatively less for network costs and non-recoverable taxes/levies (excluding RES levies). However, this conclusion does not hold in the SE region.

Figure 2 Electricity prices (€/MWh) – Box plots and simple averages



Note: data for the CEE region cannot be shown due to confidentiality reasons; 35 observations in 2008, 39 observations in 2010, 44 observations in 2012, 50 observations in 2013, 52 observations in 2014, 50 observations in 2015, 58 observations in 2016 and in 2017; data for 2009 and 2011 are not available.
Source: Authors' elaboration

Table 6 Electricity prices (€/MWh) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	Weighted	68.2	n.a.	75.8	n.a.	80.5	82.9	84.7	86.6	76.0	72.3
	Simple	72.8	n.a.	81.4	n.a.	85.5	85.2	85.6	85.9	78.0	74.7
SE	Weighted	100.4	n.a.	96.6	n.a.	130.1	129.1	123.8	121.1	121.3	117.1
	Simple	95.0	n.a.	94.6	n.a.	130.9	123.5	118.5	125.7	128.8	123.3
CEE	Weighted	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
	Simple	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
EU	Weighted	**76.1**	**n.a.**	**77.8**	**n.a.**	**85.7**	**86.4**	**86.2**	**85.6**	**78.3**	**75.6**
	Simple	**79.0**	**n.a.**	**82.2**	**n.a.**	**94.3**	**91.7**	**90.4**	**90.1**	**86.3**	**83.1**

Note: weighting factor: electricity purchased; 35 observations in 2008, 39 observations in 2010, 44 observations in 2012, 50 observations in 2013, 52 observations in 2014, 50 observations in 2015, 58 observations in 2016 and in 2017.
Source: Authors' elaboration

Components of the electricity price[22]

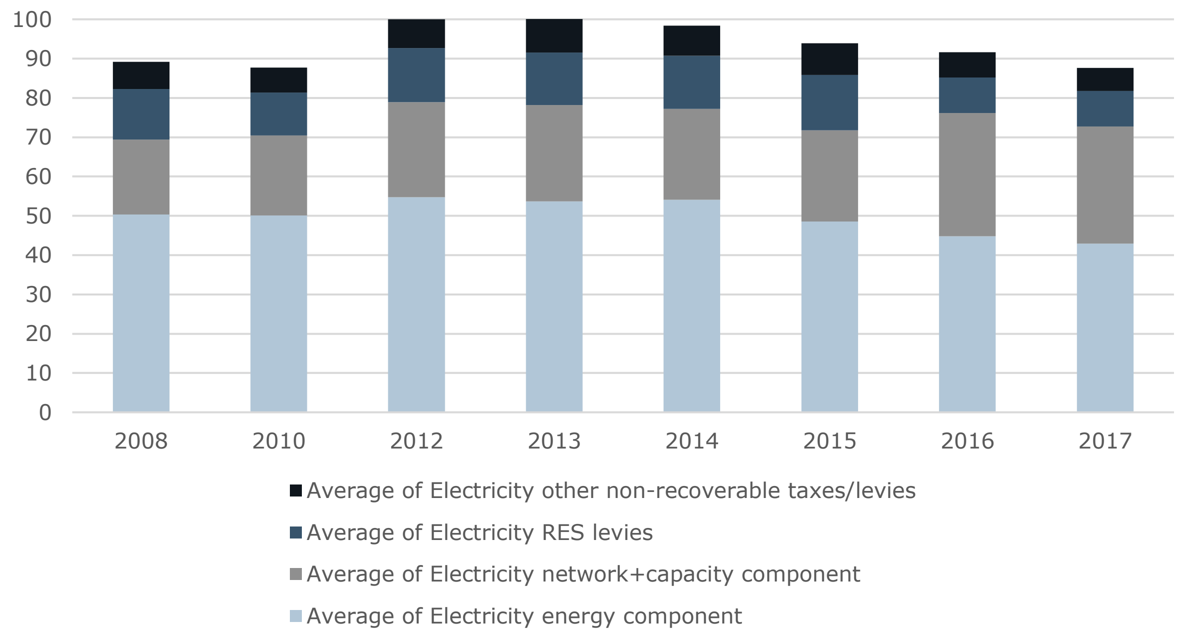
The price of electricity is split into five components:

- Electricity supply
- Network costs
- Cost of the capacity market
- Renewable levies
- Other non-recoverable taxes/levies (excluding VAT).

Not all plants provided a split per component of electricity prices; however, in some cases, the Research Team was able to estimate the split of components based on the electricity bills provided by the respondents. Network costs here include also the capacity market component, which was explicitly reported only by 11 plants.

Figure 3 and Figure 4 show the breakdown of components at the EU level. About 50% of the electricity price is due to the energy costs. In this respect, whereas the electricity component recorded a decreasing trend as of 2012, network costs (including market capacity costs) went from about 20% of the price in 2008 to 30% in 2017. Both non-recoverable taxes and RES fluctuated across the years under examination and decreased in the last two years.

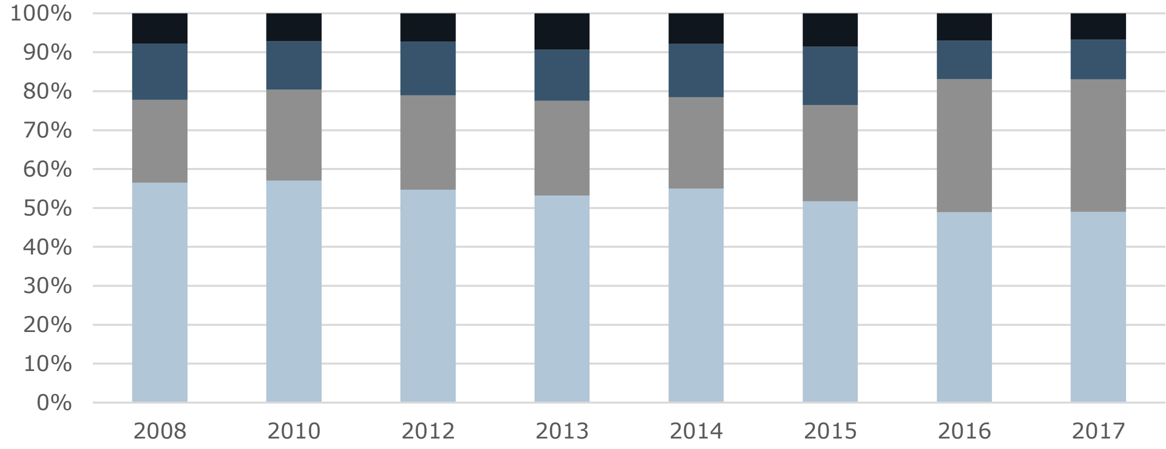
Figure 3 Components of the electricity price (€/MWh, EU) – Simple averages



Note: 13 observations in 2008, 20 observations in 2010, 24 observations in 2012, 23 observations in 2013, 25 observations in 2014, 24 observations in 2015, 43 observations in 2016 and 44 observations in 201; data for 2009 and 2011 are not available.
Source: Authors' elaboration

[22] The sum of the electricity bill components does not necessarily add up to the total electricity price mentioned before, as there might be plants that did not provide a breakdown of the electricity bill components while still providing the total electricity price.

Figure 4 Components of the electricity price (%, EU) – Simple averages



Note: 13 observations in 2008, 20 observations in 2010, 24 observations in 2012, 23 observations in 2013, 25 observations in 2014, 24 observations in 2015, 43 observations in 2016 and 44 observations in 2017; data for 2009 and 2011 are not available.
Source: Authors' elaboration

The trend is broadly confirmed by looking at the weighted averages presented in the tables below. Interestingly, as regards the impact of regulated components on the electricity prices, it is evident that the costs borne by SE bricks and roof tiles producers are higher than those incurred by NWE producers, especially in recent years.

Table 7 Components of the electricity price: energy component (€/MWh) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	**Weighted**	55.7	n.a.	56.6	n.a.	57.9	57.0	57.5	50.1	43.5	39.3
	Simple	57.9	n.a.	57.7	n.a.	57.3	55.3	56.4	47.7	43.8	41.1
SE	**Weighted**	45.2	n.a.	50.9	n.a.	64.6	61.0	68.1	65.5	57.0	54.6
	Simple	44.1	n.a.	52.6	n.a.	65.3	60.8	66.9	64.0	55.7	55.5
CEE	**Weighted**	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
	Simple	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
EU	**Weighted**	**49.2**	**n.a.**	**48.8**	**n.a.**	**54.8**	**53.8**	**53.7**	**48.0**	**42.9**	**39.9**
	Simple	**50.3**	**n.a.**	**50.1**	**n.a.**	**54.7**	**53.7**	**54.1**	**48.5**	**44.8**	**42.9**

Note: weighting factor: electricity purchased; 13 observations in 2008, 20 observations in 2010, 24 observations in 2012, 23 observations in 2013, 25 observations in 2014, 24 observations in 2015, 43 observations in 2016 and 44 observations in 2017.
Source: Authors' elaboration

Table 8 Components of the electricity price: network + capacity component (€/MWh) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	Weighted	13.6	n.a.	19.5	n.a.	20.6	20.3	22.3	22.6	22.6	21.4
	Simple	14.8	n.a.	24.7	n.a.	26.6	23.0	23.3	23.7	23.1	22.3
SE	Weighted	9.1	n.a.	9.1	n.a.	17.4	23.4	17.5	20.2	56.7	54.0
	Simple	8.8	n.a.	9.1	n.a.	18.7	25.1	19.0	20.6	64.3	59.3
CEE	Weighted	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
	Simple	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
EU	Weighted	**18.2**	**n.a.**	**17.8**	**n.a.**	**21.0**	**22.8**	**22.6**	**22.8**	**25.8**	**24.8**
	Simple	**19.0**	**n.a.**	**20.4**	**n.a.**	**24.2**	**24.5**	**23.1**	**23.2**	**31.4**	**29.8**

Note: weighting factor: electricity purchased; 13 observations in 2008, 20 observations in 2010, 24 observations in 2012, 23 observations in 2013, 25 observations in 2014, 24 observations in 2015, 43 observations in 2016 and 44 observations in 2017.
Source: Authors' elaboration

Table 9 Components of the electricity price: RES levies (€/MWh) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	Weighted	7.2	n.a.	8.8	n.a.	13.5	10.6	12.3	14.0	11.4	11.5
	Simple	6.4	n.a.	7.5	n.a.	11.4	8.2	9.2	10.7	11.3	11.4
SE	Weighted	38.1	n.a.	31.3	n.a.	34.5	35.5	32.8	28.4	5.1	5.3
	Simple	37.1	n.a.	29.2	n.a.	30.7	32.3	32.8	31.8	6.4	5.7
CEE	Weighted	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
	Simple	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
EU	Weighted	**15.4**	**n.a.**	**12.5**	**n.a.**	**14.0**	**13.1**	**12.6**	**12.7**	**9.1**	**9.3**
	Simple	**12.9**	**n.a.**	**10.9**	**n.a.**	**13.8**	**13.3**	**13.5**	**14.1**	**9.0**	**9.0**

Note: weighting factor: electricity purchased; 13 observations in 2008, 20 observations in 2010, 24 observations in 2012, 23 observations in 2013, 25 observations in 2014, 24 observations in 2015, 43 observations in 2016 and 44 observations in 2017.
Source: Authors' elaboration

Table 10 Components of the electricity price: Other non-recoverable taxes/levies (€/MWh) – Simple and weighted averages

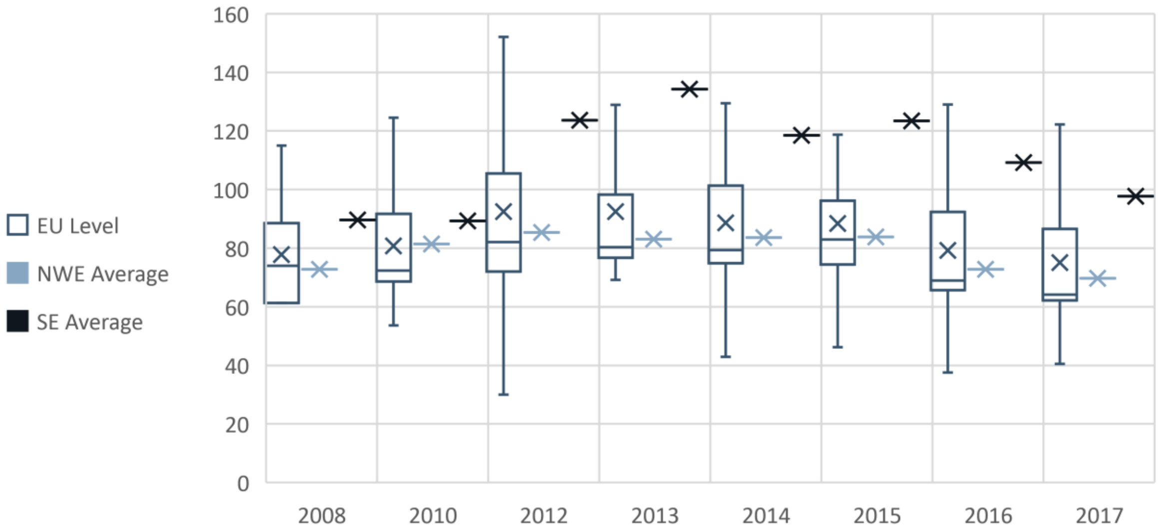
Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	Weighted	8.8	n.a.	5.1	n.a.	6.6	7.6	7.0	7.6	6.1	5.5
	Simple	9.4	n.a.	6.7	n.a.	8.2	11.3	8.8	9.1	7.0	6.1
SE	Weighted	15.5	n.a.	13.4	n.a.	15.5	15.3	13.5	11.6	5.5	5.7
	Simple	15.1	n.a.	12.8	n.a.	14.4	14.1	13.4	13.0	6.8	6.1
CEE	Weighted	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
	Simple	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
EU	Weighted	**7.2**	**n.a.**	**5.7**	**n.a.**	**6.4**	**6.9**	**6.1**	**6.2**	**5.4**	**5.3**
	Simple	**6.9**	**n.a.**	**6.3**	**n.a.**	**7.3**	**9.4**	**7.7**	**8.1**	**6.4**	**5.9**

Note: weighting factor: electricity purchased; 13 observations in 2008, 20 observations in 2010, 24 observations in 2012, 23 observations in 2013, 25 observations in 2014, 24 observations in 2015, 43 observations in 2016 and 44 observations in 2017.
Source: Authors' elaboration

Electricity costs

Average electricity costs in €/MWh are largely aligned with electricity prices in €/MWh.[23] A few plants in the three regions are self-generating electricity (11% of the sampled plants); 12 of the sampled plants were reimbursed by national authorities for part of the RES costs (reimbursements were small and only given in some years). Figure 5 shows the trend from 2008 to 2017: after a peak in 2012, costs diminished and went back to 2008 levels. At the EU level, after a peak in 2012, electricity costs sharply declined, from almost €92/MWh in 2012 to about €75/MWh in 2017. At the regional level, NWE manufacturers spend on average less than their peers in the SE region do. Weighted averages, as for electricity prices, are below simple averages, suggesting that larger consumers are able to strike better deals for electricity inputs. Self-generating electricity plants tend to have higher electricity prices (as they buy less electricity than other plants); however, their electricity costs appear to be aligned with (or lower than) other plants, especially if they sell electricity to the grid. When looking at differences between weighted and simple averages for electricity prices and electricity costs in €/MWh, it is apparent that flexibility schemes, self-generation and *ex post* reimbursement had a similar impact on both large and small consumers.

Figure 5 Electricity costs (€/MWh) – Box plots and simple averages



Note: data for the CEE region cannot be shown due to confidentiality reasons. 35 observations in 2008, 39 observations in 2010, 44 observations in 2012, 50 observations in 2013, 52 observations in 2014, 50 observations in 2015, 58 observations in 2016 and 58 observations in 2017; data for 2009 and 2011 are not available.
Source: Authors' elaboration

Table 11 Electricity costs (€/MWh) – Simple and weighted averages

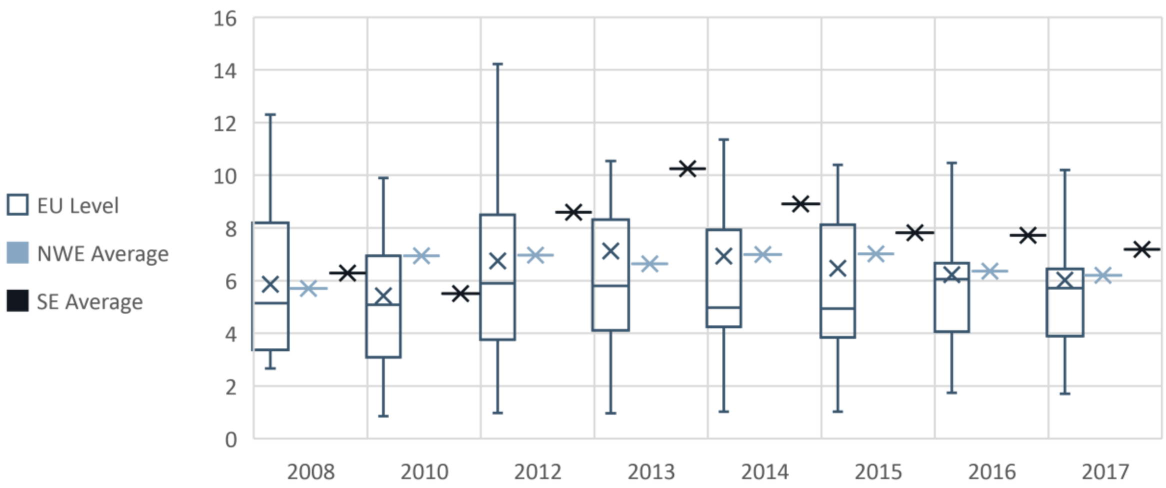
Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	Weighted	68.2	n.a.	75.8	n.a.	80.2	80.2	82.2	83.9	70.8	67.2
	Simple	72.8	n.a.	81.4	n.a.	85.3	83.0	83.6	83.8	72.8	69.7
SE	Weighted	89.0	n.a.	84.8	n.a.	116.8	119.9	114.7	115.5	99.9	93.1

[23] Electricity prices in €/MWh are defined as follows: Total price paid to purchase electricity/Total electricity purchased. Electricity costs in €/MWh are defined 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).

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
	Simple	89.7	n.a.	89.2	n.a.	123.6	134.2	118.5	123.4	109.2	97.8
CEE	**Weighted**	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
	Simple	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
EU	**Weighted**	**74.5**	**n.a.**	**76.2**	**n.a.**	**85.1**	**84.7**	**84.3**	**84.1**	**74.0**	**70.9**
	Simple	**77.8**	**n.a.**	**80.8**	**n.a.**	**92.5**	**92.4**	**89.2**	**88.4**	**79.3**	**75.1**

Note: weighting factor: total electricity consumption; 35 observations in 2008, 39 observations in 2010, 44 observations in 2012, 50 observations in 2013, 52 observations in 2014, 50 observations in 2015, 58 observations in 2016 and 58 observations in 2017.
Source: Authors' elaboration

Figure 6 Electricity costs (€/tonne) – Box plots and simple averages



Note: data for the CEE region cannot be shown due to confidentiality reasons; 19 observations in 2008, 24 observations in 2010, 29 observations in 2012, 31 observations in 2013, 38 observations in 2014, 35 observations in 2015, 58 observations in 2016 and 58 observations in 2017; data for 2009 and 2011 are not available.
Source: Authors' elaboration

Table 12. Electricity costs (€/tonne) – Simple and weighted averages

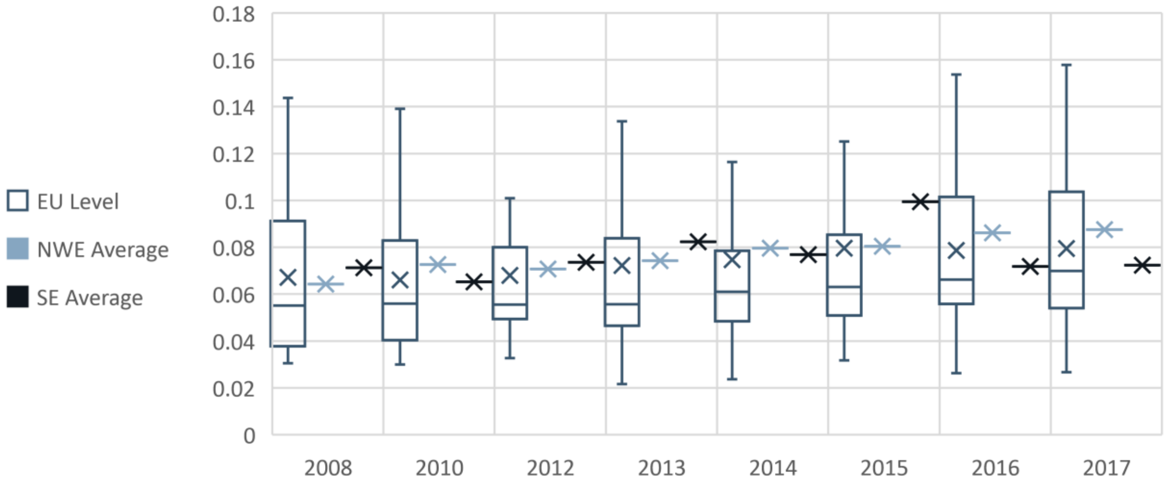
Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	**Weighted**	4.7	n.a.	5.8	n.a.	5.7	5.5	5.4	5.5	5.5	5.3
	Simple	5.7	n.a.	6.9	n.a.	7.0	6.6	7.0	7.0	6.4	6.2
SE	**Weighted**	4.7	n.a.	4.7	n.a.	6.6	6.6	6.4	7.1	6.5	6.0
	Simple	6.3	n.a.	5.5	n.a.	8.6	10.2	8.9	7.8	7.7	7.2
CEE	**Weighted**	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
	Simple	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
EU	**Weighted**	**4.7**	**n.a.**	**4.5**	**n.a.**	**5.4**	**5.3**	**5.1**	**5.1**	**5.0**	**4.8**
	Simple	**5.9**	**n.a.**	**5.4**	**n.a.**	**6.7**	**7.1**	**6.9**	**6.5**	**6.2**	**6.0**

Note: weighting factor: production output; 19 observations in 2008, 24 observations in 2010, 29 observations in 2012, 31 observations in 2013, 38 observations in 2014, 35 observations in 2015, 58 observations in 2016 and 58 observations in 2017.
Source: Authors' elaboration

Electricity intensity

As shown in Figure 7, the overall electricity intensity of the bricks and roof tiles sector slightly increased in the last decade, from 0.07 to 0.08 MWh/tonne (simple average; see below 'natural gas intensity' for further details on factors affecting the energy efficiency of the production process). No significant difference can be identified between NWE and SE plants. However, the large variety of output produced by bricks and roof tiles manufacturers affects the variance of the energy intensity of the sector. In fact, the sampled plants produce more than four types of product, including building blocks, roof tiles, flooring blocks and other clay building products, which require different levels of electricity intensity. Weighted averages are constantly below simple averages, thus indicating that larger plants are more efficient than smaller ones when it comes to electricity.

Figure 7 Electricity intensity (MWh/tonne) – Box plots and simple averages



Note: data for the CEE region cannot be shown due to confidentiality reasons; 35 observations in 2008, 39 observations in 2010, 44 observations in 2012, 50 observations in 2013, 52 observations in 2014, 50 observations in 2015, 58 observations in 2016 and 58 observations in 2017; data for 2009 and 2011 are not available.
Source: Authors' elaboration

Table 13 Electricity intensity (MWh/tonne) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	Weighted	0.05	n.a.	0.06	n.a.	0.06	0.07	0.07	0.07	0.08	0.08
	Simple	0.06	n.a.	0.07	n.a.	0.07	0.07	0.08	0.08	0.09	0.09
SE	Weighted	0.05	n.a.	0.06	n.a.	0.06	0.05	0.05	0.06	0.06	0.06
	Simple	0.07	n.a.	0.07	n.a.	0.07	0.08	0.08	0.10	0.07	0.07
CEE	Weighted	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
	Simple	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
EU	**Weighted**	**0.05**	**n.a.**	**0.06**	**n.a.**	**0.06**	**0.06**	**0.06**	**0.06**	**0.07**	**0.07**
	Simple	**0.07**	**n.a.**	**0.07**	**n.a.**	**0.07**	**0.07**	**0.07**	**0.08**	**0.08**	**0.08**

Note: weighting factor: production output; 35 observations in 2008, 39 observations in 2010, 44 observations in 2012, 50 observations in 2013, 52 observations in 2014, 58 observations in 2016 and 58 observations in 2017.
Source: Authors' elaboration

Additional information

As illustrated in Table 14, most of the surveyed plants (93%) purchase their electricity from one or more energy suppliers. Some plants rely on a mixed supply strategy, where the larger share of electricity is provided by a supplier, and a smaller part is taken directly from generators via PPAs. Most of the plants directly purchasing electricity from the wholesale market are based in the NWE region and they did not necessarily coincide with the largest consumers. The large majority of plants have a contract of up to five years, whereas about 10% of the surveyed plants are on contracts of indeterminate duration, automatically renewed each year.

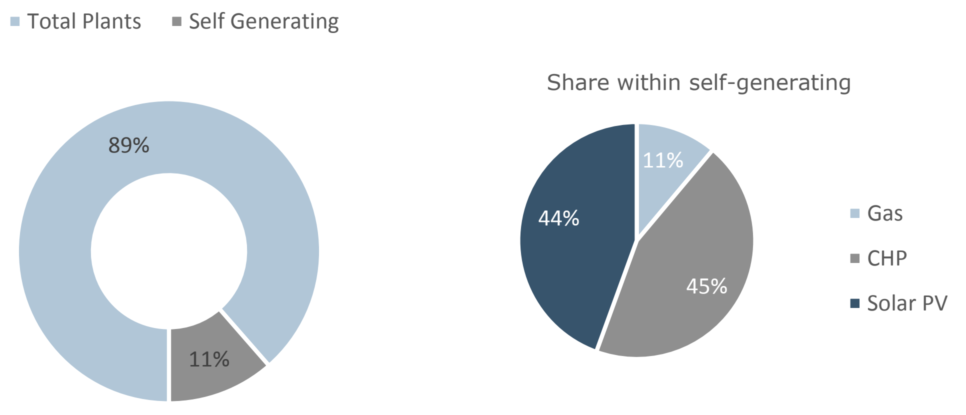
Table 14. Electricity contract type

EU	Electricity Contract Type Breakdown	
Contract type	**No. of plants**	**% of plants**
PPA	4	7%
Provider	54	93%
Wholesale	4	7%

Note: 58 observations.
Source: Authors' elaboration

About 11% of the sampled plants are currently self-producing electricity. Solar panels and combined heat and power (CHP) account for almost 90% of self-generation, whereas gas turbines are used by about 11% of the plants. Among the plants that are self-generating electricity, six sell it to the grid.

Figure 8 Electricity self-generation



Source: Authors' elaboration

Four plants participated in flexibility schemes in at least one year of the timespan covered by the study. With regard to the continuity of the electricity supply, Table 15 illustrates the number of outages reported by bricks and roof tiles producers across the EU. Unplanned outages seem to occur more frequently than planned outages, and their duration is usually longer.

Table 15 Electricity outages

	Planned outages		Other planned outages		Unplanned outages	
	Total number	Average duration in minutes	Total number	Average duration in minutes	Total number	Average duration in minutes
2015	4	63	5	150	78	206
2016	65	118	7	200	84	126
2017	9	63	4	150	105	290

Note: Planned outages are linked to flexibility schemes; other planned outages are not linked to flexibility schemes, but notified in advance by the energy supplier; unplanned outages are not notified.
Source: Authors' elaboration

2.3 Natural gas

Natural gas is a key energy carrier in the bricks and roof tiles sector and has an impact on its cost competitiveness. The main indicators regarding natural gas are summarised in Table 16. Both natural gas prices and costs fluctuated between 2008 and 2017; prices and costs peaked in 2013 at €31.6/MWh and €21/tonne respectively, then decreased to €22.9/MWh and €14.4/tonne in the last year under observation. The latest downward trend is mainly due to a decrease in the energy component of the gas price. The trend of the natural gas intensity of the production process shows a U-shaped trend in the 10 years under observation.

Table 16 Natural gas: summary table (EU, simple averages)

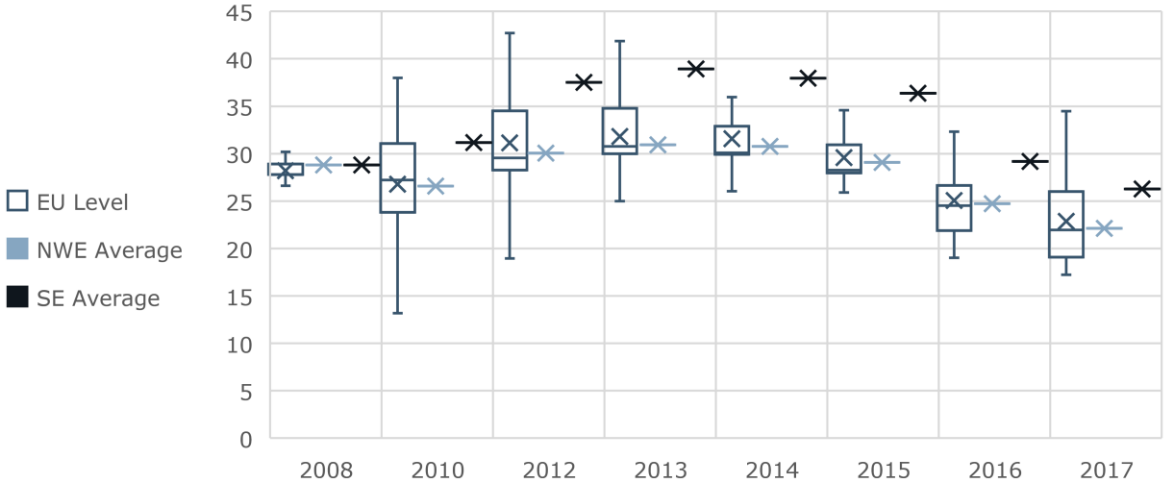
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas prices (€/MWh)	28.2	n.a.	26.8	n.a.	31.1	31.8	31.6	29.6	25.1	22.9
Natural gas costs (€/tonne)	20.7	n.a.	17.8	n.a.	20.1	21.0	20.9	18.7	15.7	14.4
Natural gas intensity (MWh/tonne)	0.69	n.a.	0.62	n.a.	0.64	0.63	0.64	0.63	0.64	0.65

Source: Authors' elaboration

<u>Natural gas prices</u>

The trend of natural gas prices is very similar to the one recorded for electricity; in fact, after a peak in gas prices in 2013 (€31.8/MWh), a significant decrease was recorded (prices were at around €23/MWh in 2017). Figure 9 illustrates the regional breakdown of gas prices. It is apparent that, on average, the price paid by the SE manufacturers is higher than the one paid by the NWE competitors in all the years under investigation. EU weighted averages are generally below simple averages, indicating that larger plants are able to strike better deals with gas suppliers (Table 17) and pay lower network costs (see below). There is no difference in this sector between natural gas prices and costs in €/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.

Figure 9 Natural gas prices (€/MWh) – Box plots and simple averages



Note: data for the CEE region cannot be shown due to confidentiality reasons; 35 observations in 2008, 40 observations in 2010, 44 observations in 2012, 50 observations in 2013, 52 observations in 2014, 50 observations in 2015, 58 observations in 2016 and 58 observations in 2017; data for 2009 and 2011 are not available.
Source: Authors' elaboration

Table 17 Natural gas prices (€/MWh) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	**Weighted**	28.6	n.a.	26.4	n.a.	29.4	30.1	30.2	28.9	24.4	21.5
	Simple	28.8	n.a.	26.6	n.a.	30.1	30.9	30.8	29.1	24.7	22.1
SE	**Weighted**	29.1	n.a.	31.5	n.a.	35.9	36.4	35.9	33.0	28.7	25.5
	Simple	28.8	n.a.	31.2	n.a.	37.5	39.0	38.0	36.4	29.2	26.3
CEE	**Weighted**	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
	Simple	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
EU	**Weighted**	**28.3**	**n.a.**	**26.5**	**n.a.**	**29.9**	**30.3**	**30.3**	**28.4**	**24.3**	**21.9**
	Simple	**28.2**	**n.a.**	**26.8**	**n.a.**	**31.1**	**31.8**	**31.6**	**29.6**	**25.1**	**22.9**

Note: weighting factor: natural gas purchased; 35 observations in 2008, 40 observations in 2010, 44 observations in 2012, 50 observations in 2013, 52 observations in 2014, 50 observations in 2015, 58 observations in 2016 and 58 observations in 2017.
Source: Authors' elaboration

Components of the natural gas price[24]

The price of natural gas is split into three components:

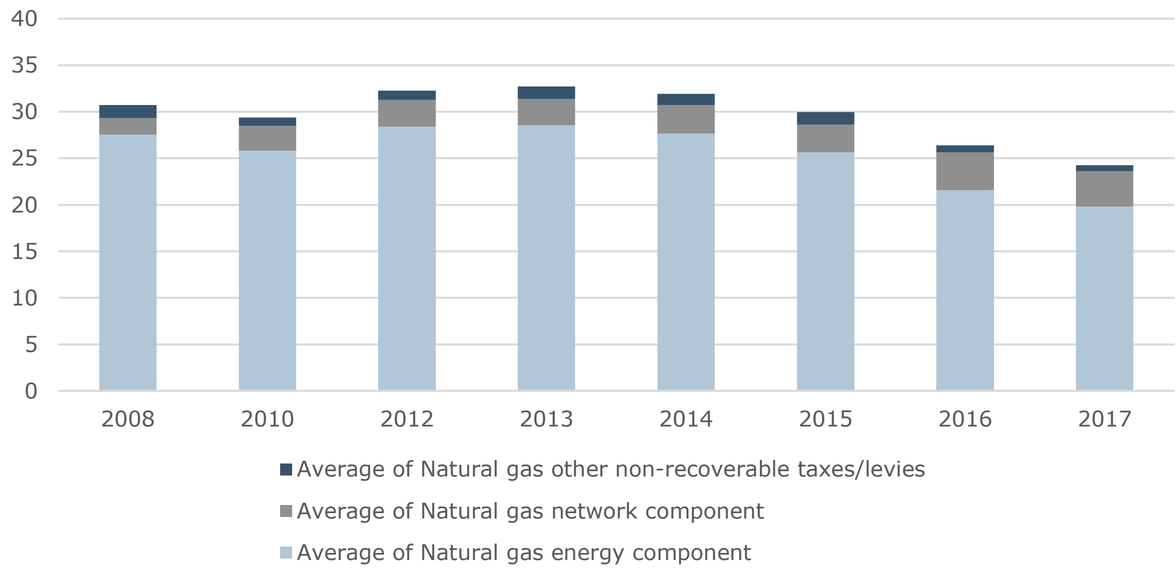
- Energy component
- Network costs
- Other non-recoverable taxes/levies.

[24] The sum of the natural gas bill components does not necessarily add up to the total natural gas price mentioned before, as there might be plants that did not provide a breakdown of the natural gas bill components while still providing the total natural gas price.

Not all plants provided a split per component of natural gas prices; however, in some cases, the Research Team was able to estimate the split of components based on the natural gas bills provided by the respondents.

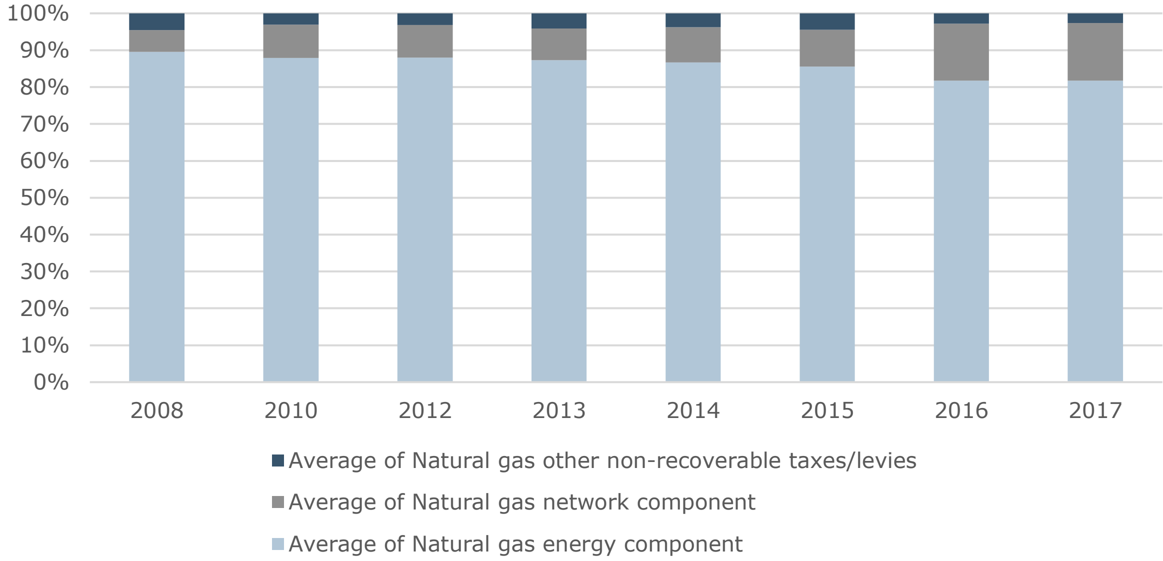
The breakdown of the natural gas price is shown in Figure 10. The reduction in the energy component determined the overall reduction of natural gas prices in the EU. Also, other non-recoverable taxes and levies underwent a contraction over the period under observation; however, they represent a marginal share of the natural gas price. Interestingly, network costs doubled between 2008 and 2017 (from €1.8/MWh to €3.8/MWh), representing almost 15% of the price in 2017. It is worth noting that regulatory components play a limited role in the natural gas price when compared to the electricity price. However, a similar path can be identified, as both energy carriers recorded an increase in the regulated part of the price.

Figure 10 Components of the natural gas price (€/MWh, EU) – Simple averages



Note: 12 observations in 2008, 22 observations in 2010, 23 observations in 2012, 24 observations in 2013, 26 observations in 2014, 24 observations in 2015, 40 observations in 2016 and 41 observations in 2017; data for 2009 and 2011 are not available.
Source: Authors' elaboration

Figure 11 Components of the natural gas price (%, EU) – Simple averages



Note: 12 observations in 2008, 22 observations in 2010, 23 observations in 2012, 24 observations in 2013, 26 observations in 2014, 24 observations in 2015, 40 observations in 2016 and 41 observations in 2017; data for 2009 and 2011 are not available.
Source: Authors' elaboration

Apart from a few exceptions, simple averages of energy and network components tend to exceed weighted averages (Table 18 and Table 19). By contrast, for non-recoverable taxes, simple averages are below weighted averages. This is plausible, as the bargaining power of larger consumers is expected to have limited impact on the amount of tax paid. The analysis at regional level shows slight differences between NWE and SE regions. Network costs in the SE region are almost double those in the NWE region in all years under observation. This partially explains the higher prices of gas paid by SE plants.

Table 18 Components of the natural gas price: energy component (€/MWh) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	**Weighted**	28.8	n.a.	27.0	n.a.	26.2	26.3	26.8	25.9	22.1	19.9
	Simple	29.0	n.a.	26.1	n.a.	26.7	27.3	27.0	25.6	21.8	20.1
SE	**Weighted**	26.6	n.a.	28.7	n.a.	32.0	32.2	30.4	28.5	23.7	19.9
	Simple	26.4	n.a.	28.2	n.a.	32.3	32.1	30.3	28.7	23.4	20.0
CEE	**Weighted**	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
	Simple	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
EU	**Weighted**	**27.1**	**n.a.**	**26.2**	**n.a.**	**27.7**	**27.7**	**27.3**	**25.6**	**21.5**	**19.7**
	Simple	**27.5**	**n.a.**	**25.8**	**n.a.**	**28.4**	**28.6**	**27.7**	**25.6**	**21.6**	**19.8**

Note: weighting factor: natural gas purchased; 12 observations in 2008, 22 observations in 2010, 23 observations in 2012, 24 observations in 2013, 26 observations in 2014, 24 observations in 2015, 40 observations in 2016 and 41 observations in 2017.
Source: Authors' elaboration

Table 19 Components of the natural gas price: network component (€/MWh) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	Weighted	0.8	n.a.	1.3	n.a.	1.7	1.5	1.8	1.8	2.7	2.4
	Simple	0.8	n.a.	2.2	n.a.	2.6	2.3	2.5	2.5	3.6	3.2
SE	Weighted	2.0	n.a.	2.3	n.a.	2.7	2.7	3.0	2.7	4.7	4.7
	Simple	2.2	n.a.	2.6	n.a.	3.1	3.4	3.7	3.5	5.5	5.3
CEE	Weighted	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
	Simple	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
EU	Weighted	**2.0**	**n.a.**	**2.3**	**n.a.**	**2.3**	**2.2**	**2.3**	**2.3**	**3.2**	**3.0**
	Simple	**1.8**	**n.a.**	**2.7**	**n.a.**	**2.9**	**2.8**	**3.1**	**3.0**	**4.1**	**3.8**

Note: weighting factor: natural gas purchased; 12 observations in 2008, 22 observations in 2010, 23 observations in 2012, 24 observations in 2013, 26 observations in 2014, 24 observations in 2015, 40 observations in 2016 and 41 observations in 2017; data for 2009 and 2011 are not available.
Source: Authors' elaboration

Table 20 Components of the natural gas price: Other non-recoverable taxes/levies (€/MWh) – Simple and weighted averages

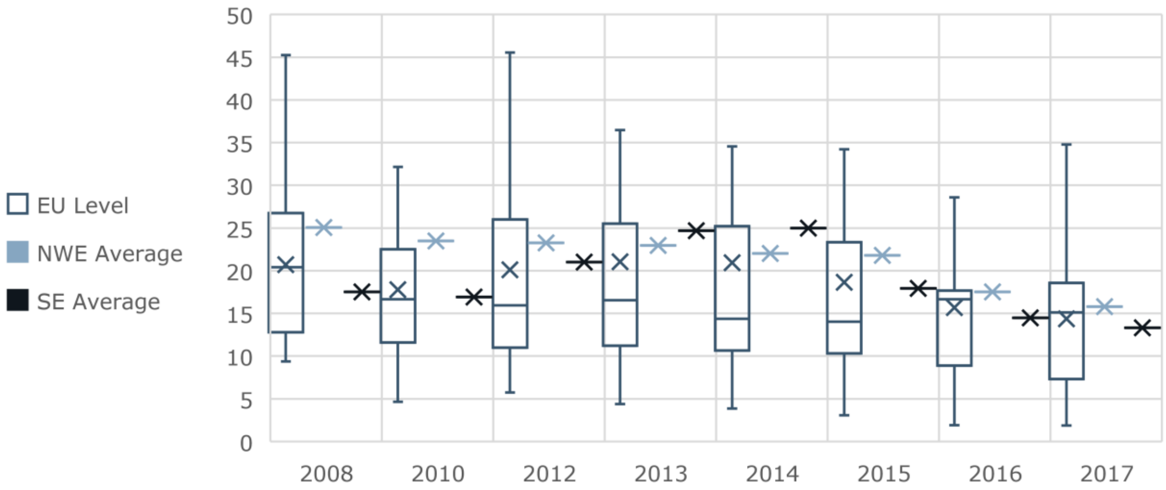
Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	Weighted	3.3	n.a.	1.8	n.a.	1.7	2.1	1.8	1.9	1.1	1.0
	Simple	3.4	n.a.	1.6	n.a.	1.7	2.2	1.9	2.0	1.0	0.7
SE	Weighted	0.5	n.a.	0.5	n.a.	0.5	0.7	0.6	0.7	0.6	0.5
	Simple	0.5	n.a.	0.4	n.a.	0.5	0.7	0.6	0.7	0.6	0.6
CEE	Weighted	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
	Simple	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
EU	Weighted	**1.2**	**n.a.**	**1.0**	**n.a.**	**1.1**	**1.4**	**1.2**	**1.3**	**0.8**	**0.8**
	Simple	**1.4**	**n.a.**	**0.9**	**n.a.**	**1.0**	**1.3**	**1.2**	**1.3**	**0.8**	**0.6**

Note: weighting factor: natural gas purchased;12 observations in 2008, 22 observations in 2010, 23 observations in 2012, 24 observations in 2013, 26 observations in 2014, 24 observations in 2015, 40 observations in 2016 and 41 observations in 2017.
Source: Authors' elaboration

Natural gas costs

On average, EU manufacturers of bricks and roof tiles faced natural gas costs of between €20.7/tonne in 2008 and €14.4/tonne in 2017 (Figure 12). The simple average of natural gas costs for EU bricks and roof tiles producers fluctuated over the last 10 years. Costs peaked in 2013 at €21/tonne and went down to €14.4/tonne in 2017. The trend is aligned with gas prices (see Figure 9 above). However, the variance of such indicators appears to be high due to the diversity of outputs produced by the sampled plants. With regard to regional values, interestingly, NWE manufacturers faced higher costs than SE counterparts, despite lower prices recorded in the region; this is mainly due to the higher natural gas intensity of manufacturers based in the NWE region. When looking at weighted averages (Table 21), the figures suggest that larger plants incur lower costs than smaller ones; this may be due to i) quantity discount for larger consumers of natural gas (see 'natural gas prices' above); ii) lower network costs (see 'price components' above); and iii) economies of scale allowing larger plants to be more efficient than smaller ones (see 'natural gas intensity' and 'production costs' below).

Figure 12 Natural gas costs (€/tonne) – Box plots and simple averages



Note: data for the CEE region cannot be shown due to confidentiality reasons; 35 observations in 2008, 39 observations in 2010, 44 observations in 2012, 50 observations in 2013, 52 observations in 2014, 58 observations in 2016 and 58 observations in 2017; data for 2009 and 2011 are not available.
Source: Authors' elaboration

Table 21 Natural gas costs (€/tonne) – Simple and weighted averages

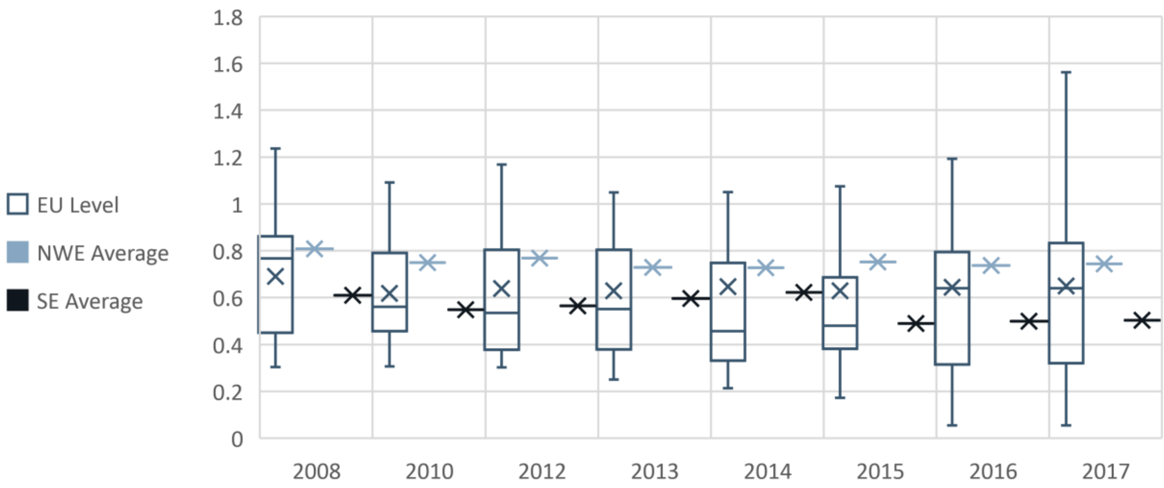
Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	**Weighted**	22.7	n.a.	21.6	n.a.	18.4	18.4	16.1	16.8	15.1	13.2
	Simple	25.1	n.a.	23.5	n.a.	23.2	23.0	22.0	21.8	17.5	15.8
SE	**Weighted**	14.4	n.a.	15.7	n.a.	16.1	16.2	16.3	15.0	12.6	10.8
	Simple	17.5	n.a.	16.9	n.a.	21.0	24.7	25.0	17.9	14.5	13.3
CEE	**Weighted**	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
	Simple	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
EU	**Weighted**	**17.4**	**n.a.**	**15.8**	**n.a.**	**16.1**	**16.0**	**14.9**	**14.5**	**12.5**	**11.2**
	Simple	**20.7**	**n.a.**	**17.8**	**n.a.**	**20.1**	**21.0**	**20.9**	**18.7**	**15.7**	**14.4**

Note: weighting factor: production output; 35 observations in 2008, 39 observations in 2010, 44 observations in 2012, 50 observations in 2013, 52 observations in 2014, 58 observations in 2016 and 58 observations in 2017.
Source: Authors' elaboration

Natural gas intensity

Figure 13 illustrates that, at EU level, the average intensity of natural gas was quite stable between 2008 and 2017 (ranging between 0.6 MWh/tonne and 0.7 MWh/tonne). In fact, the energy efficiency of the production process was affected by two opposing factors that neutralised each other. On the one hand, bricks and tiles producers introduced technological improvements leading to higher energy efficiency and lower natural gas intensity; on the other hand, the fall in demand generated by the economic crisis led to a reduction of the kiln utilisation rate, with negative impacts on energy efficiency and higher natural gas intensity. The NWE region has, on average, a higher natural gas intensity than the SE region, which explains higher regional natural gas costs in €/tonne in spite of lower natural gas prices in €/MWh. Weighted average natural gas intensities went from 0.6 MWh/tonne in 2008 to 0.5 MWh/tonne in 2017, thus pointing at efficiency gains achieved by larger plants. The weighted average is generally below the simple average, which may indicate that larger plants are more efficient than smaller ones. Similarly, in terms of electricity intensity, the large variance in the sampled companies is due to some heterogeneity in production output. In fact, this sector also includes high-intensity products such as clay pipes, which require relatively more MWh per tonne produced.

Figure 13 Natural gas intensity (MWh/tonne) – Box plots and simple averages



Note: data for the CEE region cannot be shown due to confidentiality reasons; 35 observations in 2008, 39 observations in 2010, 44 observations in 2012, 50 observations in 2013, 52 observations in 2014, 58 observations in 2016 and 58 observations in 2017; data for 2009 and 2011 are not available.
Source: Authors' elaboration

Table 22 Natural gas intensity (MWh/tonne) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	**Weighted**	0.75	n.a.	0.70	n.a.	0.63	0.61	0.53	0.58	0.62	0.61
	Simple	0.81	n.a.	0.75	n.a.	0.77	0.73	0.73	0.75	0.74	0.74
SE	**Weighted**	0.49	n.a.	0.50	n.a.	0.46	0.45	0.46	0.46	0.44	0.43
	Simple	0.61	n.a.	0.55	n.a.	0.56	0.60	0.62	0.49	0.50	0.50
CEE	**Weighted**	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
	Simple	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
EU	**Weighted**	**0.58**	**n.a.**	**0.56**	**n.a.**	**0.54**	**0.53**	**0.49**	**0.51**	**0.52**	**0.51**
	Simple	**0.69**	**n.a.**	**0.62**	**n.a.**	**0.64**	**0.63**	**0.64**	**0.63**	**0.64**	**0.65**

Note: 35 observations in 2008, 39 observations in 2010, 44 observations in 2012, 50 observations in 2013, 52 observations in 2014, 58 observations in 2016 and 58 observations in 2017.
Source: Authors' elaboration

Additional information

At the EU level, 93% of sampled plants purchase natural gas via an energy provider, whereas only 7% of the plants rely on the wholesale market. Contract duration is less than five years for most of the plants, with only four companies stating they have contracts of indeterminate duration, automatically renewed each year. When it comes to plants participating in flexibility schemes, seven of the 58 sampled plants declared being remunerated by the natural gas supplier. Finally, with regard to the quality of the natural gas supply, only one plant reported one unplanned outage (Table 23). A few plants faced planned outages not linked to interruptibility schemes, which lasted for several hours. Finally, self-production of gas is not relevant to the bricks and roof tiles sector.

Table 23. Natural gas outages

	Planned outages		Other planned outages		Unplanned outages	
	Total number	Average duration in minutes	Total number	Average duration in minutes	Total number	Average duration in minutes
2015	0	-	2	360	1	480
2016	0	-	2	480	0	-
2017	0	-	1	480	0	-

Note: Planned outages are linked to interruptibility schemes; other planned outages are not linked to interruptibility schemes, but notified in advance by the energy supplier; unplanned outages are not notified.
Source: Authors' elaboration

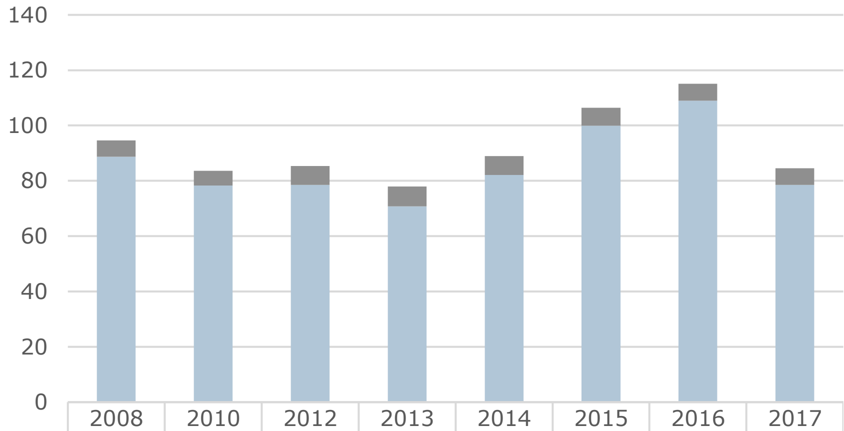
2.4 Competitiveness

Cost competitiveness

Electricity

This section examines the cost competitiveness of bricks and roof tiles producers. In the period under investigation, electricity costs represented on average 5-9% of the production costs faced by manufacturers of bricks and roof tiles. Production costs decreased after the crisis and started increasing again between 2013 and 2016. They then dropped from €115/tonne (in 2016) to €85/tonne (in 2017); however, this contraction may be affected by changes in the composition of the sample. By comparing weighted and simple averages, it is evident that economies of scale play a key role, as production costs in €/tonne incurred by larger plants are much lower than those experienced by smaller ones. In fact, larger plants focus more on 'mass production', while 'smaller plants' focus on 'special products' (like accessories); therefore, larger plants can easily reduce specific costs and therefore handle variable costs more easily.

Figure 14 Electricity costs as a share of production costs (€/tonne, EU) – Simple averages



	2008	2010	2012	2013	2014	2015	2016	2017
Average of Electricity cost €/tonne	5.9	5.4	6.7	7.1	6.9	6.5	6.2	6.0
Average of other Production costs €/tonne	89	78	79	71	82	100	109	79

Note: for production costs: 20 observations in 2008, 25 observations in 2010, 28 observations in 2012, 29 observations in 2013, 34 observations in 2014, 33 observations in 2015, 53 observations in 2016 and 40 observations in 2017; for electricity costs: 19 observations in 2008, 24 observations in 2010, 29 observations in 2012, 31 observations in 2013, 38 observations in 2014, 35 observations in 2015, and 58 observations in 2016 and 2017; data for 2009 and 2011 are not available.
Source: Authors' elaboration

Table 24 Electricity costs as a share of production costs (EU) – Simple and weighted averages

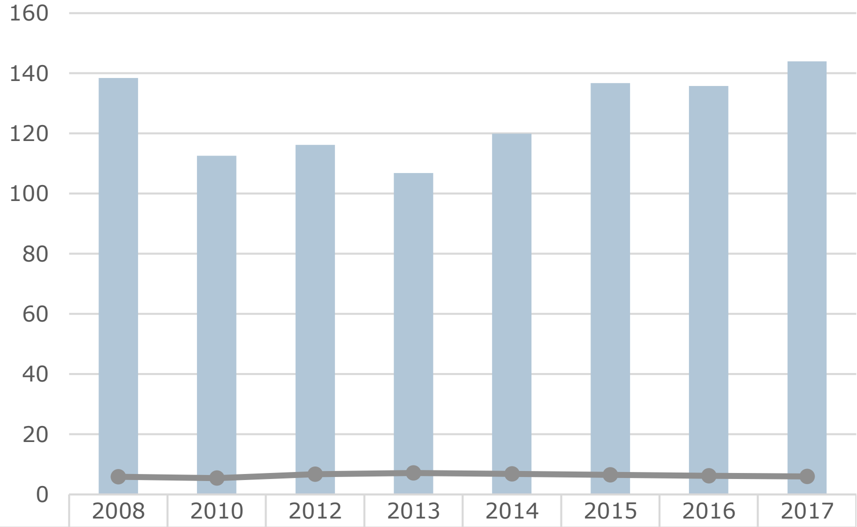
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity costs simple average (€/tonne)	5.9	n.a.	5.4	n.a.	6.7	7.1	6.9	6.5	6.2	6.0
Electricity costs weighted average (€/tonne)	4.7	n.a.	4.5	n.a.	5.4	5.3	5.1	5.1	5.0	4.8
Production costs simple average (€/tonne)	94.6	n.a.	83.7	n.a.	85.3	77.9	89.0	106.4	115.1	84.6
Production costs weighted average (€/tonne)	74.3	n.a.	68.8	n.a.	75.8	67.0	77.7	81.9	89.3	64.3
Electricity costs as a share of production costs simple averages (%)	6.2%	n.a.	6.5%	n.a.	7.9%	9.1%	7.7%	6.1%	5.4%	7.1%

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity costs as a share of production costs weighted averages (%)	6.3%	n.a.	6.5%	n.a.	7.2%	7.9%	6.6%	6.3%	5.6%	7.4%

Note: weighting factor: production output; for production costs: 20 observations in 2008, 25 observations in 2010, 28 observations in 2012, 29 observations in 2013, 34 observations in 2014, 33 observations in 2015, 53 observations in 2016 and 40 observations in 2017; for electricity costs: 19 observations in 2008, 24 observations in 2010, 29 observations in 2012, 31 observations in 2013, 38 observations in 2014, 35 observations in 2015, and 58 observations in 2016 and 2017.
Source: Authors' elaboration

Figure 15 shows that turnover in €/tonne is back to 2008 levels. In fact, the downward trend for turnover stopped in 2013. In 2014, turnover figures started to increase again and peaked in 2017. Fluctuations in electricity costs were less sharp; it therefore seems that electricity costs have little impact on the turnover of the sampled plants. As shown in Table 25, the share of electricity costs out of turnover increased between 2008 and 2013 (from 4.2% to 6.7%) and went back to 4.2% in the last year under observation. Weighted averages for turnover are below simple averages; this may indicate that larger plants rely on their cost advantage to apply lower prices in €/tonne of output.

Figure 15 Electricity costs versus turnover (€/tonne, EU) – Simple averages



	2008	2010	2012	2013	2014	2015	2016	2017
Average of Turnover €/tonne	138.4	112.5	116.3	106.8	119.9	136.8	135.8	143.9
Average of Electricity cost €/tonne	5.9	5.4	6.7	7.1	6.9	6.5	6.2	6.0

Note: for turnover: 20 observations in 2008, 25 observations in 2010, 28 observations in 2012, 29 observations in 2013, 34 observations in 2014, 33 observations in 2015, 53 observations in 2016 and 40 observations in 2017; for electricity costs: 19 observations in 2008, 24 observations in 2010, 29 observations in 2012, 31 observations in 2013, 38 observations in 2014, 35 observations in 2015, and 58 observations in 2016 and 2017; data for 2009 and 2011 are not available.
Source: Authors' elaboration

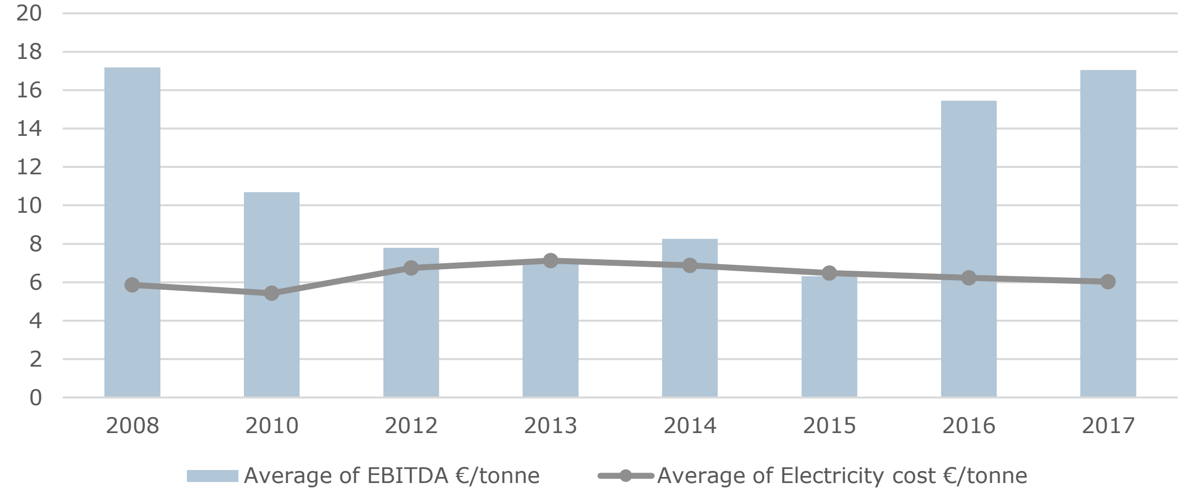
Table 25 Electricity costs versus turnover (EU) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity costs simple average (€/tonne)	5.9	n.a.	5.4	n.a.	6.7	7.1	6.9	6.5	6.2	6.0
Electricity costs weighted average (€/tonne)	4.7	n.a.	4.5	n.a.	5.4	5.3	5.1	5.1	5.0	4.8
Turnover simple average (€/tonne)	138.4	n.a.	112.5	n.a.	116.3	106.8	119.9	136.8	135.8	143.9
Turnover weighted average (€/tonne)	107.4	n.a.	91.4	n.a.	104.9	95.1	109.4	112.8	120.1	124.4
Electricity costs as a share of turnover simple averages (%)	4.2%	n.a.	4.8%	n.a.	5.8%	6.7%	5.7%	4.7%	4.6%	4.2%
Electricity costs as a share of turnover weighted averages (%)	4.4%	n.a.	4.9%	n.a.	5.2%	5.6%	4.7%	4.6%	4.2%	3.8%

Note: weighting factor: production output; for turnover: 20 observations in 2008, 25 observations in 2010, 28 observations in 2012, 29 observations in 2013, 34 observations in 2014, 33 observations in 2015, 53 observations in 2016 and 40 observations in 2017; for electricity costs: 19 observations in 2008, 24 observations in 2010, 29 observations in 2012, 31 observations in 2013, 38 observations in 2014, 35 observations in 2015, and 58 observations in 2016 and 2017.
Source: Authors' elaboration

With regard to profitability, it is not possible to draw conclusions on the impact of electricity costs on EBIT and EBITDA. EBITDA first declined between 2008 and 2015 and then increased in the last two years under observation. Likewise, negative values for EBIT were recorded up to 2015, and the negative trend was only recently reverted. By contrast, electricity costs were quite stable for the whole period under observation, especially when compared to margins. Interestingly, weighted averaged margins were always higher than simple averaged margins; this may indicate that economies of scale allow larger plants to be more profitable.

Figure 16 Electricity costs versus EBITDA (€/tonne, EU) – Simple averages



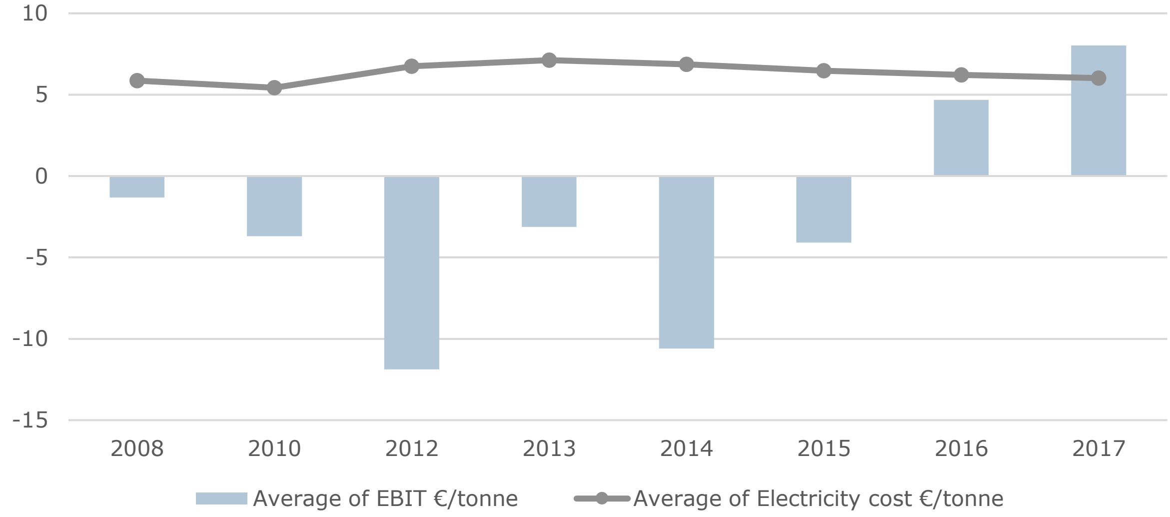
Note: for EBITDA: 20 observations in 2008, 25 observations in 2010, 28 observations in 2012, 29 observations in 2013, 34 observations in 2014, 32 observations in 2015, 42 observations in 2016 and 39 observations in 2017; for electricity costs: 19 observations in 2008, 24 observations in 2010, 29 observations in 2012, 31 observations in 2013, 38 observations in 2014, 35 observations in 2015, and 58 observations in 2016 and 2017; data for 2009 and 2011 are not available.
Source: Authors' elaboration

Table 26 Electricity costs versus EBITDA (EU) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity costs simple average (€/tonne)	5.9	n.a.	5.4	n.a.	6.7	7.1	6.9	6.5	6.2	6.0
Electricity costs weighted average (€/tonne)	4.7	n.a.	4.5	n.a.	5.4	5.3	5.1	5.1	5.0	4.8
EBITDA simple average (€/tonne)	17.2	n.a.	10.7	n.a.	7.8	7.2	8.3	6.3	15.5	17.1
EBITDA weighted average (€/tonne)	20.6	n.a.	12.0	n.a.	12.0	11.3	13.4	13.6	17.4	20.1

Note: weighting factor: production output; for EBITDA: 20 observations in 2008, 25 observations in 2010, 28 observations in 2012, 29 observations in 2013, 34 observations in 2014, 32 observations in 2015, 42 observations in 2016 and 39 observations in 2017; for electricity costs: 19 observations in 2008, 24 observations in 2010, 29 observations in 2012, 31 observations in 2013, 38 observations in 2014, 35 observations in 2015, and 58 observations in 2016 and 2017.
Source: Authors' elaboration

Figure 17 Electricity costs versus EBIT (€/tonne, EU) – Simple averages



Note: for EBIT: 20 observations in 2008, 25 observations in 2010, 28 observations in 2012, 29 observations in 2013, 34 observations in 2014, 32 observations in 2015, 42 observations in 2016 and 39 observations in 2017; for electricity costs: 19 observations in 2008, 24 observations in 2010, 29 observations in 2012, 31 observations in 2013, 38 observations in 2014, 35 observations in 2015, and 58 observations in 2016 and 2017.
Source: Authors' elaboration

Table 27. Electricity costs versus EBIT (EU) – Simple and weighted averages

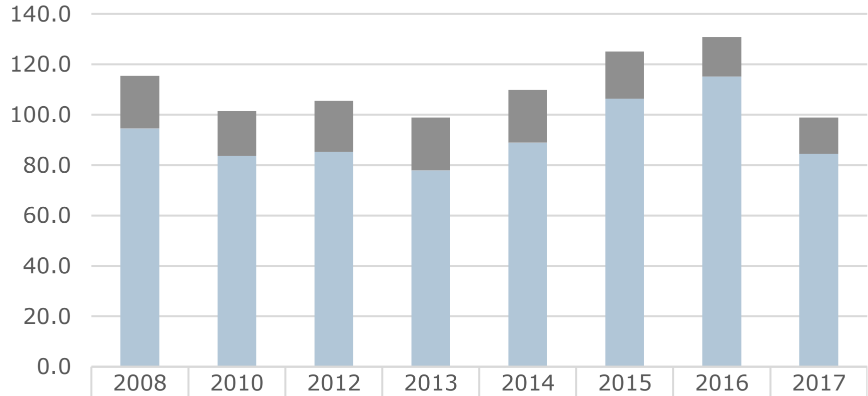
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity costs simple average (€/tonne)	5.9	n.a.	5.4	n.a.	6.7	7.1	6.9	6.5	6.2	6.0
Electricity costs weighted average (€/tonne)	4.7	n.a.	4.5	n.a.	5.4	5.3	5.1	5.1	5.0	4.8
EBIT simple average (€/tonne)	-1.3	n.a.	-3.7	n.a.	-11.9	-3.1	-10.6	-4.1	4.7	8.0
EBIT weighted average (€/tonne)	9.2	n.a.	0.2	n.a.	-1.7	1.3	-4.3	3.5	7.5	11.2

Note: weighting factor: production output; for EBIT: 20 observations in 2008, 25 observations in 2010, 28 observations in 2012, 29 observations in 2013, 34 observations in 2014, 32 observations in 2015, 42 observations in 2016 and 39 observations in 2017; for electricity costs: 19 observations in 2008, 24 observations in 2010, 29 observations in 2012, 31 observations in 2013, 38 observations in 2014, 35 observations in 2015, and 58 observations in 2016 and 2017.
Source: Authors' elaboration

Natural gas

Natural gas costs play a more prominent role in the production costs incurred by bricks and roof tiles manufacturers. Whereas electricity costs were approximately 6% of production costs (see Figure 14), natural gas costs ranged between almost 22% of production costs in 2008 and 14% in 2016 (Figure 18).

Figure 18 Natural gas costs as a share of production costs (€/tonne, EU) – Simple averages



	2008	2010	2012	2013	2014	2015	2016	2017
Average of Natural gas cost €/tonne	20.7	17.8	20.1	21.0	20.9	18.7	15.7	14.4
Average of other Production costs €/tonne	94.6	83.7	85.3	77.9	89.0	106.4	115.1	84.6

Note: for production costs: 20 observations in 2008, 25 observations in 2010, 25 observations in 2012, 29 observations in 2013, 31 observations in 2014, 38 observations in 2015, 53 observations in 2016 and 40 observations in 2017; for natural gas costs: 19 observations in 2008, 24 observations in 2010, 29 observations in 2012, 31 observations in 2013, 38 observations in 2014, 36 observations in 2015, and 58 observations in 2016 and 2017; data for 2009 and 2011 are not available.
Source: Authors' elaboration

Table 28 Natural gas costs versus production costs (EU) – Simple and weighted averages

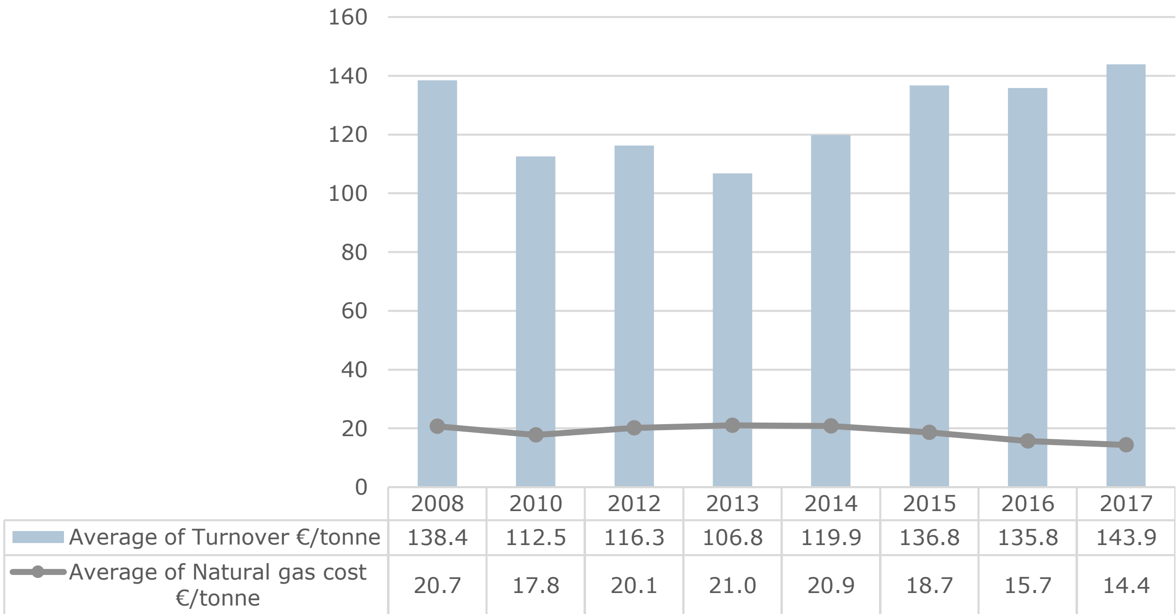
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas costs simple average (€/tonne)	20.7	n.a.	17.8	n.a.	20.1	21.0	20.9	18.7	15.7	14.4
Natural gas costs weighted average (€/tonne)	17.4	n.a.	15.8	n.a.	16.1	16.0	14.9	14.5	12.5	11.2
Production costs simple average (€/tonne)	94.6	n.a.	83.7	n.a.	85.3	77.9	89.0	106.4	115.1	84.6
Production costs weighted	74.3	n.a.	68.8	n.a.	75.8	67.0	77.7	81.9	89.3	64.3

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
average (€/tonne)										
Natural gas costs as a share of production costs simple averages (%)	21.9%	n.a.	21.3%	n.a.	23.6%	27.0%	23.5%	17.6%	13.6%	17.0%
Natural gas costs as a share of production costs weighted averages (%)	23.4%	n.a.	23.0%	n.a.	21.2%	23.9%	19.2%	17.7%	14.0%	17.4%

Note: weighting factor: production output; for production costs: 20 observations in 2008, 25 observations in 2010, 25 observations in 2012, 29 observations in 2013, 31 observations in 2014, 38 observations in 2015, 53 observations in 2016 and 40 observations in 2017; for natural gas costs: 19 observations in 2008, 24 observations in 2010, 29 observations in 2012, 31 observations in 2013, 38 observations in 2014, 36 observations in 2015, and 58 observations in 2016 and 2017.
Source: Authors' elaboration

Whereas natural gas costs slightly decreased in the period under observation, turnover in €/tonne recorded an upward trend (Figure 19). Therefore, it seems that there is no direct correlation between natural gas costs and price paid by buyers of bricks and roof tiles.

Figure 19 Natural gas costs versus turnover (€/tonne, EU) – Simple averages



Note: data for the CEE region cannot be shown due to confidentiality reasons. For turnover: 20 observations in 2008, 25 observations in 2010, 28 observations in 2012, 29 observations in 2013, 34 observations in 2014, 33 observations in 2015, 53 observations in 2016 and 40 observations in 2017. For natural gas costs: 19 observations in 2008, 24 observations in 2010, 29 observations in 2012, 31 observations in 2013, 38 observations in 2014, 36

observations in 2015, and 58 observations in 2016 and 2017; data for 2009 and 2011 are not available.
Source: Authors' elaboration

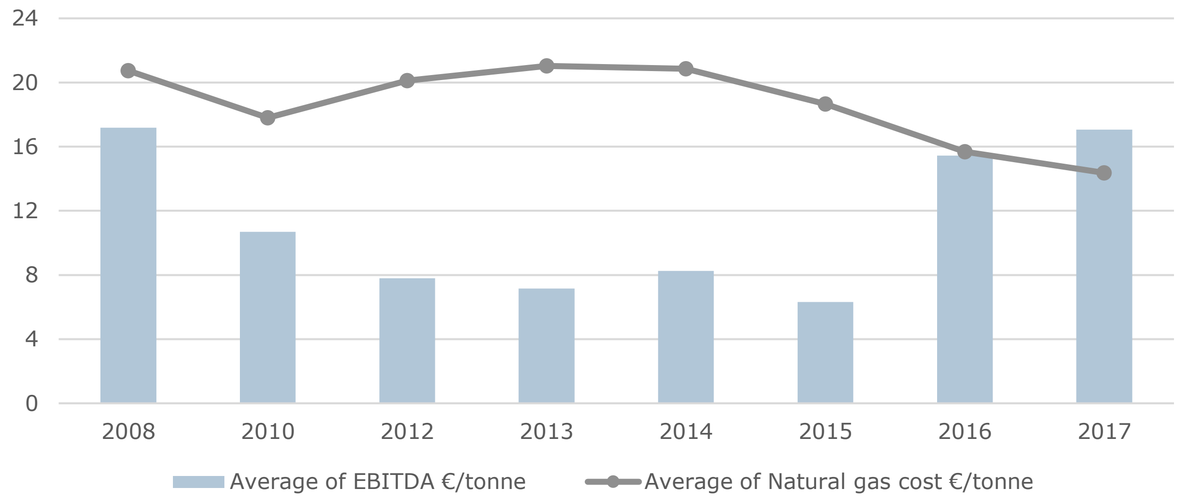
Table 29 Natural gas costs versus turnover (EU) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas costs simple average (€/tonne)	20.7	n.a.	17.8	n.a.	20.1	21.0	20.9	18.7	15.7	14.4
Natural gas costs weighted average (€/tonne)	17.4	n.a.	15.8	n.a.	16.1	16.0	14.9	14.5	12.5	11.2
Turnover simple average (€/tonne)	138.4	n.a.	112.5	n.a.	116.3	106.8	119.9	136.8	135.8	143.9
Turnover weighted average (€/tonne)	107.4	n.a.	91.4	n.a.	104.9	95.1	109.4	112.8	120.1	124.4
Natural gas costs as a share of turnover simple averages (%)	15.0%	n.a.	15.8%	n.a.	17.3%	19.7%	17.4%	13.7%	11.6%	10.0%
Natural gas costs as a share of turnover weighted averages (%)	16.2%	n.a.	17.3%	n.a.	15.4%	16.8%	13.6%	12.9%	10.4%	9.0%

Note: weighting factor: production output; for turnover: 20 observations in 2008, 25 observations in 2010, 28 observations in 2012, 29 observations in 2013, 34 observations in 2014, 33 observations in 2015, 53 observations in 2016 and 40 observations in 2017; for natural gas costs: 19 observations in 2008, 24 observations in 2010, 29 observations in 2012, 31 observations in 2013, 38 observations in 2014, 36 observations in 2015, and 58 observations in 2016 and 2017.
Source: Authors' elaboration

On average, natural gas costs are higher than EBITDA registered by EU producers of bricks and roof tiles in all years except for 2016 and 2017 (Figure 20). In the same vein, natural gas costs seem to be higher than EBIT in all years under observation (Figure 21). Interestingly, in the last two years under observation, natural gas costs in €/tonne were exceptionally low and margins exceptionally high. However, no strong conclusion can be drawn about the impact of natural gas costs on profitability.

Figure 20 Natural gas costs versus EBITDA (€/tonne, EU) – Simple averages



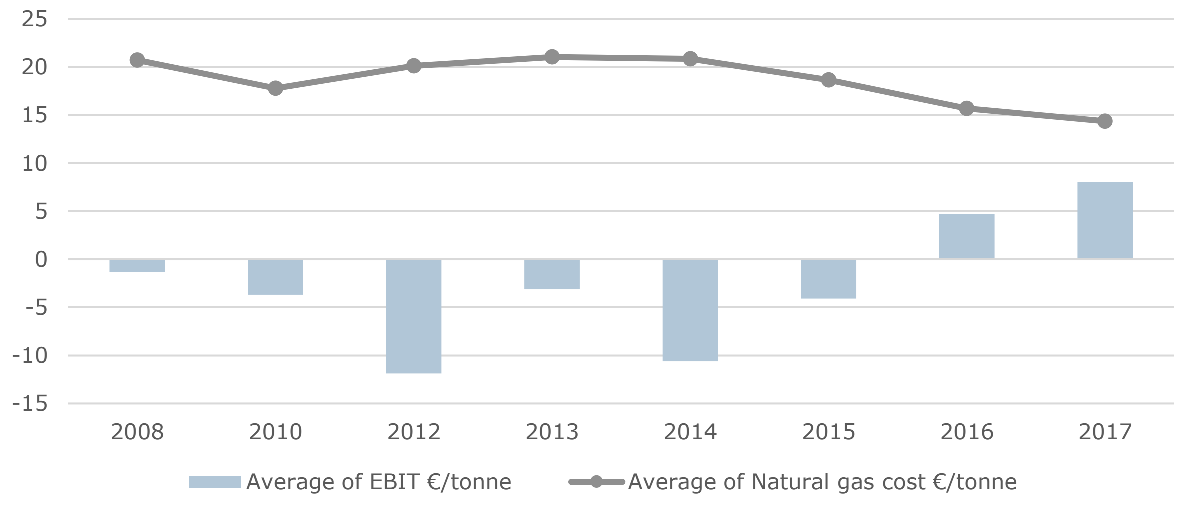
Note: for EBITDA: 20 observations in 2008, 25 observations in 2010, 28 observations in 2012, 29 observations in 2013, 34 observations in 2014, 32 observations in 2015, 42 observations in 2016 and 39 observations in 2017; for natural gas costs: 19 observations in 2008, 24 observations in 2010, 29 observations in 2012, 31 observations in 2013, 38 observations in 2014, 36 observations in 2015, and 58 observations in 2016 and 2017; data for 2009 and 2011 are not available.
Source: Authors' elaboration

Table 30 Natural gas costs versus EBITDA (EU) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas costs simple average (€/tonne)	20.7	n.a.	17.8	n.a.	20.1	21.0	20.9	18.7	15.7	14.4
Natural gas costs weighted average (€/tonne)	17.4	n.a.	15.8	n.a.	16.1	16.0	14.9	14.5	12.5	11.2
EBITDA simple average (€/tonne)	17.2	n.a.	10.7	n.a.	7.8	7.2	8.3	6.3	15.5	17.1
EBITDA weighted average (€/tonne)	20.6	n.a.	12.0	n.a.	12.0	11.3	13.4	13.6	17.4	20.1

Note: weighting factor: production output; for EBITDA: 20 observations in 2008, 25 observations in 2010, 28 observations in 2012, 29 observations in 2013, 34 observations in 2014, 32 observations in 2015, 42 observations in 2016 and 39 observations in 2017; for natural gas costs: 19 observations in 2008, 24 observations in 2010, 29 observations in 2012, 31 observations in 2013, 38 observations in 2014, 36 observations in 2015, and 58 observations in 2016 and 2017.
Source: Authors' elaboration

Figure 21 Natural gas costs versus EBIT (€/tonne, EU) – Simple averages



Note: for EBIT: 20 observations in 2008, 25 observations in 2010, 28 observations in 2012, 29 observations in 2013, 34 observations in 2014, 32 observations in 2015, 42 observations in 2016 and 39 observations in 201; for natural gas costs: 19 observations in 2008, 24 observations in 2010, 29 observations in 2012, 31 observations in 2013, 38 observations in 2014, 36 observations in 2015, and 58 observations in 2016 and 2017; data for 2009 and 2011 are not available.
Source: Authors' elaboration

Table 31 Natural gas costs versus EBIT (EU) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas costs simple average (€/tonne)	20.7	n.a.	17.8	n.a.	20.1	21.0	20.9	18.7	15.7	14.4
Natural gas costs weighted average (€/tonne)	17.4	n.a.	15.8	n.a.	16.1	16.0	14.9	14.5	12.5	11.2
EBIT simple average (€/tonne)	-1.3	n.a.	-3.7	n.a.	-11.9	-3.1	-10.6	-4.1	4.7	8.0
EBIT weighted average (€/tonne)	9.2	n.a.	0.2	n.a.	-1.7	1.3	-4.3	3.5	7.5	11.2

Note: weighting factor: production output; for EBIT: 20 observations in 2008, 25 observations in 2010, 28 observations in 2012, 29 observations in 2013, 34 observations in 2014, 32 observations in 2015, 42 observations in 2016 and 39 observations in 2017. For natural gas costs: 19 observations in 2008, 24 observations in 2010, 29 observations in 2012, 31 observations in 2013, 38 observations in 2014, 36 observations in 2015, and 58 observations in 2016 and 2017.
Source: Authors' elaboration

International competitiveness

This Section compares energy prices and costs borne by EU ceramics producers with those borne by producers based in third countries. The Section relies on primary data collected at the plant level for the year 2016 as well as on data published in the 2016 EPC Study for 2010, 2014 and 2015. Regarding primary data, when it comes to the overall ceramics sector, international data on energy prices and costs were only disclosed by three bricks and roof tiles manufacturers (two based in Russia and one in the US) and one wall and floor tiles manufacturer (based in Russia).[25] The manufacturers of bricks and roof tiles authorised the Research Team to show plant-level data in an anonymised form. The manufacturer of wall and floor tiles authorised relevant data to be shown provided that they were averaged with those disclosed by the Russian bricks and roof tiles plants. This approach appeared to be meaningful for electricity and natural gas prices in €/MWh, which happened to be very similar in the two sectors; in fact, the same approach was followed in the 2016 EPC Study. By contrast, given the large differences in terms of production costs and margins between the two sectors, averaging energy costs in €/tonne, production costs and margins of bricks and roof tiles producers and wall and floor tiles producers would distort the analysis; for this reason, the competitiveness analysis is limited to the bricks and roof tiles subsector.

Against this background, the subsection on 'International energy prices' presents average electricity and natural gas prices borne by bricks and roof tiles and wall and floor tiles producers in the EU, Russia and the US; to reuse data published in the 2016 EPC Study, this subsection shows weighted averages. By contrast, the subsection on 'International competitiveness' compares key performance indicators of EU bricks and roof tiles producers with those recorded by international competitors; in line with other sections of the current Study, this subsection presents simple averages in the figures as well as weighted averages in tables. Interestingly, Russia is among the main destination markets for European bricks and roof tiles; the US is among the main destination markets for European wall and floor tiles.

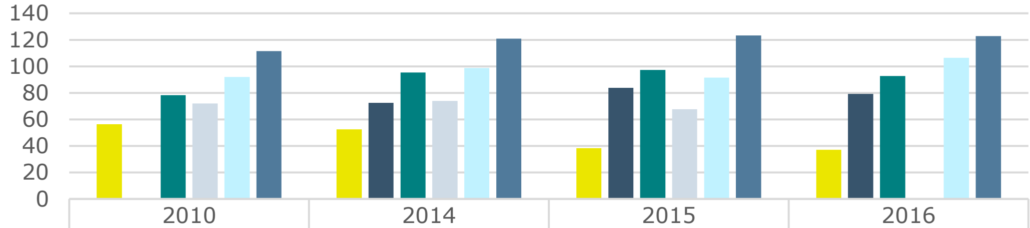
International energy prices: bricks and roof tiles and wall and floor tiles

Figure 22 compares electricity prices borne by bricks and roof tiles and wall and floor tiles producers based in the EU, Russia and the US. On average, EU producers seem to face higher prices than US and Russian counterparts. In detail, Russian prices declined from €56.3/MWh in 2010 to €37.1/MWh in 2016. Conversely, US prices increased between 2014 and 2015 (from around €72/MWh to almost €84/MWh) but decreased in 2016. A similar trend was registered also at the EU level. As average prices in the NWE and SE regions are above the EU averages, it is possible to conclude that CEE still pays the lowest prices for electricity in the EU; however, CEE prices are expected to be almost double the price paid by plants based in Russia.

When it comes to the components of the electricity prices, it is apparent that non-energy components play a more prominent role in the EU than in third countries. On average, they represent about 50% of the total price paid by EU producers, some 35% of Russian prices and less than 10% of prices borne by US producers (Figure 23).

[25] Please note that no public or private database providing international data for ceramics producers is available.

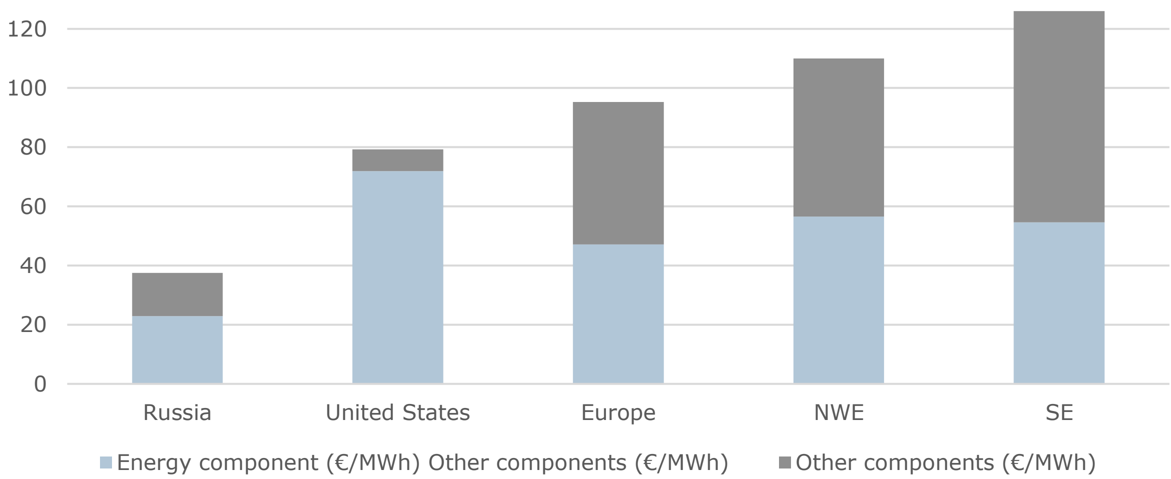
Figure 22 Electricity prices (€/MWh) – Weighted averages



	2010	2014	2015	2016
Russia	56.3	52.4	38.4	37.1
United States		72.5	83.8	79.3
EU	78.2	95.4	97.3	92.7
CEE	71.9	74.0	67.6	
NWE	92.1	98.7	91.6	106.4
SE	111.5	120.8	123.4	122.9

Note: weighting factor: purchased electricity; data for 2010, 2014 and 2015 are taken from the 2016 EPC Study; data for 2016 are based on 3 observations for Russia, 1 observation for the US, 80 observations for the EU; EU, NWE and SE averages for 2016 are simple averages of sectoral weighted average electricity prices presented in this Chapter and in the Chapter covering the wall and floor tiles sector, CEE data for 2016 cannot be shown for confidentiality reasons; US data for 2010 are not available.
Source: Authors' elaboration

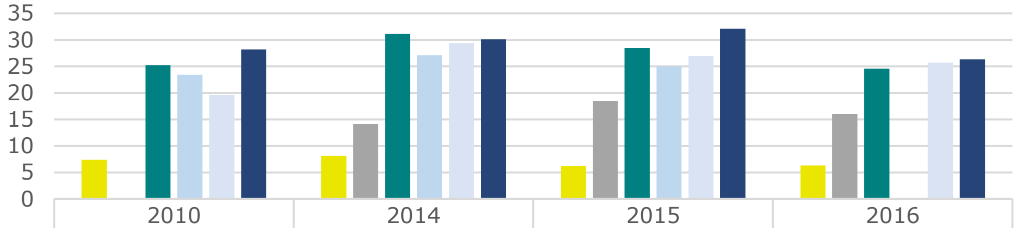
Figure 23 Components of the electricity price (€/MWh, 2016) – Weighted averages



Note: weighting factor: purchased electricity; 3 observations for Russia, 1 observation for the US, 64 observations for the EU; EU, NWE and SE averages for 2016 are simple averages of sectoral weighted averages presented in this Chapter and in the Chapter covering the wall and floor tiles sector, CEE data cannot be shown for confidentiality reasons.
Source: Authors' elaboration

As illustrated in Figure 24, natural gas prices in Russia are significantly lower than in the other regions; they went from €7.4/MWh in 2010 to €6.3/MWh in 2016. By contrast, natural gas prices paid by EU producers fluctuated between €25 and €31/MWh, with few exceptions at the regional level. In the US, prices of natural gas ranged between €14 and €18.5/MWh, thus remaining well below EU prices.

Figure 24 Natural gas prices (€/MWh) – Weighted averages



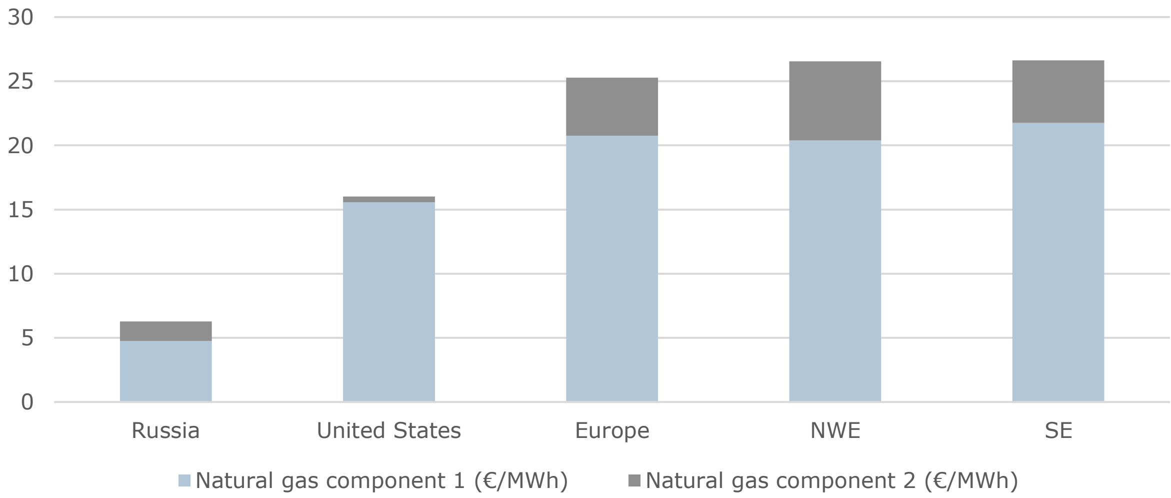
	2010	2014	2015	2016
Russia	7.4	8.1	6.2	6.3
United States		14.1	18.5	16.0
EU	25.2	31.1	28.5	24.6
CEE	23.4	27.1	25.0	
NWE	19.6	29.4	27.0	25.7
SE	28.2	30.1	32.1	26.3

Russia United States EU CEE NWE SE

Note: weighting factor: purchased natural gas; data for 2010, 2014 and 2015 are taken from the 2016 EPC Study; data for 2016 are based on 3 observations for Russia, 1 observation for the US, 79 observations for the EU; EU, NWE and SE averages for 2016 are simple averages of sectoral weighted average electricity prices presented in this Chapter and in the Chapter covering the wall and floor tiles sector, CEE data for 2016 cannot be shown for confidentiality reasons; US data for 2010 are not available.
Source: Authors' elaboration

Non-energy components represent a relatively lower share when comparing natural gas prices with electricity prices in all regions. Again, US prices are mostly driven by the energy components, while in the EU and Russia non-energy components represent respectively about 15% and 20% of the natural gas price (Figure 25).

Figure 25 Components of the natural gas price (€/MWh) – Weighted averages (2016)



Note: weighting factor: purchased electricity; 3 observations for Russia, 1 observation for the US, 61 observations for the EU; EU, NWE and SE averages for 2016 are simple averages of sectoral weighted averages presented in this Chapter and in the Chapter covering the wall and floor tiles sector, CEE cannot be shown for confidentiality reasons.
Source: Authors' elaboration

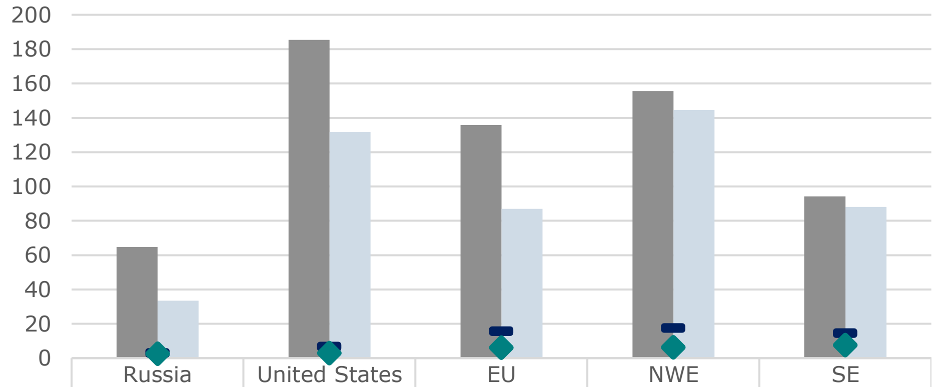
International competitiveness: bricks and roof tiles

Figure 26 compares energy costs with production costs and turnover in euros per tonne of bricks and roof tiles. Electricity and gas costs cumulatively represent about 17% of total production costs in Russia, 7% in the US and 25% in the EU. In the same vein, they represent about 9% of turnover in Russia, 5% in the US and 16% in the EU. However, turnover and production costs are highest in the US, followed by the EU (with a major difference across the EU regions) and then by Russia (where production costs are 25% of the costs borne by US plants and less than 40% of those borne by EU plants).

The gap across regions becomes smaller when it comes to profitability. In fact, EBITDA in the bricks and roof tiles sectors range between €11.4 and €16.5/tonne (although variance within the EU regions is somewhat larger); EBIT is negative in the US and equal to €4.7/tonne in the EU and Russia. It is worth emphasising, however, that energy costs appear to be larger than EBITDA only in the EU.

For the sake of transparency, Table 32 presents both weighted and simple averages for all key performance indicators. However, as data for the US are based only on one observation and data for Russia on two observations, it is not possible to draw any robust conclusion by comparing weighted and simple averages.

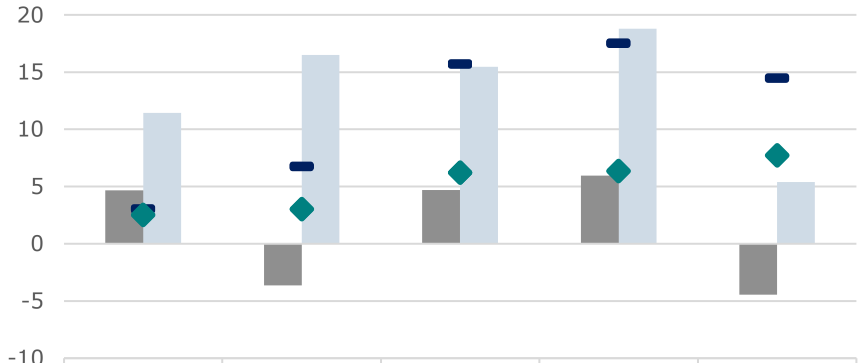
Figure 26 Electricity and natural gas costs vs production costs and turnover (€/tonne, 2016) – Simple averages



	Russia	United States	EU	NWE	SE
Turnover (€/tonne)	64.8	185.4	135.8	155.6	94.2
Production costs (€/tonne)	33.4	131.6	86.9	144.6	88.1
Natural gas cost (€/tonne)	3.0	6.8	15.7	17.5	14.5
Electricity cost (€/tonne)	2.5	3.0	6.2	6.4	7.7

Note: 2 observations for Russia, 1 observation for the US, 58 observations for EU electricity costs and natural gas costs, 53 observations for EU production costs and turnover; CEE data cannot be shown for confidentiality reasons.
Source: Authors' elaboration

Figure 27 Electricity and natural gas costs vs EBIT and EBITDA (€/tonne, 2016) – Simple averages



	Russia	United States	EU	NWE	SE
EBIT (€/tonne)	4.7	-3.6	4.7	6.0	-4.4
EBITDA (€/tonne)	11.4	16.5	15.5	18.8	5.4
Natural gas cost (€/tonne)	3.0	6.8	15.7	17.5	14.5
Electricity cost (€/tonne)	2.5	3.0	6.2	6.4	7.7

Note: 2 observations for Russia, 1 observation for the US, 58 observations for EU electricity costs and natural gas costs, 42 observations for EU EBITDA and EBIT; CEE data cannot be shown for confidentiality reasons.
Source: Authors' elaboration

Table 32 International competitiveness – (€/tonne, 2016)

Indicator	Average	Russia	United States	EU	NWE	SE
Natural gas cost (€/tonne)	Simple	3.0	6.8	15.7	17.5	14.5
	Weighted	3.1	n.a.	12.5	15.1	12.6
Electricity cost (€/tonne)	Simple	2.5	3.0	6.2	6.4	7.7
	Weighted	2.6	n.a.	5.0	5.5	6.5
Turnover (€/tonne)	Simple	64.8	185.4	135.8	155.6	94.2
	Weighted	69.1	n.a.	120.1	145.4	86.2
EBIT (€/tonne)	Simple	4.7	-3.6	4.7	6.0	-4.4
	Weighted	5.4	n.a.	7.5	8.3	-4.7
EBITDA (€/tonne)	Simple	11.4	16.5	15.5	18.8	5.4
	Weighted	12.0	n.a.	17.4	21.1	2.9
Production costs (€/tonne)	Simple	33.4	131.6	86.9	144.6	88.1
	Weighted	33.9	n.a.	67.1	89.7	68.8

Note: 2 observations for Russia, 1 observation for the US, 58 observations for EU electricity costs and natural gas costs, 53 observations for EU production costs and turnover, 42 observations for EU EBITDA and EBIT; CEE data cannot be shown for confidentiality reasons; weighted averages for the US are not available as data are based on 1 observation.
Source: Authors' elaboration

3 Wall and floor tiles

Box 3 Highlights – Wall and floor tiles

In the EU wall and floor tiles sector, while electricity costs represented on average 6% of total production costs (simple average) between 2008 and 2017, natural gas represented on average 13% of total production costs (simple average).

Electricity

- Electricity prices and costs in €/MWh remained quite stable throughout the period under observation.
- **Electricity prices** (simple average) fluctuated between €90 and €100/MWh. The weighted average (by purchased electricity) for this indicator was between €10 and €20/MWh lower than the simple average. When looking at the components of the electricity price, it is apparent that larger consumers: i) benefitted from stronger bargaining power when negotiating electricity prices (lower energy component); and ii) paid relatively less for network costs and non-recoverable taxes/levies (excluding RES levies). Only a few plants relied on the wholesale market to purchase electricity and these did not coincide with the largest consumers.
- **Electricity costs** (simple average) went from €96/MWh in 2008 to €86/MWh in 2017, with a peak in 2013 (€105/MWh). The small difference between electricity prices and costs in €/MWh is due to: i) compensation received by two plants for participating in flexibility schemes; ii) *ex post* reimbursements granted to two other sampled plants; and iii) self-generation of electricity by five plants. The weighted average (by electricity consumption) for this indicator was lower than the simple average, confirming better conditions for larger consumers. When looking at differences between weighted and simple averages for electricity prices and electricity costs in €/MWh, it is apparent that larger consumers benefitted the most from flexibility schemes, self-generation and *ex post* reimbursement.
- **Electricity costs in €/tonne** (simple average) were equal to €21/tonne in 2008 and €19/tonne in 2017 and registered a peak in 2013 (€22/tonne). When comparing simple and weighted averages (by production output), plants with higher production output registered slightly lower costs per tonne, mainly linked to better bargaining power when negotiating the energy component of the electricity price and relatively lower network costs and non-recoverable taxes/levies.
- The **electricity intensity** of the production process (simple averages) was quite stable throughout the period under observation, ranging between 0.21 and 0.25 MWh/tonne. The difference between simple and weighted averages (by production output) is very limited, which indicates that economies of scale play a limited role when it comes to electricity.

Natural gas

- 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 2012 and 2013, the **natural gas price** (simple average) decreased sharply, from almost €33/MWh (in 2013) to about €22/MWh (in 2017). There is no significant difference between simple and weighted averages (by purchased gas); this may indicate that the bargaining power of buyers and exemptions from regulatory components are less relevant when it comes to natural gas prices than for electricity prices. Only two plants relied on the wholesale market to purchase natural gas. There is no difference in this sector between natural gas prices and costs in €/MWh for two reasons: i) self-generation of natural gas is not relevant; ii) only three plants participated in

interruptibility schemes, with very limited compensation compared to total natural gas costs.
- **Natural gas costs** (simple average) ranged between €36 and €51/tonne over the period under observation. They decreased sharply to less than €40/tonne in 2016 and 2017. The weighted average (by production output) for this indicator was slightly above the simple average, indicating 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.
- **Natural gas intensity** in the EU wall and floor tiles sector decreased over the 10 years, declining from 1.8 MWh/tonne in 2008 to 1.6 MWh/tonne in 2017. This indicates that wall and floor tiles producers are making increasingly efficient use of natural gas. The weighted average (by production output) for this indicator is comparable to the simple average; this may indicate limited or no economies of scale linked to natural gas usage.

Competitiveness

- The share of **electricity costs** in **total production costs** declined from above 7% in 2008 to about 4% in 2017 (simple average). In fact, whereas electricity costs in €/tonne decreased throughout the period under observation, production costs in €/tonne followed a rising trend.
- The simple average for production costs was lower than the weighted average (by production output); this may indicate a limited role for **economies of scale** in the production of wall and floor tiles. By contrast, the simple average for electricity costs was higher than the weighted average (by production output). Hence, the share of electricity costs in total production costs was larger in smaller plants.
- **Natural gas costs** are responsible for a larger share of **total production costs** than electricity costs. In the 10-year observation period, however, this share decreased, especially in the most recent years, declining from about 17% in 2008 to 7% in 2017 (simple average).
- The share of electricity costs relative to **turnover** declined from about 5% in 2008 to 3% in 2017 (simple average). Natural gas costs represented between 12% (2008) and 5 % (2017) of the average sectoral turnover. Trends in turnover were similar to trends in production costs.
- It is not possible to draw conclusions on the impact of electricity and natural gas costs on profitability (more details on this point are provided in Annex B to this Study). To have an idea of the importance of electricity and natural gas costs with respect to profit indicators, it is worth emphasising that electricity and natural gas costs were higher than **EBITDA** and **EBIT** in most of the years under observation, except for 2016 and 2017 when a sharp increase in margins was partially influenced by the different composition of the sample.

Sample and limitations

- The **sample** for 2016 and 2017 included 22 plants across the EU, representing about **12% of the total production sold** by EU wall and floor tiles producers (in value). The sample for previous years included 18 plants, representing about 8% of the total production value in the EU. About 50% of the sample is composed of plants based in the SE region, 35% of plants based in the CEE, 15% based in the NWE; hence, the SE region is under-represented, as almost 80% of the EU production value is generated by SE Member States. SME operating in the sector are under-represented.
- 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.

- For some indicators, the number of available observations varies between years; the trends may therefore be affected by **changes in the sample size**. More details about the number of observations are provided beneath each figure and table.
  Averages for the CEE region cannot be shown for confidentiality reasons. However, data provided by CEE plants are included in the EU averages.

3.1 Composition of the sample

Sampling strategy

Dividing the EU population of manufacturers of wall and floor tiles (NACE rev.2 23.31) into homogenous groups requires considering the following sampling criteria:

- Geographical distribution
- Company size/ownership.

The sample aims to cover three geographical regions (Southern Europe, Central Eastern Europe and North-Western Europe) to account for differences in energy prices and costs generated by the plant location.

Based on Eurostat data, in the manufacturing of clay building materials (NACE rev.2 23.3), most of the turnover is generated by large (above 50%) and medium-sized (35%) companies. However, according to industry associations, SME have a more central role in the wall and floor tile sector than in the bricks and roof tiles sector. In this context, company size can be considered a relevant sampling variable.

Plant features are not a relevant variable for the wall and floor tiles sector. Although the sector comprises heterogeneous products (in terms of physical composition, dimension, weight, shape, surface and colour), it is fairly homogenous when it comes to the production process as well as energy prices and costs. This was confirmed by the 2016 EPC Study.

The configuration of the value chain in the wall and floor tile sectors is quite straightforward and does not entail downstream processing activities performed by different companies. Nevertheless, there is room for different levels of vertical integration that should be considered while assessing energy costs.

Against this background, and keeping in mind international best practices to collect data on regulatory costs, the target sample for this Assignment is presented in Table 33.

Table 33 Minimum number of plants to be surveyed

Geographical regions	Wall and floor tiles	Wall and floor tiles
	Large	SME
Southern Europe	5	5
Central Eastern Europe	5	5
North-Western Europe	5	5
Total	**15**	**15**

Source: Authors' elaboration.

Box 4 Key features of the wall and floor tiles sector

- Key statistics pertaining to the wall and floor tiles sector (NACE 23.31) are presented as follows:
  - Production value (2015): €10,005 million
  - Number of enterprises in absolute value (2015): 1,225

  - Top five European wall and floor tiles producers (2016, production value): Italy (42%), Spain (39%), Poland (7%), Germany (6%) and Portugal (2%).
  - Intra-EU vs extra-EU trade (2016): intra-EU trade accounts for almost 64% of the total trade value. With regard to international trade, the EU is a net exporter of wall and floor tiles.
  - The main importers of European wall and floor tiles (2016) are the US, Switzerland and Saudi Arabia.
  - The main exporters to the EU of wall and floor tiles (2016) are Turkey, China and the United Arab Emirates.
- Typical firms within the wall and floor tiles sector are often SME, but can exist as a conglomerate of SME-sized plants. Plants tend to be spread throughout Europe, according to the availability of raw materials and requirements of the production process, which entails the following steps:
  - Preparation of raw materials
  - Shaping
  - Drying
  - Glazing
  - Firing
- Across the period under observation, most of the plants included in this study tend to fall in the following ranges (first quartile – third quartile range) for the indicators presented. The wall and floor tiles sector comprises heterogeneous products in terms of physical composition, dimension, weight, shape, surface, colour and value added; this largely explains the variance of such indicators.
  - Electricity consumption: 7,100 MWh to 31,300 MWh per year
  - Electricity intensity: 0.1 MWh/tonne to 0.3 MWh/tonne
  - Natural gas consumption: 52,000 MWh to 242,000 MWh per year
  - Natural gas intensity: 1.1 MWh/tonne to 2.3 MWh/tonne

For additional details pertaining to the production process of a 'typical plant' and sector information, please refer to Annex A.

Source: Authors' elaboration on Eurostat SBS, Eurostat PRODCOM, Eurostat COMEXT.

Sample statistics

In the context of the current Assignment, the Research Team contacted 41 plants from the wall and floor tiles sector, the regional distribution of which can be found in Table 34.[26] Of these 41 plants, 22 returned the questionnaire, seven of which belong to SME.[27] Five companies that returned the questionnaire also provided supporting evidence in the form of electricity and/or natural gas bills. Indicators for the SE and NWE regions will be shown, but CEE indicators cannot be shown for this sector to protect the confidentiality of respondents, as they are based on data provided by plants belonging to less than three independent companies.

[26] It is worth mentioning that samples for the period 2008-2015 and for 2016-2017 are different. More specifically, for 2008-2015, the sample includes: i) plants not participating in the current Study which, however, gave their consent to use data they provided for the Cumulative Cost Assessment of the EU ceramics industry; ii) companies participating in both the current Study and the Cumulative Cost Assessment which gave their consent to also use data they provided for the Cumulative Cost Assessment; and iii) a few companies participating only in the current Study which voluntarily also provided data for the period 2008-2015.

[27] Due to the small number of observations collected from plants belonging to SME, it is not possible to provide a separate analysis for energy prices and costs borne by SME.

Table 34 Plants participating in the survey

Geographical regions	Wall and floor tiles		
	Plants contacted	Questionnaires collected	Number of plants sharing supporting evidence
Southern Europe	26	10	3
Central-Eastern Europe	9	8	1
North-Western Europe	6	4	1
Total	41	22	5

Source: Authors' elaboration

The coverage of the EU population shows the share of total EU capacity in a certain sector made by the surveyed plants (i.e. total production of the sample divided by total EU production) in each year and can be found in Table 35. However, the true coverage of the EU population is expected to be higher as some plants did not provide their turnover.

Table 35 Turnover of sampled plants out of total value of production sold by EU producers (%)

Wall and floor tiles	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Turnover %	4.9	5.6	5.6	8.4	8.6	8.3	8.9	8.8	11.5	n.a.
Number of plants disclosing their turnover	14	15	15	16	16	16	16	16	18	11
Total number of sampled plants	18	18	18	18	18	18	18	18	22	22

Note: PRODCOM values for 2017 are not available.
Source: Authors' elaboration on data collected at the plant level and PRODCOM.

It is worth mentioning that, in order to increase the response rate, the Research Team implemented several mitigation measures, including:

- Sending several rounds of reminders via email to all contacted companies
- Calling companies wherever the phone number was available
- Inviting additional companies randomly selected from lists available on the websites of national associations
- Contacting national associations in several Member States
- Arranging a webinar to which companies and national associations as well as the Commission were invited to participate
- Arranging bilateral meetings with companies to explain how to complete the questionnaire.

In addition, the Research Team worked in close cooperation with Cerame-Unie (the relevant sectoral association at the EU level) and with national associations (e.g. Confindustria Ceramica, Asociación Española de Fabricantes de Azulejos y Pavimentos Cerámicos, Associação Portuguesa das Indústrias de Cerâmica e de Cristalaria) to build trust across stakeholders.

International comparison

As only one EU producer of wall and floor tiles shared international data for a plant based in Russia, it is not possible to present the international comparison in this sector due to confidentiality reasons. However, energy prices and natural gas prices paid by wall and floor tiles manufacturers based in Russia appear to be very similar to those paid by bricks and roof tiles producers. Therefore, the international comparison presented in the bricks and roof tile chapter (see above) also includes data collected in the wall and floor tiles sector.

3.2 Electricity

This Section provides an overview of the main figures for electricity within the wall and floor tiles sector. Electricity prices remained fairly steady over the 10 years under observation, starting at €96.1/MWh with a peak in 2013 (€100.3/MWh) and a drop from 2014 onwards. Electricity costs in €/MWh followed the same path as electricity prices; differences are due to self-generation and reimbursement received by some plants. Trends in electricity costs in €/tonne is also aligned with electricity price trends. With regard to electricity intensity, it appears to be quite stable over the 10 years under analysis.

Table 36 Electricity: summary table (EU) – Simple averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity prices (€/MWh)	96.1	90.2	90.3	92.7	99.0	100.3	97.6	99.6	99.2	95.9
Electricity costs (€/MWh)	95.7	91.6	91.4	96.1	104.1	104.6	100.0	98.2	88.1	86.4
Electricity costs (€/tonne)	21.4	20.1	19.7	20.1	21.2	21.6	19.7	19.3	19.9	19.3
Electricity intensity (MWh/tonne)	0.23	0.25	0.23	0.21	0.23	0.23	0.21	0.21	0.24	0.24

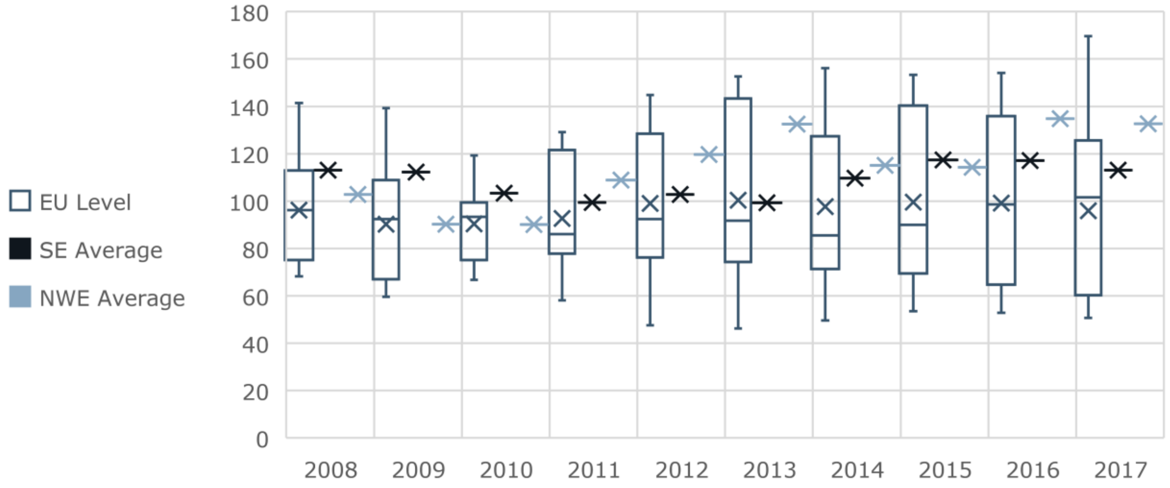
Source: Authors' elaboration

Electricity prices

Average electricity prices in the EU remained steady within the wall and floor tiles sector over a 10-year period. At the EU level prices fluctuated between €90 and €100/MWh. When weighting on purchased electricity, the price drops between €10 and €20/MWh, indicating that larger electricity consumers in this sector have increased leverage when negotiating their electricity prices, resulting in lower prices. When looking at the components of the electricity price (see below), it is apparent that larger consumers: i) benefitted from stronger bargaining power when negotiating electricity prices (lower energy component); and ii) paid relatively less for network costs and non-recoverable taxes/levies (excluding RES levies).

Electricity price trends within the two regions reveal that prices increased slightly in the SE region and more sharply in the NWE region. It is important to note the small sample size in the NWE region and greater variance across years. While not shown in Figure 28 due to confidentiality reasons, the CEE region drives down the EU average in the wall and floor tile sector, and this trend is visible in the other indicators presented in this study.

Figure 28 Electricity prices (€/MWh) – Box plots and simple averages



Note: 22 observations in 2016 and 2017, 12 observations in 2008 and 2009, 14 in 2010, 2014, 2015, and 15 from 2011 to 2013; CEE averages are omitted due to confidentiality.
Source: Authors' elaboration

Table 37 Electricity prices (€/MWh) - Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	Weighted	104.6	89.3	87.4	104.6	116.8	128.9	104.5	107.7	123.8	116.6
	Simple	102.8	90.3	90.1	108.9	119.6	132.5	115.0	114.3	134.8	132.6
SE	Weighted	105.1	115.3	105.1	78.5	73.9	72.6	74.1	79.3	120.1	115.0
	Simple	113.1	112.3	103.3	99.4	102.9	99.2	109.7	117.4	117.1	113.0
EU	Weighted	**86.8**	**80.1**	**82.5**	**83.1**	**86.1**	**88.7**	**78.8**	**80.1**	**91.6**	**87.3**
	Simple	**96.1**	**90.2**	**90.3**	**92.7**	**99.0**	**100.3**	**97.6**	**99.6**	**99.2**	**95.9**

Note: weighting factor: electricity purchased; 22 observations in 2016 and 2017, 12 observations in 2008 and 2009, 14 in 2010, 2014, 2015, and 15 from 2011 to 2013; CEE averages are omitted due to confidentiality.
Source: Authors' elaboration

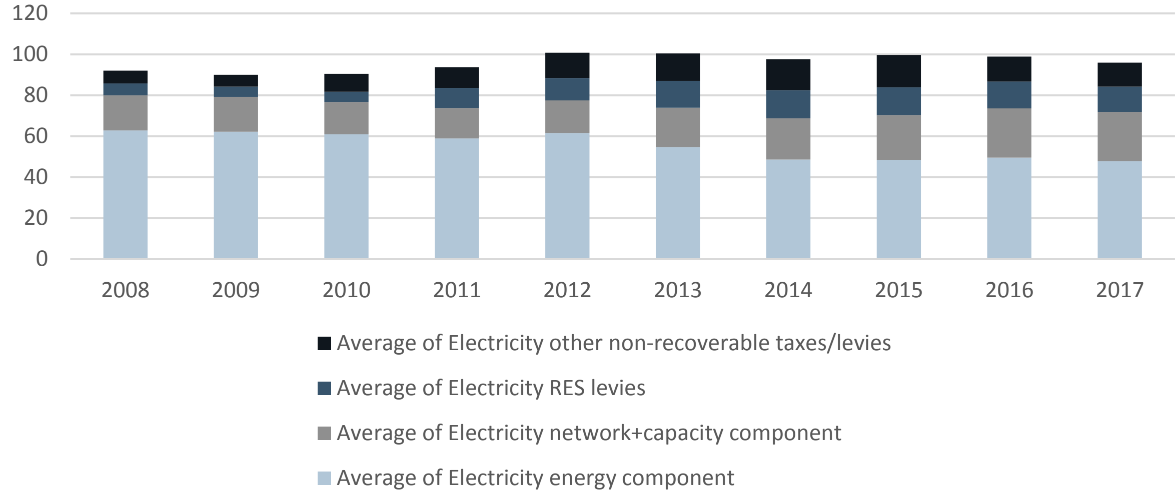
Components of the electricity price[28]

A clear trend exists within the wall and floor tiles sector regarding the breakdown of components within the electricity price. Network and capacity components increased in both absolute value and share of the price. This occurred while prices remained stable in the €95-100 range, meaning that these costs partially supplanted decreasing energy component costs.

Weighting the components of the electricity price on the amount of electricity purchased often lowers the price of the components both at the EU level and within the regions shown. This trend was prevalent in the energy component as well as for network costs and non-recoverable taxes/levies (excluding RES levies). While this trend was present at the EU level and, to some extent, in the SE region, the NWE region saw its energy component price slightly increase when considering the amount of purchased electricity, while the network and capacity components decreased significantly.

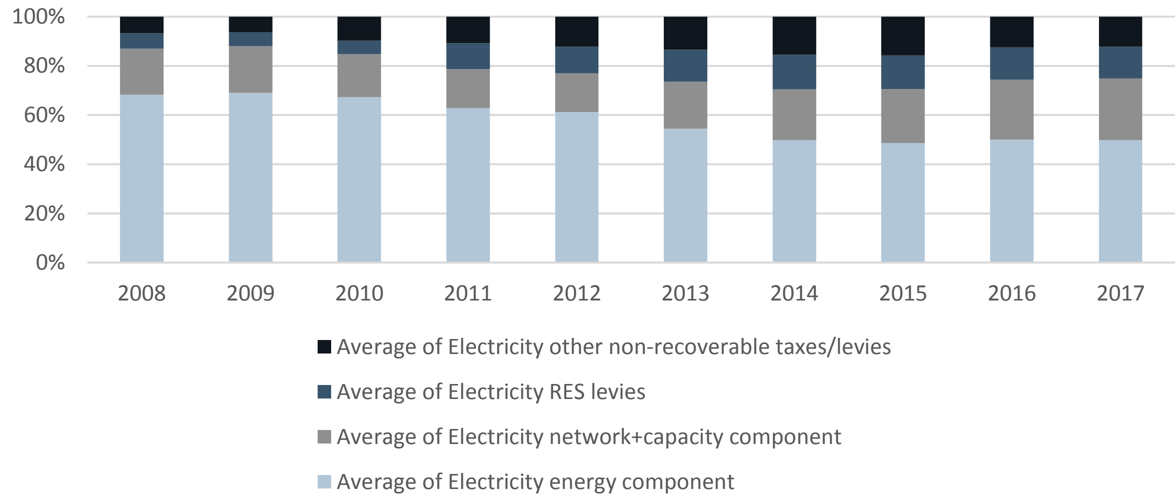
[28] The sum of the electricity bill components does not necessarily add up to the total electricity price mentioned before, as there might be plants that did not provide a breakdown of the electricity bill components while still providing the total electricity price.

Figure 29 Components of the electricity price (€/MWh, EU) – Simple averages



Note: 21 observations in 2016 and 2017, 11 observations in 2008 and 2009, 13 in 2010, 14 in 2011-2012, and 2014-2015, and 15 in 2013.
Source: Authors' elaboration

Figure 30 Components of the electricity price (%, EU) – Simple averages



Note: 21 observations in 2016 and 2017, 11 observations in 2008 and 2009, 13 in 2010, 14 in 2011-2012, and 2014-2015, and 15 in 2013.
Source: Authors' elaboration

Table 38 Components of the electricity price: energy component (€/MWh) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	Weighted	70.7	55.0	53.9	61.1	63.1	63.2	47.3	46.4	59.0	49.8
	Simple	67.4	54.4	53.6	59.3	61.5	62.3	49.6	44.7	69.3	64.7
SE	Weighted	75.3	94.0	77.0	44.3	42.2	37.3	35.6	38.1	54.7	51.9
	Simple	74.8	91.6	74.7	69.5	71.5	55.7	56.1	59.8	53.5	52.8
EU	Weighted	**60.7**	**54.8**	**55.3**	**49.3**	**50.7**	**47.1**	**39.6**	**39.4**	**45.9**	**42.8**
	Simple	**62.7**	**62.1**	**60.9**	**58.8**	**61.6**	**54.7**	**48.6**	**48.4**	**49.5**	**47.8**

Note: weighting factor: electricity purchased; 21 observations in 2016 and 2017, 11 observations in 2008 and 2009, 13 in 2010, 14 in 2011 – 2012, and 2014-2015, and 15 in 2013; CEE averages are omitted due to confidentiality.
Source: Authors' elaboration

Table 39 Components of the electricity price: network + capacity component (€/MWh) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	Weighted	18.1	18.5	15.2	15.4	20.5	21.3	18.3	21.0	26.5	26.0
	Simple	17.8	18.1	15.3	15.4	19.6	19.6	17.3	19.6	27.1	27.0
SE	Weighted	10.0	12.1	11.1	9.5	8.9	12.4	12.7	13.1	36.7	36.6
	Simple	15.6	15.2	13.7	12.2	11.5	18.8	22.8	26.4	34.0	33.5
EU	Weighted	**15.9**	**16.0**	**15.2**	**13.7**	**14.4**	**16.0**	**14.9**	**15.3**	**22.7**	**22.8**
	Simple	**17.3**	**17.0**	**15.8**	**14.8**	**15.9**	**19.2**	**20.2**	**21.9**	**24.1**	**24.0**

Note: weighting factor: electricity purchased; 21 observations in 2016 and 2017, 11 observations in 2008 and 2009, 13 in 2010, 14 in 2011-2012, and 2014-2015, and 15 in 2013; CEE averages are omitted due to confidentiality.
Source: Authors' elaboration

Table 40 Components of the electricity price: RES levies (€/MWh) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	Weighted	10.5	10.8	13.5	21.7	25.2	35.2	31.4	31.2	24.1	26.2
	Simple	10.8	11.3	14.9	24.8	27.9	38.8	37.5	37.3	26.0	28.3
SE	Weighted	0.0	0.0	0.0	14.8	13.2	12.2	13.4	15.2	14.8	13.5
	Simple	0.0	0.0	0.0	3.9	3.4	3.4	3.5	4.0	12.0	10.7
EU	Weighted	**5.2**	**5.2**	**7.0**	**14.9**	**15.5**	**18.7**	**17.3**	**17.8**	**13.3**	**12.5**
	Simple	**5.7**	**5.0**	**4.9**	**9.9**	**10.8**	**13.0**	**13.8**	**13.6**	**13.0**	**12.3**

Note: weighting factor: electricity purchased; 21 observations in 2016 and 2017, 11 observations in 2008 and 2009, 13 in 2010, 14 in 2011-2012, and 2014-2015, and 15 in 2013; CEE averages are omitted due to confidentiality.
Source: Authors' elaboration

Table 41 Components of the electricity price: Other non-recoverable taxes/levies (€/MWh) – Simple and weighted averages

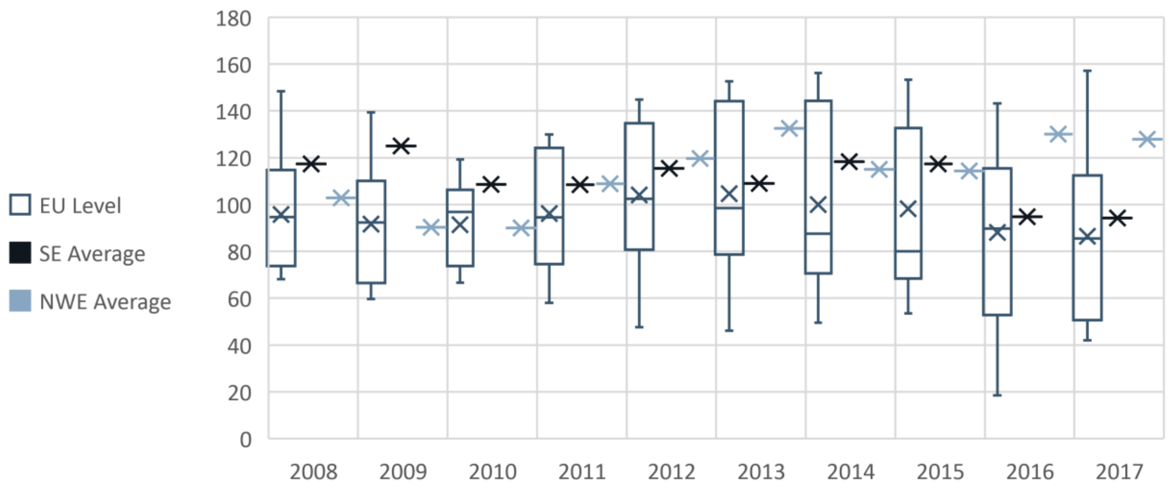
Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	Weighted	5.3	5.1	4.7	6.4	7.9	9.2	7.6	9.1	14.2	14.6
	Simple	6.9	6.5	6.3	9.3	10.7	11.9	10.7	12.6	12.4	12.6
SE	Weighted	14.9	14.7	18.8	9.1	10.4	11.7	12.3	12.9	14.3	13.4
	Simple	13.3	12.2	17.6	17.2	21.1	21.7	27.2	27.2	19.4	18.0
EU	Weighted	**4.1**	**3.8**	**4.9**	**5.1**	**6.1**	**7.2**	**7.0**	**7.5**	**9.4**	**9.2**
	Simple	**6.3**	**5.8**	**8.8**	**10.1**	**12.4**	**13.5**	**15.1**	**15.7**	**12.3**	**11.8**

Note: weighting factor: electricity purchased; 21 observations in 2016 and 2017, 11 observations in 2008 and 2009, 13 in 2010, 14 in 2011-2012, and 2014-2015, and 15 in 2013; CEE averages are omitted due to confidentiality.
Source: Authors' elaboration

Electricity costs

The average electricity cost in €/MWh is slightly lower than the electricity price as this accounts for reimbursements and revenues for self-produced electricity, where applicable.[29] The trend follows a similar path as for the electricity price. The decrease was most prevalent in the SE region, while only a small decrease is shown in the NWE region. Only a few of the 22 plants reported receiving a reimbursement for their electricity bills in 2016 and 2017; and only five plants met part of their electricity demand via self-generation. Additionally, weighted averages (by production output) are lower than the simple averages, confirming better conditions for larger consumers. When looking at differences between weighted and simple averages for electricity prices and electricity costs in €/MWh, it is apparent that larger consumers benefitted the most from flexibility schemes, self-generation and *ex post* reimbursement.

Figure 31 Electricity costs (€/MWh) – Box plots and simple averages



Note: 21 observations in 2016 and 2017, observations in 2008 and 2009, 13 in 2010, 2014, 2015, and 14 from 2011 to 2013; CEE averages are omitted due to confidentiality.
Source: Authors' elaboration

[29] Electricity prices in €/MWh are defined as follows: Total price paid to purchase electricity/Total electricity purchased. Electricity costs in €/MWh are defined 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).

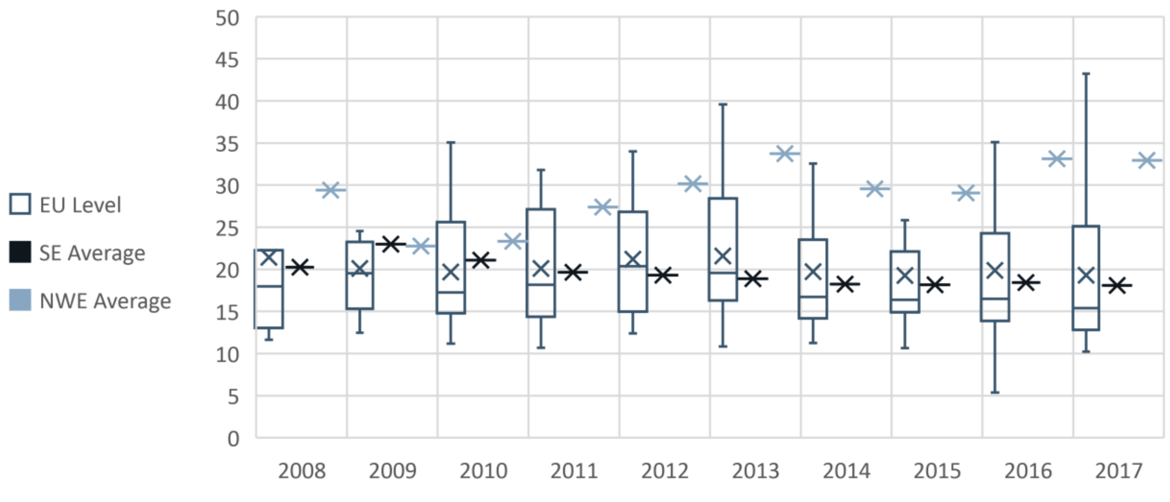
Table 42 Electricity costs (€/MWh) - Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	Weighted	104.6	89.3	87.4	104.6	116.8	128.9	104.5	107.7	120.6	113.6
	Simple	102.8	90.3	90.1	108.9	119.6	132.5	115.0	114.3	130.0	127.9
SE	Weighted	86.3	69.5	31.1	77.4	69.5	67.3	75.2	74.3	82.5	80.3
	Simple	117.4	125.0	108.5	108.5	115.4	109.0	118.3	117.4	94.8	94.3
EU	Weighted	**84.7**	**72.8**	**63.3**	**82.2**	**83.0**	**84.3**	**78.7**	**77.6**	**79.4**	**76.4**
	Simple	**95.7**	**91.6**	**91.4**	**96.1**	**104.1**	**104.6**	**100.0**	**98.2**	**88.1**	**86.4**

Note: weighting factor: total electricity consumption; 21 observations in 2016 and 2017, observations in 2008 and 2009, 13 in 2010, 2014, 2015, and 14 from 2011 to 2013; CEE averages are omitted due to confidentiality.
Source: Authors' elaboration

For the electricity costs in €/tonne, the trend at the EU level is aligned with electricity price trends. However, the differences between the regions become more prevalent. For the SE region, the trend is stable across 10 years, albeit with a very slight decrease since 2009. The NWE region sees a cost increase in €/tonne from 2008 to 2013, with costs stabilising after 2014, though it is important to note the sample size changes between 2016 and 2017 and the previous years for this region in particular. While the regional average cannot be shown due to confidentiality reasons, the CEE region costs in €/tonne align more closely with the overall mean as indicated by the contraction in the lower quartile and minimum when compared to the electricity price.

Figure 32 Electricity costs (€/tonne) – Box plots and simple averages



Note: 21 observations in 2016 and 2017, 11 observations in 2008 and 2009, 13 in 2010, 2014, 2015, and 14 from 2011 to 2013; CEE averages are omitted due to confidentiality.
Source: Authors' elaboration

When comparing simple and weighted averages (by production output), plants with higher production output registered slightly lower costs per tonne, mainly linked to better bargaining power when negotiating the energy component of the electricity price and relatively lower network costs and non-recoverable taxes/levies However, in 2016 and 2017 for the NWE region, the weighted average was slightly higher, which is due to the sample increasing by one in these years and this plant having higher costs, while also having a high production capacity.

Table 43 Electricity costs (€/tonne) - Simple and weighted averages

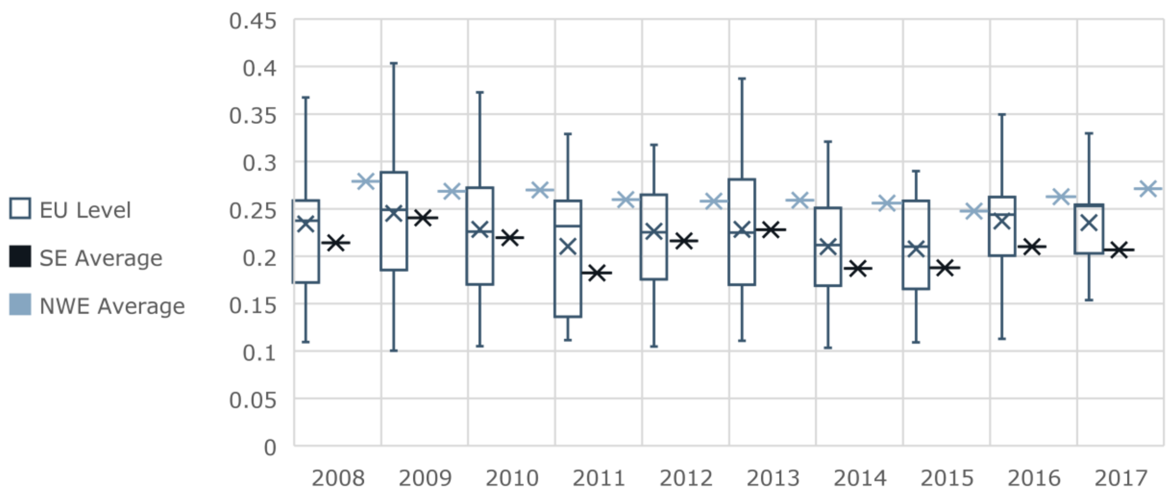
Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	**Weighted**	26.8	22.1	22.0	25.9	28.7	31.6	25.6	25.5	34.9	33.8
	Simple	29.4	22.8	23.3	27.4	30.2	33.7	29.6	29.1	33.1	32.9
SE	**Weighted**	17.9	16.5	6.3	15.7	15.2	14.8	16.1	15.8	17.7	17.2
	Simple	20.3	23.0	21.1	19.6	19.3	18.9	18.2	18.2	18.4	18.1
EU	**Weighted**	**19.4**	**17.7**	**14.1**	**18.1**	**18.8**	**18.7**	**17.2**	**16.7**	**18.6**	**17.7**
	Simple	**21.4**	**20.1**	**19.7**	**20.1**	**21.2**	**21.6**	**19.7**	**19.3**	**19.9**	**19.3**

Note: weighting factor: production output; 21 observations in 2016 and 2017, 11 observations in 2008 and 2009, 13 in 2010, 2014, 2015, and 14 from 2011 to 2013; CEE averages are omitted due to confidentiality.
Source: Authors' elaboration

Electricity intensity

Electricity intensity is also stable over the 10-year period at the EU level. In contrast to electricity prices and costs, the intensity is most stable in the NWE region, while greater fluctuations occur over the 10-year period in the SE region. The data indicate that wall and floor tile production processes in the NWE region are slightly more electricity intensive (~0.5 MWh/tonne) than in the SE region, and the EU average typically floats somewhere in between these two regional averages, between 0.21 and 0.25 MWh/tonne. This stable trend indicates that little change to the production processes regarding electricity utilisation has occurred over the last 10 years within the sampled plants. This is most likely due to two factors: first, technical improvements in the electricity efficiency of the production process have been more limited than those related to natural gas efficiency; second, in recent years EU manufacturers have progressively refocused their business towards value-added products such as rectified tiles[30] that require more electricity in the finishing phase. In addition, the difference between weighted and simple averages is very limited, thus indicating that economies of scale play a limited role in the sector (at least as concerns electricity inputs).

Figure 33 Electricity intensity (MWh/tonne) – Box plots and simple averages



Note: 21 observations in 2016 and 2017, 12 observations in 2008 and 2009, 13 in 2010, 2014, 2015, and 14 from 2011 to 2013; CEE averages are omitted due to confidentiality.
Source: Authors' elaboration

[30] Rectified tiles are consistent in size; their edges are mechanically cut to ensure uniformity.

Table 44 Electricity intensity (MWh/tonne) - Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	**Weighted**	0.26	0.25	0.25	0.25	0.25	0.25	0.25	0.24	0.29	0.30
	Simple	0.28	0.27	0.27	0.26	0.26	0.26	0.26	0.25	0.26	0.27
SE	**Weighted**	0.21	0.24	0.20	0.20	0.22	0.22	0.21	0.21	0.21	0.21
	Simple	0.21	0.24	0.22	0.18	0.22	0.23	0.19	0.19	0.21	0.21
EU	**Weighted**	**0.23**	**0.24**	**0.22**	**0.22**	**0.23**	**0.22**	**0.22**	**0.22**	**0.24**	**0.23**
	Simple	**0.23**	**0.25**	**0.23**	**0.21**	**0.23**	**0.23**	**0.21**	**0.21**	**0.24**	**0.24**

Note: weighting factor: production output; 21 observations in 2016 and 2017, 12 observations in 2008 and 2009, 13 in 2010, 2014, 2015, and 14 from 2011 to 2013; CEE averages are omitted due to confidentiality.
Source: Authors' elaboration

Additional information

All but two of the surveyed plants purchased electricity from a supplier. The other two plants purchased from the wholesale market (they did not coincide with the largest consumers), thus none of the plants in the sample purchased electricity via PPA agreements, further illustrating the limited utilisation of these contracts across Europe. Regarding the length of contract, 18 plants had contracts of up to five years, while the remaining four were of an indeterminate duration (with the possibility of being automatically renewed each year).

For flexibility schemes, only two of the 22 plants participating in the most recent round of data collection had contracts in place for electricity. With regard to the continuity of electricity supply, the sample registered few planned outages, but numerous unplanned outages. The average duration of unplanned outages was reduced by half from 2015 to 2016 and was further reduced in 2017.

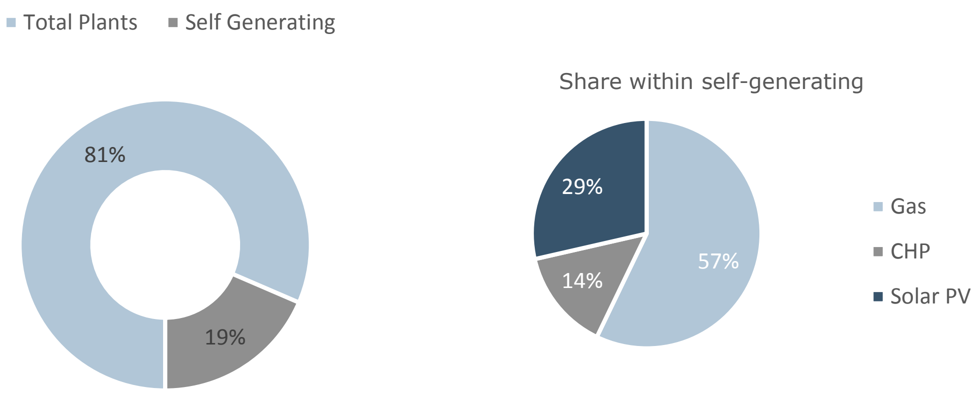
Table 45 Electricity outages

Year	Planned outages		Other planned outages		Unplanned outages	
	Number	Minutes	Number	Minutes	Number	Minutes
2015	0	-	1	120	46	208
2016	2	6	3	190	55	106
2017	3	4	1	120	48	81

Note: Planned outages are linked to flexibility schemes; other planned outages are not linked to flexibility schemes, but notified in advance by the energy supplier; unplanned outages are not notified.
Source: Authors' elaboration

Of the plants currently reporting self-generation data, about 20% (5) had the capacity for self-generation of electricity. Within this 20% of self-generating plants, 29% (2) had solar PV installed, 14% (1) had cogeneration heat and power (CHP) and 57% (4) had gas generators. One plant had both gas and solar PV electricity generation installed and one had both gas and CHP installed.

Figure 34 Self-generation and type of self-generation



Source: Authors' elaboration

3.3 Natural gas

Table 46 illustrates a breakdown of the main figures pertaining to natural gas within the wall and floor tiles sector. Natural gas prices, as well as natural gas costs, fluctuated in the years under observation. With regard to natural gas intensity, a decreasing trend was registered over the last 10 years. This indicates that production processes within the wall and floor tiles sector are making increasingly efficient use of natural gas.

Table 46 Natural gas: summary table (EU, simple averages)

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas prices (€/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: Authors' elaboration

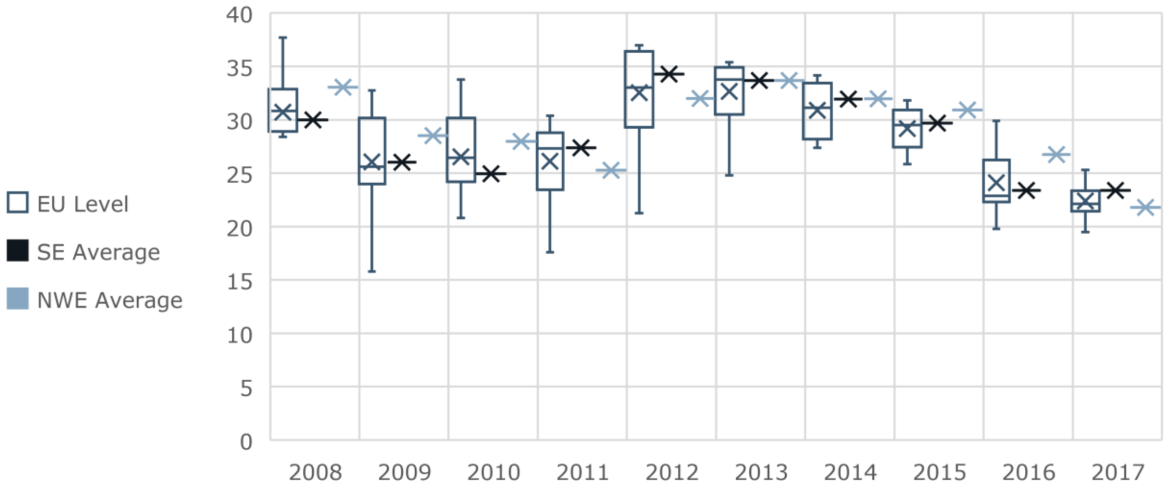
Natural gas prices

Natural gas prices for the wall and floor tiles sector fluctuated greatly over the 10-year observation period, particularly when compared to electricity prices. Prices declined from 2008 to 2011 and then increased by €6.9/MWh between 2011 and 2012. The price has since declined, reaching its lowest in 2017. There is also less variance in the price of natural gas. Due to the sample, it is impossible to tell if the SE or NWE region pays higher prices, as over the 10-year period they followed similar trends and exchanged places several times.

With regard to the weighted averages, which was calculated using the amount of purchased natural gas as a weight, there is no significant change between these and the simple averages. This may indicate that the bargaining power of buyers and exemptions from regulatory components are less relevant when it comes to natural gas prices than for electricity prices.

There is no difference in this sector between natural gas prices and costs in €/MWh for two reasons: i) self-generation of natural gas is not relevant; ii) only three plants participated in interruptibility schemes, with very limited compensation compared to total natural gas costs.

Figure 35 Natural gas price (€/MWh) – Box plots and simple averages



Note: 21 observations in 2016 and 2017, 13 observations in 2008, 2009 and in 2010, 2014, 2015, and 14 from 2011 to 2013; CEE averages are omitted due to confidentiality.
Source: Authors' elaboration

Table 47 Natural gas price (€/MWh) - Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	**Weighted**	32.2	28.1	27.9	24.7	31.5	33.4	31.7	30.8	25.9	21.6
	Simple	33.0	28.5	28.0	25.3	32.0	33.7	32.0	30.9	26.7	21.8
SE	**Weighted**	29.9	24.9	27.0	28.1	36.9	35.6	35.1	33.5	25.9	25.1
	Simple	30.0	26.0	24.9	27.4	34.3	33.7	31.9	29.7	23.4	23.4
EU	**Weighted**	**30.3**	**25.9**	**26.8**	**25.8**	**32.7**	**33.0**	**32.1**	**30.7**	**25.0**	**23.6**
	Simple	**30.7**	**26.1**	**26.5**	**26.1**	**32.5**	**32.7**	**30.9**	**29.2**	**24.1**	**22.4**

Note: weighting factor: natural gas purchased; 21 observations in 2016 and 2017, 13 observations in 2008 and 2009, in 2010, 2014 and 2015, and 14 from 2011 to 2013; CEE averages are omitted due to confidentiality.
Source: Authors' elaboration

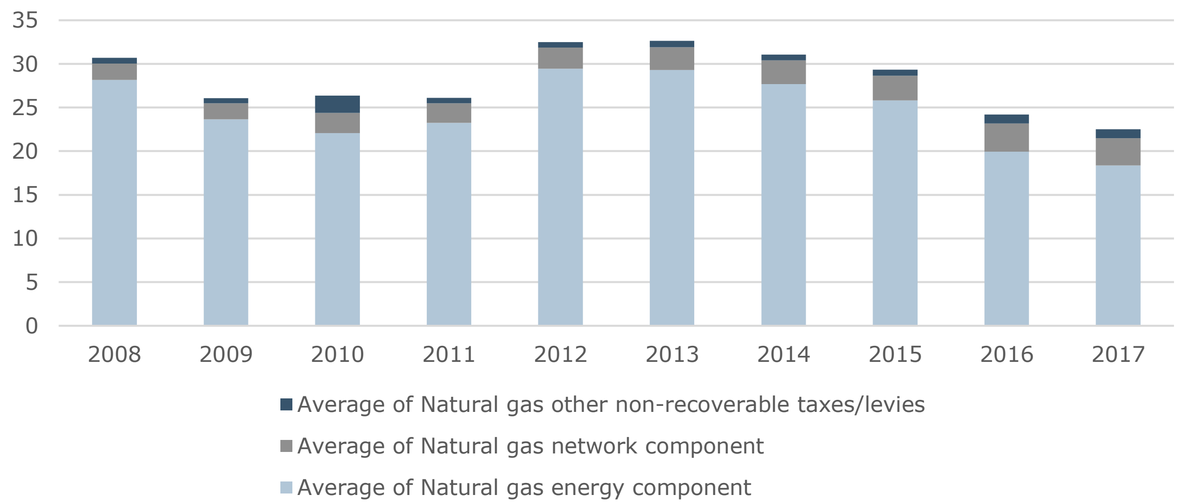
Components of the natural gas price[31]

Following the same trend seen in the overall natural gas prices, it is clear that the price fluctuations are due to changes in the energy component of the natural gas price. Over the 10-year period, network costs and non-recoverable taxes/levies have made up a small portion of the natural gas price, consistently under 20%. However, in recent years the share increased, though this is due to the decrease in the price of the energy component. The value of network costs and non-recoverable taxes/levies increased from 2012 to 2014, but has since remained stable.

[31] The sum of the natural gas bill components does not necessarily add up to the total natural gas price mentioned before, as there might be plants that did not provide a breakdown of the natural gas bill components while still providing the total natural gas price.

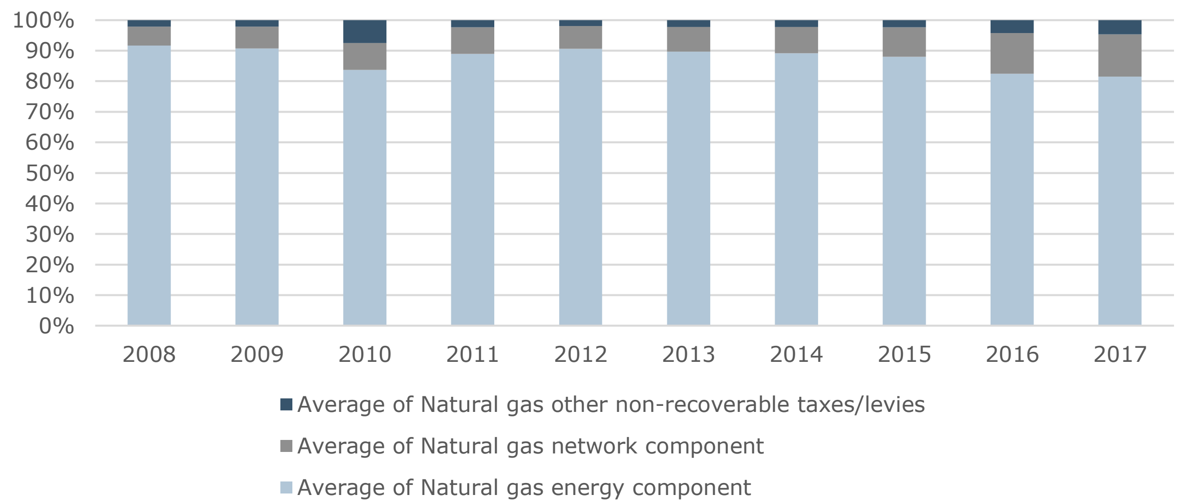
There is no significant difference between simple and weighted averages, therefore confirming the limited bargaining power of wall and floor tiles manufacturers when it comes to negotiating natural gas prices.

Figure 36 Components of the natural gas price (€/MWh, EU) – Simple averages



Note: for 2016 and 2017, there are in total 22 observations in 2016 and 2017, 13 observations in 2008, 2009, 2010, 2014 and 2015, and 14 from 2011 to 2013.
Source: Authors' elaboration

Figure 37 Components of the natural gas price (%, EU) – Simple averages



Note: for 2016 and 2017, there are in total 22 observations, 13 observations in 2008, 2009, 2010, 2014 and 2015, and 14 from 2011 to 2013.
Source: Authors' elaboration

Table 48 Components of the natural gas price: energy component (€/MWh) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	Weighted	29.0	25.3	20.9	21.6	28.6	30.6	29.0	27.9	18.0	14.2
	Simple	28.8	25.0	17.8	21.3	28.0	29.9	28.3	27.1	19.0	14.4
SE	Weighted	28.9	23.6	25.7	26.7	35.3	33.3	32.9	31.2	22.7	21.9
	Simple	28.3	23.9	22.9	25.4	32.0	30.7	29.4	27.1	20.1	20.1
EU	Weighted	**28.3**	**23.9**	**23.5**	**23.5**	**30.3**	**30.2**	**29.5**	**27.9**	**21.2**	**20.0**
	Simple	**28.2**	**23.6**	**22.1**	**23.2**	**29.5**	**29.3**	**27.7**	**25.8**	**20.0**	**18.4**

Note: *weighting factor: natural gas purchased; for 2016 and 2017, there are a total of 21 observations in 2016 and 2017, 13 observations in 2008, 2009, 2010, 2014 and 2015, and 14 from 2011 to 2013; CEE averages are omitted due to confidentiality.*
Source: Authors' elaboration

Table 49 Components of the natural gas price: network component (€/MWh) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	Weighted	1.5	1.4	1.6	1.7	1.6	1.5	1.6	1.8	4.3	3.6
	Simple	1.7	1.6	1.9	1.9	1.9	1.7	1.7	2.0	3.6	3.2
SE	Weighted	0.8	1.1	1.1	1.2	1.5	1.8	1.7	1.8	2.8	2.7
	Simple	1.5	1.9	1.8	1.8	2.0	2.4	2.7	2.7	3.2	3.2
EU	Weighted	**1.6**	**1.6**	**2.1**	**1.9**	**2.1**	**2.3**	**2.2**	**2.3**	**3.0**	**2.9**
	Simple	**1.9**	**1.9**	**2.3**	**2.2**	**2.4**	**2.6**	**2.7**	**2.8**	**3.2**	**3.1**

Note: *weighting factor: natural gas purchased; for 2016 and 2017, there are a total of 22 observations in 2016 and 2017, 13 observations in 2008 and 2009, 14 in 2010, 2014 and 2015, and 15 from 2011 to 2013; CEE averages are omitted due to confidentiality.*
Source: Authors' elaboration

Table 50 Components of the natural gas price: Other non-recoverable taxes/levies (€/MWh) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	Weighted	1.7	1.4	5.3	1.4	1.3	1.3	1.1	1.0	3.5	3.8
	Simple	2.5	2.0	8.3	2.1	2.1	2.1	1.9	1.9	4.1	4.1
SE	Weighted	0.2	0.2	0.2	0.1	0.2	0.5	0.5	0.5	0.4	0.4
	Simple	0.2	0.3	0.2	0.2	0.2	0.5	0.4	0.4	0.4	0.4
EU	Weighted	**0.4**	**0.4**	**1.2**	**0.4**	**0.4**	**0.5**	**0.5**	**0.5**	**0.7**	**0.7**
	Simple	**0.7**	**0.6**	**2.0**	**0.6**	**0.6**	**0.7**	**0.7**	**0.7**	**1.0**	**1.1**

Note: *weighting factor: natural gas purchased; for 2016 and 2017, there are a total of 22 observations in 2016 and 2017, 13 observations in 2008 and 2009, 14 in 2010, 2014 and 2015, and 15 from 2011 to 2013; CEE averages are omitted due to confidentiality.*
Source: Authors' elaboration

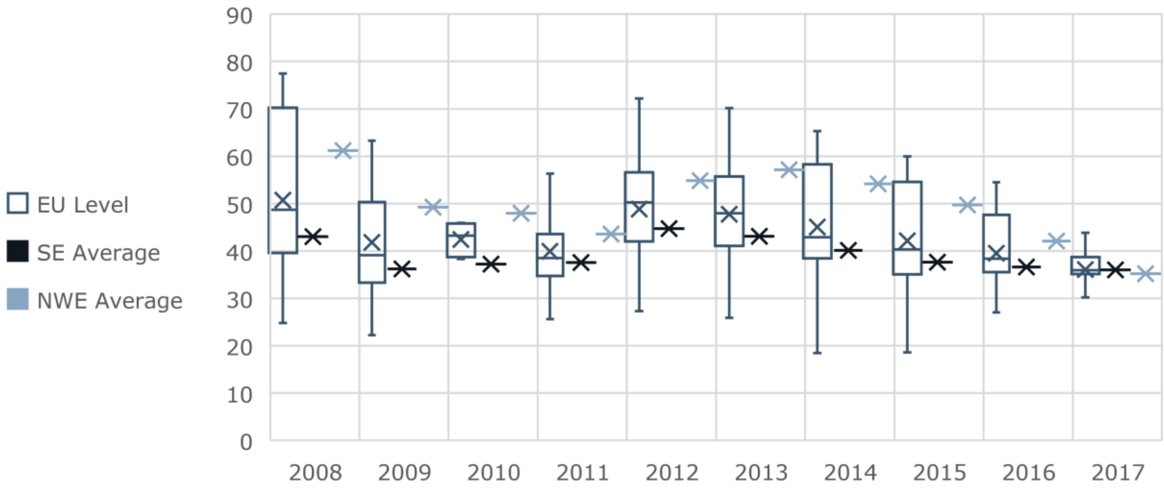
Natural gas costs

Natural gas costs in €/tonne follow the same trend as the prices. The averages at the EU level ranged over the 10-year period between €37.3/tonne and €53.9/tonne (weighted). The lowest costs were in the most recent year, 2017. Additionally, within the sample, the cost variance has decreased significantly since 2014, resulting in even costs for plants in both the

NWE and SE regions. This also indicates that the CEE region also experienced a price convergence, although the regional average is omitted to protect confidentiality. It is important to note in Figure 38, outlier indicators have been hidden to protect the confidentiality of individual plants. Thus in 2010 the regional averages are outside of the EU box plot values, meaning that some plants in these regions are outliers in the statistical sense, but when examined in the context of the region they were not in fact outliers (see Chapter 1 for further details on the way box plots are built).

Weighted averages (by production output) are slightly above simple averages, indicating that costs are marginally higher for companies producing more tonnes of wall and floor tiles. In fact, it is possible that natural gas costs are affected by plant-specific features, such as the type of output produced (the sector comprises heterogeneous products in terms of physical composition, dimension, weight, shape, surface, colour and value added). In addition, it appears that larger consumers do not benefit from lower natural gas prices (see above 'natural gas prices') and that economies of scale are fairly limited in the sector (see below 'natural gas intensity' and 'production costs').

Figure 38 Natural gas cost (€/tonne) – Box plots and simple averages



Note: 20 observations in 2016 and 2017, 11 observations in 2008 and 2009, 12 in 2010, 2014, 2015, and 13 from 2011 to 2013; CEE averages are omitted due to confidentiality.
Source: Authors' elaboration

Figure 39 Natural gas cost (€/tonne) - Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	Weighted	54.0	45.0	45.1	40.5	51.1	53.1	50.9	46.8	42.7	36.1
	Simple	61.2	49.3	48.0	43.6	54.9	57.1	54.1	49.7	42.1	35.2
SE	Weighted	58.9	47.1	47.3	44.8	53.4	53.5	52.2	49.9	38.7	37.9
	Simple	43.0	36.2	37.2	37.5	44.7	43.1	40.1	37.6	36.6	36.0
EU	Weighted	**53.9**	**44.8**	**44.5**	**41.6**	**50.3**	**50.3**	**48.2**	**45.6**	**39.7**	**37.3**
	Simple	**50.7**	**41.8**	**42.4**	**39.9**	**48.8**	**47.8**	**45.0**	**42.2**	**39.5**	**36.1**

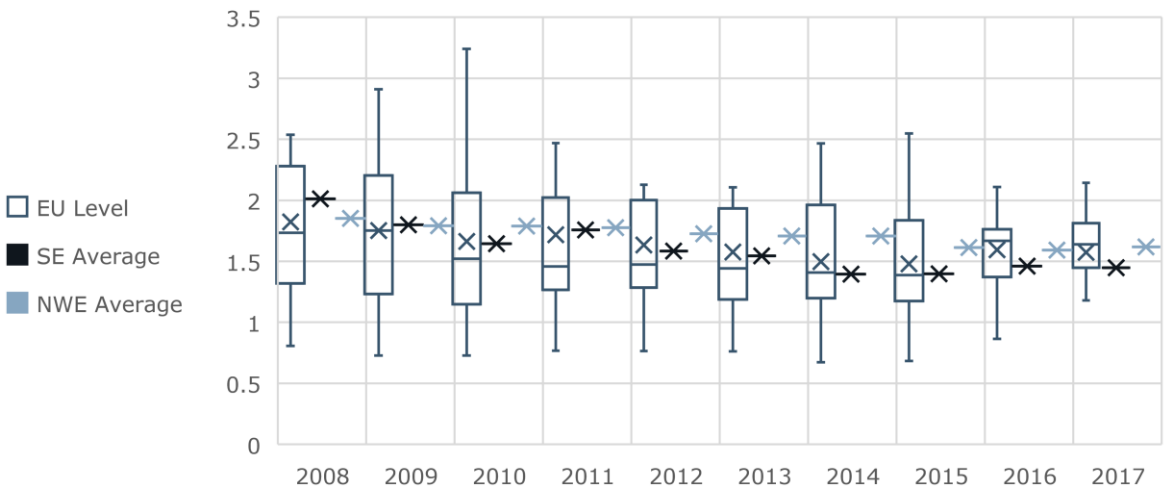
Note: weighting factor: production output; 11 observations in 2008 and 2009, 12 in 2010, 2014, 2015, and 13 from 2011 to 2013; CEE averages are omitted due to confidentiality.
Source: Authors' elaboration

Natural gas intensity

Natural gas intensity in the EU wall and floor tiles sector decreased over the last 10 years, declining from 1.8 MWh/tonne in 2008 to 1.6 MWh/tonne in 2017. This indicates that wall and floor tiles producers are making increasingly efficient use of natural gas. In fact, new machinery used in production lines is more natural-gas efficient; for instance, some steps have been taken to lower natural gas consumption of the kiln and to recover the heat generated by the kiln and reduce the energy consumption of the spry-drier (see Annex A for further details on the production process). The NWE region uses slightly less natural gas than the SE region, though the difference is marginal over the 10-year period. The SE region saw the largest efficiency increase, starting at 1.96 MWh/tonne in 2008, and needing only 1.51 MWh/tonne in 2017, when weighting for production output. The decrease in intensity is not as prevalent in the NWE region or at the EU level, but is worth noting.

The weighted average (by production output) of natural gas intensity is comparable to the simple average in all regions. This indicates limited or no economies of scale linked to natural gas usage. In this respect, it is worth emphasising that the level of differentiation in the sector is fairly high and plants of different size may produce different types of tile, which require more or less natural gas. For instance, by adapting to market trends, some large plants may have refocused their production on large tiles, which require a more energy intensive production process.

Figure 40 Natural gas intensity (MWh/tonne) – Box plots and simple averages



Note: 21 observations in 2016 and 2017, 12 observations in 2008 and 2009, 14 in 2010, 2014, 2015, and 15 from 2011 to 2013; CEE averages are omitted due to confidentiality.
Source: Authors' elaboration

Figure 41 Natural gas intensity (MWh/tonne) - Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	**Weighted**	1.68	1.60	1.62	1.64	1.62	1.59	1.61	1.52	1.65	1.67
	Simple	1.85	1.79	1.79	1.78	1.73	1.71	1.71	1.61	1.59	1.62
SE	**Weighted**	1.96	1.90	1.75	1.60	1.45	1.50	1.48	1.49	1.49	1.51
	Simple	2.01	1.80	1.64	1.76	1.58	1.55	1.39	1.40	1.46	1.45
EU	**Weighted**	**1.78**	**1.73**	**1.66**	**1.61**	**1.54**	**1.53**	**1.50**	**1.49**	**1.59**	**1.58**
	Simple	**1.82**	**1.75**	**1.66**	**1.72**	**1.63**	**1.58**	**1.50**	**1.48**	**1.59**	**1.57**

Note: weighting factor: production output; 21 observations in 2016 and 2017, 12 observations in 2008 and 2009, 14 in 2010, 2014, 2015, and 15 from 2011 to 2013; CEE averages are omitted due to confidentiality.
Source: Authors' elaboration

Additional information

Regarding the breakdown of natural gas contracts in the wall and floor tiles sector, 19 of the 22 respondent plants provided relevant information, 17 of which currently purchase from providers while two purchase on the wholesale market. All 22 plants provided information regarding the length of their gas contracts, however, with the majority (17) having contracts of up to five years, while five have a contract of indeterminate duration (with the possibility of renewing each year).

Regarding continuity of the natural gas supply, three of the respondent plants take part in a flexibility scheme. There were no outages reported. This indicates that among the sampled plants the stability of natural gas supply has been extremely good over the last three years (2015-2017). Self-generation of gas is not relevant to the bricks and tiles sector.

3.4 Competitiveness

Cost competitiveness

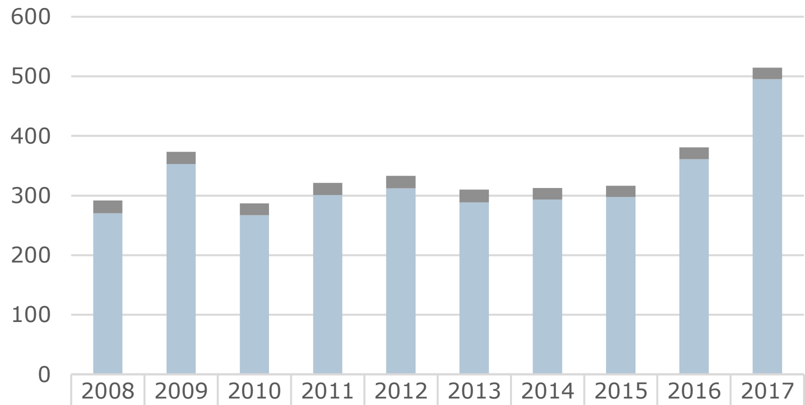
This Section examines the key performance indicators within the wall and floor tiles sector. It is important to note that the number of observations was reduced by half in 2017, due to the unavailability of financial data for many plants for 2017 during the data collection process. Plants that provided financial KPIs for 2017 skew towards higher production costs, turnover, and margins; hence, an upward trend between 2016 and 2017 is observed in all indicators.

Electricity

The share of electricity costs in total production costs declined from above 7% in 2008 to about 4% in 2017 (simple average). In fact, whereas electricity costs in €/tonne decreased throughout the period under observation, production costs in €/tonne followed a rising trend. The overall trend was a decrease in electricity costs, though this was under 1% over 10 years and is aligned with the reduction in electricity prices.

In Table 51, simple production costs are lower than weighted production costs. This may indicate a limited role for economies of scale in the production of wall and floor tiles; in this respect, it has been confirmed that small plants may have very lean and efficient production lines and that some large plants may focus their production on tiles of larger size, which are thicker, more energy intensive and therefore more costly in €/tonne. By contrast, the simple average for electricity costs was higher than the weighted average (by production output). Hence, the share of electricity costs relative to total production costs is larger in smaller plants (they have less bargaining power *vis-à-vis* electricity suppliers and experience overall lower production costs).

Figure 42 Electricity costs as a share of production costs (€/tonne) – Simple averages



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Average of Electricity cost €/tonne	21	20	20	20	21	22	20	19	20	19
Average of other Production costs €/tonne	270	353	267	301	312	289	293	297	361	495

Note: electricity costs: 21 observations in 2016 and 2017, 11 observations in 2008 and 2009, 13 in 2010, 2014, 2015, and 14 from 2011 to 2013; production costs: 14 observations in 2008, 15 observations in 2009 and 2010, 16 observations from 2011 to 2015, 17 in 2016 and 8 in 2017.
Source: Authors' elaboration

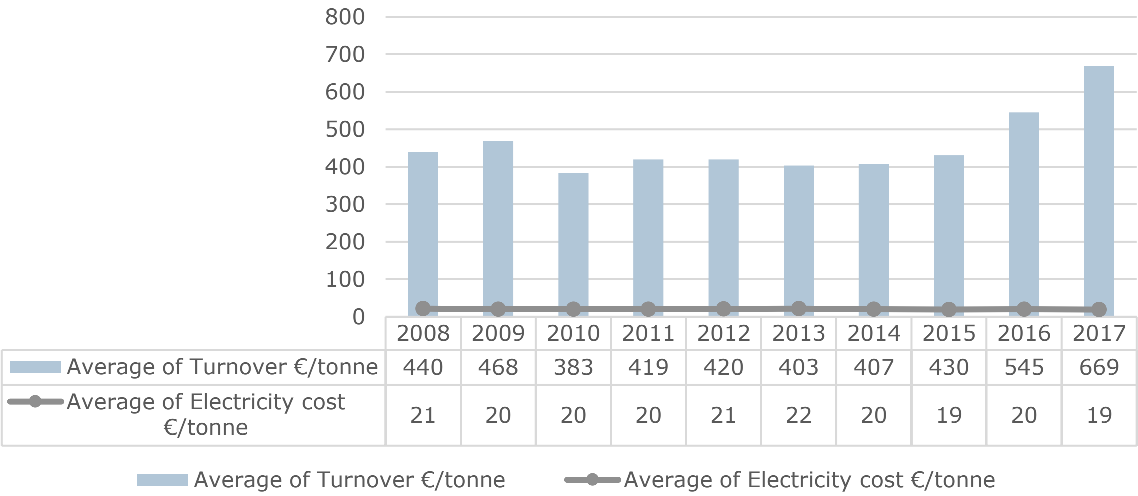
Table 51 Electricity costs as a share of production costs (EU) - Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity costs simple average (€/tonne)	21.4	20.1	19.7	20.1	21.2	21.6	19.7	19.3	19.9	19.3
Electricity costs weighted average (€/tonne)	19.4	17.7	14.1	18.1	18.8	18.7	17.2	16.7	18.6	17.7
Production costs simple average (€/tonne)	291.5	373.3	286.9	321.2	333.2	310.1	312.8	316.6	380.9	514.6
Production costs weighted average (€/tonne)	281.6	336.3	268.0	358.4	370.6	351.8	339.3	348.1	414.1	619.4
Electricity costs as a share of production costs simple averages (%)	7.3%	5.4%	6.9%	6.3%	6.4%	7.0%	6.3%	6.1%	5.2%	3.8%
Electricity costs as a share of production costs weighted averages (%)	6.9%	5.2%	5.3%	5.1%	5.1%	5.3%	5.1%	4.8%	4.5%	2.9%

Note: weighting factor: production output; electricity costs: 21 observations in 2016 and 2017, 11 observations in 2008 and 2009, 13 in 2010, 2014, 2015, and 14 from 2011 to 2013; production costs: 14 observations in 2008, 15 observations in 2009 and 2010, 16 observations from 2011 to 2015, 17 in 2016 and 8 in 2017.
Source: Authors' elaboration

The same trend registered for production costs can be seen with electricity costs €/tonne in relation to turnover €/tonne. Turnover within the wall and floor tiles sector is, to some extent, proportional to the production costs. In most of the years under observation, there is an increase in turnover when weighting on production output. This may indicate that larger plants focus on high-cost/high-value outputs.

Figure 43 Electricity costs versus turnover (€/tonne, EU) – Simple averages



Note: electricity costs: 21 observations in 2016 and 2017, 11 observations in 2008 and 2009, 13 in 2010, 2014, 2015, and 14 from 2011 to 2013; turnover: 14 observations in 2008, 15 observations in 2009 and 2010, 16 observations from 2011 to 2015, 18 in 2016 and 11 in 2017.
Source: Authors' elaboration

Table 52 Electricity costs versus turnover (EU) - Simple and weighted averages

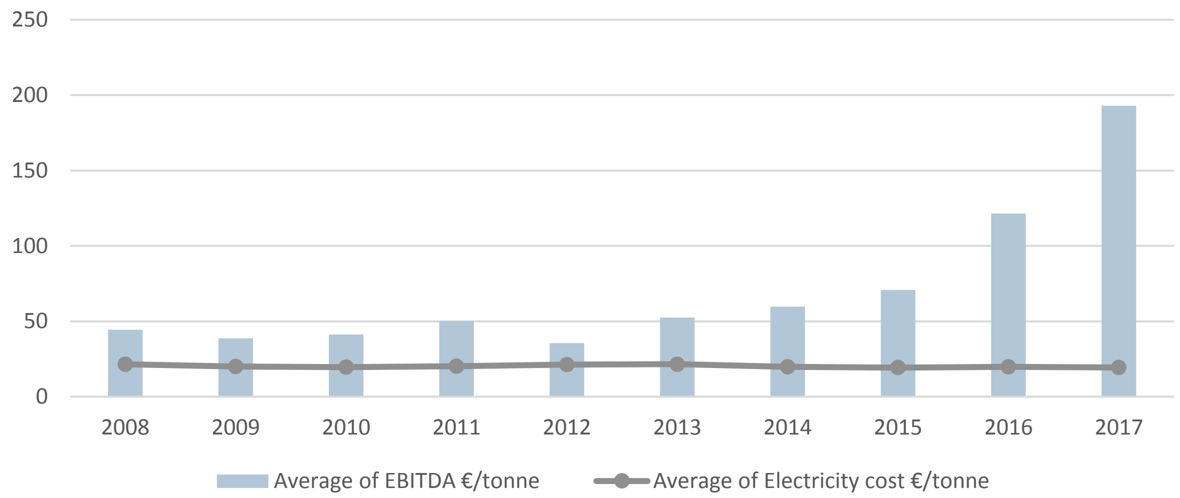
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity costs simple average (€/tonne)	21.4	20.1	19.7	20.1	21.2	21.6	19.7	19.3	19.9	19.3
Electricity costs weighted average (€/tonne)	19.4	17.7	14.1	18.1	18.8	18.7	17.2	16.7	18.6	17.7
Turnover simple average (€/tonne)	440.0	468.4	383.4	419.4	419.6	403.0	407.1	430.4	544.9	669.0
Turnover weighted average (€/tonne)	466.5	542.0	329.7	483.9	463.3	444.6	455.6	500.1	590.4	422.2
Electricity costs as a share of turnover simple averages (%)	4.9%	4.3%	5.1%	4.8%	5.1%	5.4%	4.8%	4.5%	3.6%	2.9%
Electricity costs as a share of turnover weighted averages (%)	4.2%	3.3%	4.3%	3.7%	4.1%	4.2%	3.8%	3.3%	3.2%	4.2%

Note: weighting factor: production output; electricity costs: There are total of 21 observations in 2016 and 2017, 11 observations in 2008 and 2009, 13 in 2010, 2014, 2015, and 14 from 2011 to 2013; turnover: 14 observations in 2008, 15 observations in 2009 and

2010, 16 observations from 2011 to 2015, 17 in 2016 and 8 in 2017.
Source: Authors' elaboration

Both EBITDA and EBIT appear to be fairly stable between 2008 and 2013 and recorded an increasing trend afterwards (Figure 44 and Figure 45). The sharp increase in 2016 and 2017 is partially affected by the different composition of the sample. Weighting on production output causes an increase in margins, thus revealing that in spite of higher production costs, larger plants manage to be more profitable than smaller ones. Overall, no conclusion can be drawn when it comes to the impact of electricity costs on margins.

Figure 44 Electricity costs versus EBITDA (€/tonne, EU) – Simple averages



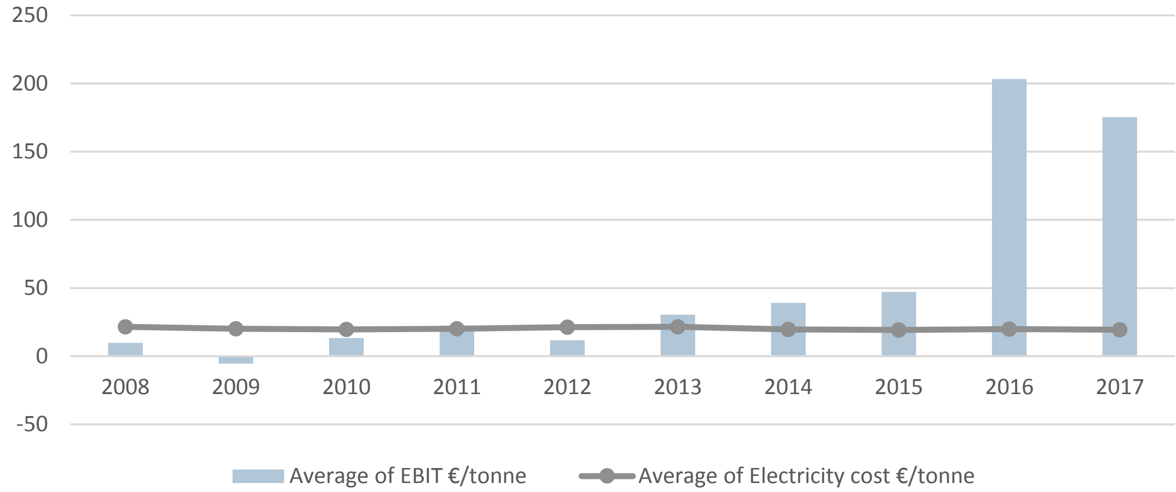
Note: electricity costs: 21 observations in 2016 and 2017, 11 observations in 2008 and 2009, 13 in 2010, 2014, 2015, and 14 from 2011 to 2013; EBITDA: 14 observations in 2008, 15 observations in 2009 and 2010, 16 observations from 2011 to 2015, 18 in 2016 and 10 in 2017.
Source: Authors' elaboration

Table 53 Electricity costs versus EBITDA (EU) - Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity costs simple average (€/tonne)	21.4	20.1	19.7	20.1	21.2	21.6	19.7	19.3	19.9	19.3
Electricity costs weighted average (€/tonne)	19.4	17.7	14.1	18.1	18.8	18.7	17.2	16.7	18.6	17.7
EBITDA simple average (€/tonne)	44.5	38.7	41.2	50.1	35.5	52.6	59.7	70.8	121.4	192.9
EBITDA weighted average (€/tonne)	44.8	95.2	38.3	79.1	46.5	63.2	66.2	73.8	130.0	107.0

Note: weighting factor: production output; electricity costs: 21 observations in 2016 and 2017, 11 observations in 2008 and 2009, 13 in 2010, 2014, 2015, and 14 from 2011 to 2013; EBITDA: 14 observations in 2008, 15 observations in 2009 and 2010, 16 observations from 2011 to 2015, 18 in 2016 and 10 in 2017.
Source: Authors' elaboration

Figure 45 Electricity costs versus EBIT (€/tonne, EU) – Simple averages



Note: electricity costs: 21 observations in 2016 and 2017, 11 observations in 2008 and 2009, 13 in 2010, 2014, 2015, and 14 from 2011 to 2013; EBIT: 14 observations in 2008, 15 observations in 2009 and 2010, 16 observations from 2011 to 2015, 18 in 2016 and 10 in 2017.
Source: Authors' elaboration

Table 54 Electricity costs versus EBIT (EU) - Simple and weighted averages

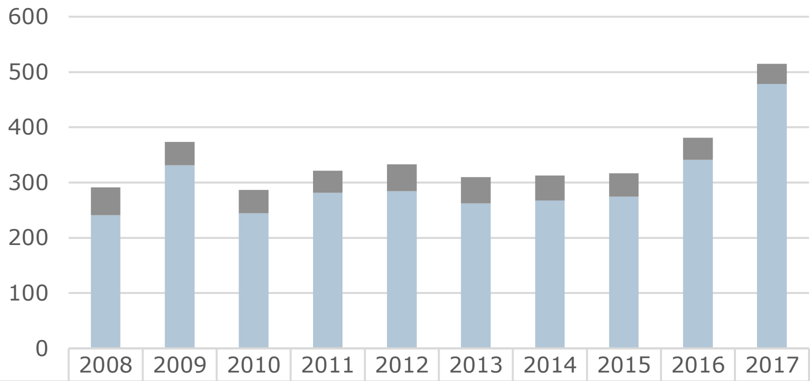
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity costs simple average (€/tonne)	21.4	20.1	19.7	20.1	21.2	21.6	19.7	19.3	19.9	19.3
Electricity costs weighted average (€/tonne)	19.4	17.7	14.1	18.1	18.8	18.7	17.2	16.7	18.6	17.7
EBIT simple average (€/tonne)	9.8	-5.5	13.3	22.4	11.6	30.3	39.1	47.1	203.3	175.3
EBIT weighted average (€/tonne)	11.4	49.2	16.3	47.9	17.4	36.9	39.9	49.2	206.5	77.9

Note: weighting factor: production output; electricity costs: 21 observations in 2016 and 2017, 11 observations in 2008 and 2009, 13 in 2010, 2014, 2015, and 14 from 2011 to 2013; EBIT: 14 observations in 2008, 15 observations in 2009 and 2010, 16 observations from 2011 to 2015, 18 in 2016 and 10 in 2017.
Source: Authors' elaboration

Natural gas

Natural gas costs make up a larger share of the production costs than electricity throughout the 10-year observation period. However, this share recorded a decreasing trend, especially in the most recent years. This reflects the trends in natural gas prices and costs presented above. Differences between simple and weighted averages appear to be quite small and this may be explained by the limited role played by economies of scale as well as by bargaining power of larger consumers when negotiating natural gas prices.

Figure 46 Natural gas cost as a share of total production costs (€/tonne, EU) – Simple averages



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Average of Natural gas cost €/tonne	51	42	42	40	49	48	45	42	39	36
Average of other Production costs €/tonne	241	331	244	281	284	262	268	274	341	479

Note: natural gas costs: 20 observations in 2016 and 2017, 11 observations in 2008 and 2009, 12 in 2010, 2014, 2015, and 13 from 2011 to 2013; production costs: 14 observations in 2008, 15 observations in 2009 and 2010, 16 observations from 2011 to 2015, 17 in 2016 and 8 in 2017.
Source: Authors' elaboration

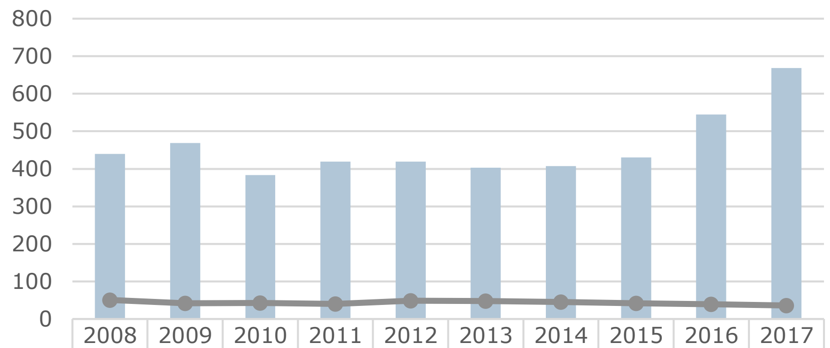
Table 55 Natural gas costs as a share of production costs (EU) - Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas costs simple average (€/tonne)	50.7	41.8	42.4	39.9	48.8	47.8	45.0	42.2	39.5	36.1
Natural gas costs weighted average (€/tonne)	53.9	44.8	44.5	41.6	50.3	50.3	48.2	45.6	39.7	37.3
Production costs simple average (€/tonne)	291.5	373.3	286.9	321.2	333.2	310.1	312.8	316.6	380.9	514.6
Production costs weighted average (€/tonne)	281.6	336.3	268.0	358.4	370.6	351.8	339.3	348.1	414.1	619.4
Natural gas costs as a share of production costs simple averages (%)	17.4%	11.2%	14.8%	12.4%	14.7%	15.4%	14.4%	13.3%	10.4%	7.0%
Natural gas costs as a share of production costs weighted averages (%)	19.1%	13.3%	16.6%	11.6%	13.6%	14.3%	14.2%	13.1%	9.6%	6.0%

Note: weighting factor: production output; natural gas costs: 20 observations in 2016 and 2017, 11 observations in 2008 and 2009, 12 in 2010, 2014, 2015, and 13 from 2011 to 2013; production costs: 14 observations in 2008, 15 observations in 2009 and 2010, 16 observations from 2011 to 2015, 17 in 2016 and 8 in 2017.
Source: Authors' elaboration

When compared to turnover, the same trend is visible for natural gas costs as for electricity. As weighting for production output increases the turnover value, the share of turnover from natural gas costs in most years decreases when compared to the simple averages, thus again showing the same trend for natural gas as for electricity.

Figure 47 Natural gas costs versus turnover (€/tonne) – Simple averages



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Average of Turnover €/tonne	440	468	383	419	420	403	407	430	545	669
Average of Natural gas cost €/tonne	51	42	42	40	49	48	45	42	39	36

Note: natural gas costs: 20 observations in 2016 and 2017, 11 observations in 2008 and 2009, 12 in 2010, 2014, 2015, and 13 from 2011 to 2013; turnover: 14 observations in 2008, 15 observations in 2009 and 2010, 16 observations from 2011 to 2015, 17 in 2016 and 8 in 2017.
Source: Authors' elaboration

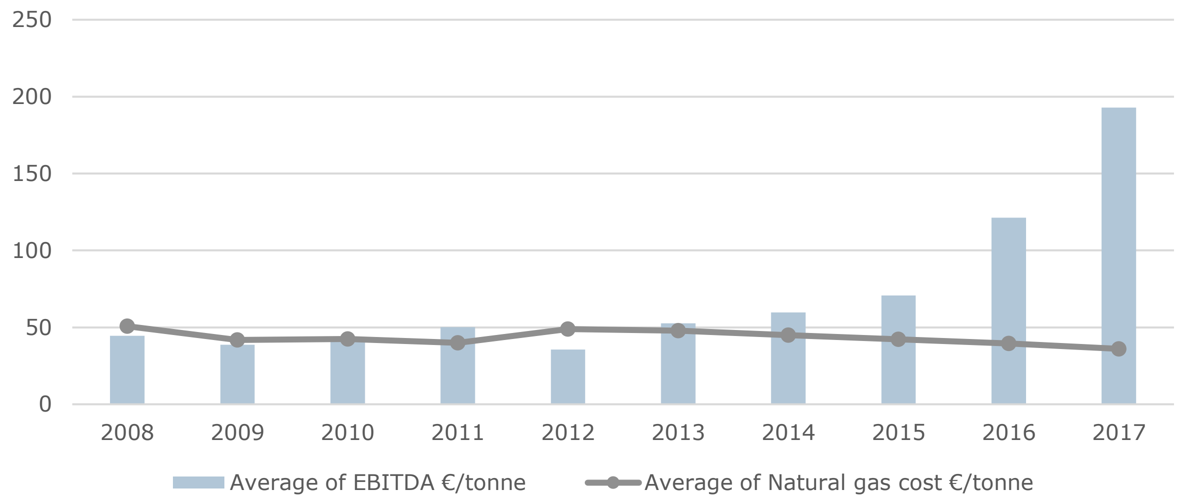
Table 56 Natural gas costs as a share of turnover (EU) - Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas costs simple average (€/tonne)	50.7	41.8	42.4	39.9	48.8	47.8	45.0	42.2	39.5	36.1
Natural gas costs weighted average (€/tonne)	53.9	44.8	44.5	41.6	50.3	50.3	48.2	45.6	39.7	37.3
Turnover simple average (€/tonne)	440.0	468.4	383.4	419.4	419.6	403.0	407.1	430.4	544.9	669.0
Turnover weighted average (€/tonne)	466.5	542.0	329.7	483.9	463.3	444.6	455.6	500.1	590.4	422.2
Natural gas costs as a share of turnover simple averages (%)	11.5%	8.9%	11.1%	9.5%	11.6%	11.9%	11.1%	9.8%	7.2%	5.4%
Natural gas costs as a share of turnover weighted averages (%)	11.5%	8.3%	13.5%	8.6%	10.9%	11.3%	10.6%	9.1%	6.7%	8.8%

Note: weighting factor: production output; 20 observations in 2016 and 2017, 11 observations in 2008 and 2009, 12 in 2010, 2014, 2015, and 13 from 2011 to 2013; turnover: 14 observations in 2008, 15 observations in 2009 and 2010, 16 observations from 2011 to 2015, 17 in 2016 and 8 in 2017.
Source: Authors' elaboration

It is not possible to draw strong conclusions with regard to the impact of natural gas costs on EBITDA and EBIT. However, as of 2012, a decrease in natural gas costs seems to be accompanied by an increase in profitability of wall and floor tiles producers.

Figure 48 Natural gas costs versus EBITDA (€/tonne, EU) – Simple averages



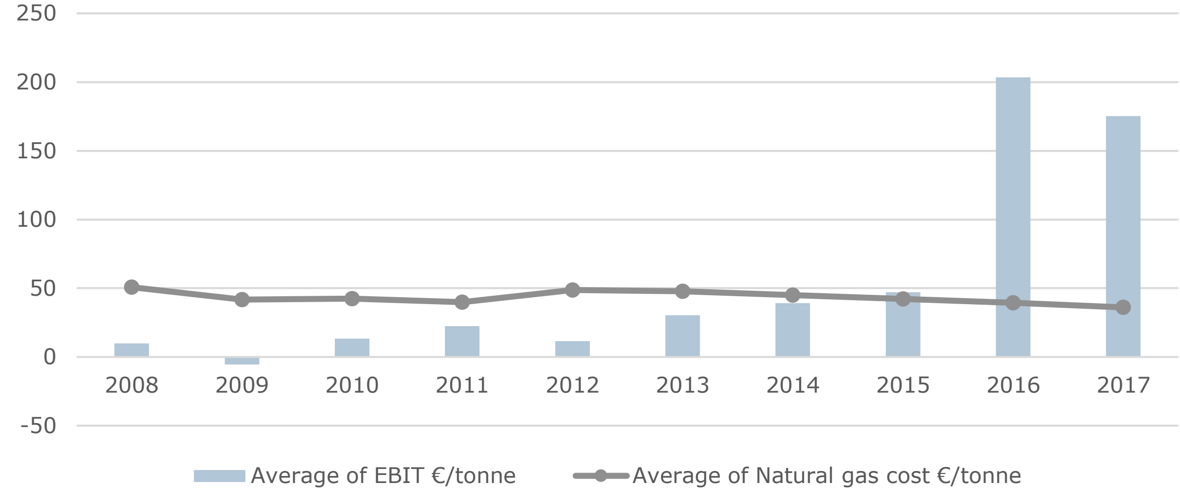
Note: natural gas costs: 20 observations in 2016 and 2017, 11 observations in 2008 and 2009, 12 in 2010, 2014, 2015, and 13 from 2011 to 2013; EBITDA: 14 observations in 2008, 15 observations in 2009 and 2010, 16 observations from 2011 to 2015, 18 in 2016 and 10 in 2017.
Source: Authors' elaboration

Table 57 Natural gas costs versus EBITDA (EU) - Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas costs simple average (€/tonne)	50.7	41.8	42.4	39.9	48.8	47.8	45.0	42.2	39.5	36.1
Natural gas costs weighted average (€/tonne)	53.9	44.8	44.5	41.6	50.3	50.3	48.2	45.6	39.7	37.3
EBITDA simple average (€/tonne)	44.5	38.7	41.2	50.1	35.5	52.6	59.7	70.8	121.4	192.9
EBITDA weighted average (€/tonne)	44.8	95.2	38.3	79.1	46.5	63.2	66.2	73.8	130.0	107.0

Note: weighting factor: production output; natural gas costs: 20 observations in 2016 and 2017, 11 observations in 2008 and 2009, 12 in 2010, 2014, 2015, and 13 from 2011 to 2013; EBITDA: 14 observations in 2008, 15 observations in 2009 and 2010, 16 observations from 2011 to 2015, 18 in 2016 and 10 in 2017.
Source: Authors' elaboration

Figure 49 Natural gas costs versus EBIT (€/tonne, EU) – Simple averages



Note: *natural gas costs: 20 observations in 2016 and 2017, 11 observations in 2008 and 2009, 12 in 2010, 2014, 2015, and 13 from 2011 to 2013; EBIT: 14 observations in 2008, 15 observations in 2009 and 2010, 16 observations from 2011 to 2015, 18 in 2016 and 10 in 2017.*
Source: Authors' elaboration

Table 58 Natural gas costs versus EBIT (EU) - Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas costs simple average (€/tonne)	50.7	41.8	42.4	39.9	48.8	47.8	45.0	42.2	39.5	36.1
Natural gas costs weighted average (€/tonne)	53.9	44.8	44.5	41.6	50.3	50.3	48.2	45.6	39.7	37.3
EBITDA simple average (€/tonne)	9.8	-5.5	13.3	22.4	11.6	30.3	39.1	47.1	203.3	175.3
EBITDA weighted average (€/tonne)	11.4	49.2	16.3	47.9	17.4	36.9	39.9	49.2	206.5	77.9

Note: weighting factor: production output; natural gas costs: 20 observations in 2016 and 2017, 11 observations in 2008 and 2009, 12 in 2010, 2014, 2015, and 13 from 2011 to 2013; EBIT: 14 observations in 2008, 15 observations in 2009 and 2010, 16 observations from 2011 to 2015, 18 in 2016 and 10 in 2017.
Source: Authors' elaboration

International competitiveness

Given the very limited number of observations collected from ceramics plants based in third countries, confidentiality concerns require presenting the international comparison at NACE three-digit level, thus encompassing the entire 'manufacture of clay building materials' sector (NACE Rev. 2 code C23.3, including both producers of wall and floor tiles and brick and roof tiles). Therefore, the overall international comparison is included in the bricks and roof tiles chapter.

4 Glass tableware

Box 5 Highlights – Glass tableware

In the EU glass tableware sector, while electricity costs represented on average 7% of total production costs (simple average) between 2008 and 2017, natural gas represented on average 8% of total production costs (simple average).

Electricity

- Electricity prices and costs in €/MWh faced by EU glass tableware producers increased between 2008 and 2017, mainly due to a rise (in absolute value) in network costs and RES levies.
- **Electricity prices** (simple average) rose from €72/MWh in 2008 to €91/MWh in 2017, with a peak in 2013 (€100/MWh). The weighted average (by purchased electricity) for this indicator was below the simple average. In fact, when looking at the components of the electricity price, it is apparent that larger consumers: i) benefitted from stronger bargaining power when negotiating electricity prices (lower energy component); and ii) paid 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. Only one plant bought electricity directly on the wholesale market; another plant had a mixed strategy (one-third of the electricity purchased on the wholesale market and two-thirds from a supplier).
- **Electricity costs in €/MWh** (simple average) increased from €69/MWh in 2008 to €85/MWh in 2017, with a peak in 2013 (€99/MWh). The difference between electricity prices and costs in €/MWh can be explained by the following factors: i) two plants participated in flexibility schemes (however, the compensation they received 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). Interestingly, no plant was self-generating electricity throughout the period under observation. The weighted average (by electricity consumption) for this indicator was lower than the simple average, confirming better conditions for larger consumers, especially in the most recent years. When looking at differences between weighted and simple averages for electricity prices and electricity costs in €/MWh, it is apparent that flexibility schemes and *ex post* reimbursement had a similar impact on both large and small consumers.
- **Electricity costs in €/tonne** (simple average) halved throughout the period under investigation, going from €205/tonne in 2008 to €108/tonne in 2017; this is mainly due to a reduction of the electricity intensity of the production process, especially in smaller plants. In fact, the **electricity intensity** of the production process (simple average) fell from 2.1 MWh/tonne in 2008 to 1.3 MWh/tonne in 2017. The weighted averages (by production output) for both electricity costs in €/tonne and electricity intensity were substantially below simple averages; this may indicate that: i) besides facing lower electricity prices, larger producers benefitted from economies of scale; and ii) electric heated/boosted furnaces were mostly used by relatively smaller plants.

Natural gas

- 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 and 2013, the **natural gas price** (simple average) decreased sharply, falling from over €32/MWh (in 2012 and 2013) to about €22/MWh (in 2017). The EU weighted average (by purchased gas) was generally below the simple average: larger plants were able to strike better deals with gas suppliers (lower energy component) and paid lower network costs as well as

other taxes and levies. However, it appears that quantity discounts and exemptions on regulatory components were less relevant when it comes to natural gas prices than electricity prices. There was no difference in this sector between natural gas prices and costs in €/MWh for two reasons: i) self-generation of natural gas is not relevant; ii) no plant was taking part in an interruptibility scheme for natural gas. Only one plant bought natural gas on the wholesale market.

- **Natural gas costs** (simple average) ranged between €144 and €170/tonne between 2008 and 2015. They decreased in recent years, falling to around €130/tonne in 2016 and 2017. The EU weighted average (by production output) for this indicator was below the simple average, indicating that larger plants incurred lower costs than smaller ones; this may be due to: i) quantity discount on the energy component for larger consumers of natural gas; ii) lower network costs and non-recoverable taxes/levies; and iii) economies of scale.
- The **natural gas intensity** (simple average) ranged between 5 and 6 MWh/tonne in the 10 years under observation. It recorded a growing trend from 2013, thus partially compensating for the decrease in electricity intensity. However, the overall energy intensity of the production process decreased between 2008 and 2017, from about 8 MWh/tonne to about 7 MWh/tonne. Larger plants recorded a lower gas intensity, thus confirming that the production process is characterised by economies of scale.

Competitiveness

- The **share of electricity costs** in **total production costs** (simple average) declined between 2008 and 2017, from 9% to about 6%. This is because electricity costs in €/tonne saw a stronger reduction than production costs throughout the period of observation. This is no surprise if one considers the overall reduction of the electricity intensity of the production process. Larger plants faced both lower electricity costs and lower production costs in €/tonne and, on average, electricity costs represented a smaller share of production costs in such plants. This is most likely due to: i) economies of scale; ii) better bargaining power of larger consumers; iii) exemptions on regulatory components of the electricity price; and iv) focus by larger plants on glass tableware products characterised by relatively lower electricity intensity.
- Between 2008 and 2017, the share of **natural gas costs** in **total production costs** (simple average) fluctuated across the period under observation between 6% (in 2010) and 9% (in 2014) and was at around 8% in the most recent years. The weighted averages (by production output) for these indicators reveal that larger plants incurred both lower natural gas costs and lower production costs in €/tonne. Nonetheless, natural gas costs represented on average a larger share of production costs in larger plants, except for years when the natural gas price in €/MWh is exceptionally low; this is in line with the evidence above showing that quantity discounts were less relevant when it comes to negotiating gas prices than electricity prices.
- The share of electricity costs relative to **turnover** fell from about 9% in 2008 to 5% in 2017 (simple average). Natural gas costs ranged between 5% (2017) and 8% (2014) of the average sectoral turnover (simple average). Turnover values followed the same trends as production costs.
- With regard to profitability, it is not possible to draw conclusions on the impact of electricity costs on margins (more details on this point are provided in Annex B to this Study). Electricity and natural gas costs are generally lower than **EBITDA**, except for those years where the sector performed badly (2008, 2009, 2015 and 2016); by contrast, they are higher than **EBIT**, as this indicator was negative in most of the years under observation. No conclusion can be drawn when comparing simple and weighted averages (by production output) for

margins; in fact, profitability most likely depends on plant-specific factors other than the quantity of output.

Sample and limitations

- The **sample** includes 12 plants belonging to large companies and representing about **90% of the total production sold** by EU glass tableware producers (in value). Therefore, the sample fully reflects the population of EU producers of glass tableware, especially if one considers that the sector is almost entirely composed of large companies.
- 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.
  For some indicators, the number of available observations varies between years; the trends may therefore be affected by **changes in the sample size**. More details about the number of observations are provided beneath each figure and table.
  Averages for the CEE region cannot be shown for confidentiality reasons. However, data provided by CEE plants are included in the EU averages.

4.1 Composition of the sample

Sampling strategy

To segment the EU population of hollow glass producers (NACE 23.13) into homogenous groups, the following sampling criteria need to be considered:

- Production technology/product range (sectors)
- Geographical distribution.

Whereas technologies adopted in the hollow glass sector are fairly homogenous irrespective of the final shape of the products (e.g. bottles, jars, drinking glasses), the Cumulative Cost Assessment of the EU Glass Industry identified important elements of heterogeneity (in terms of production costs, margins and energy intensity) between packaging glass (e.g. bottles and jars, flacons) and glass tableware (e.g. drinking glasses). Therefore, the present Assignment reflects this heterogeneity and relies on two different samples for the two sectors.

The samples for glass tableware are divided into three geographical regions, to take into account differences in energy prices and costs stemming from the plant location. Companies and plants producing glass tableware in the EU, however, are limited in number[32] (especially when compared with facilities producing packaging glass) and this makes it relatively more difficult to collect data from enough plants in each region to meet the confidentiality requirements for this Assignment.

In addition, it is worth remarking that within the glass tableware sector additional elements of heterogeneity exist. In fact, lead crystal glassware is a special segment of the glass tableware subsector, with specificities that do not allow for averaging data collected from producers of crystal glass with those from other producers of glass tableware. The very limited

[32] Based on data provided by the European Domestic Glass association, 35 glass tableware plants are based in the EU. Nonetheless, this population includes plants producing either lead crystal or jewellery as well as very small plants producing niche products: such installations cannot be considered as 'typical'. In addition, due to financial problems, some other plants have ceased their operations. This leads to about 20 plants that can be potentially included in the sample.

number of plants producing lead crystal glassware in the EU does not allow for collecting and presenting figures for this segment.

The glass tableware sector is almost entirely composed of large companies. This was confirmed by the relevant EU industry associations (FEVE and EDG) and is coherent with Eurostat SBS data. When it comes to the value chain configuration, in the glass tableware value chain, downstream activities appear to play a minor role and, with few exceptions (e.g. some decorating and/or labelling activities), are performed within the same plant producing glass tableware. Any impact of plant size on energy prices and costs is assessed when comparing weighted and simple averages.

Against this background and in light of the methodology discussed in Chapter 1, Table 59 shows the minimum number of plants to be surveyed in the glass tableware subsector.

Table 59 Minimum number of plants to be surveyed

Geographical regions	Glass tableware
Southern Europe	5
Central-Eastern Europe	5
North-Western Europe	5
Total	**15**

Source: Authors' elaboration

Box 6 Key features of the glass tableware sector

- Key statistics pertaining to the glass tableware sector (part of NACE 23.13) are presented below:
  - Production value (2015): €1,100 million
  - Number of plants (2015, EDG data): about 35
  - Top five European glass tableware producers (2016, production value): Italy (32%), France (17%), Poland (16%), Czech Republic (12%) and Spain (10%)
  - Intra-EU vs extra-EU trade (2017): intra-EU trade accounts for about 60% of the total trade value. With regard to international trade, the EU is a net exporter of glass tableware
  - The main importers of European glass tableware (2017) are the United States, Russia, China, Switzerland and Japan
  - The main exporters to the EU of glass tableware (2017) are China, Turkey, India, Serbia and the United States
- The sector is mostly composed of large companies owning one or more production sites in the EU. Some EU companies operate globally. The production process of the hollow glass sector (comprising both glass tableware and packaging glass) entails the following activities:
  - Preparation of the raw materials (batching and mixing)
  - Melting and refining
  - Forming (blow-and-blow and press-and-blow process)
  - Annealing and (online) coating
  - Inspection
- Most of the plants included in this Study tend to fall in the following ranges (first quartile – third quartile range) for the indicators presented. The variance of such indicators is quite high as glass tableware production is both horizontally and vertically differentiated; it includes a large variety of products (e.g. drinking glasses, pitchers, jugs, bowls, dishes, etc.) as well as different qualities of products (e.g.

champagne flute versus standard water glassware). In addition, the sector includes both small plants focusing on high value added products and large plants focusing on mass production.

- Electricity consumption: from 17,000 MWh to 51,500 MWh per year
- Electricity intensity: 0.6 MWh/tonne and 3.9 MWh/tonne
- Natural gas consumption: from 45,000 MWh to 240,000 MWh per year
- Natural gas intensity: 3.4 MWh/tonne and 7.6 MWh/tonne

For additional details pertaining to the production process and sector information, please refer to Annex A.

Sample statistics

In order to perform the Assignment, the Research Team shared the questionnaire with 21 plants producing glass tableware in the EU (Table 60). The questionnaire was eventually completed by 12 plants. Two plants also provided supporting evidence, namely electricity and gas bills. Due to confidentiality reasons, data for the CEE region cannot be presented in this report; however, they are taken into account when presenting EU-level indicators. For the other two regions, data confidentiality issues will be assessed on a case-by-case basis, by taking into account the number of observations available for each indicator in each year.

Table 60 Plants participating in the survey

Geographical regions	Glass tableware		
	Plants contacted	Questionnaires collected	Number of plants sharing supporting evidence
Southern Europe	9	6	1
Central-Eastern Europe	5	2	1
North-Western Europe	7	4	0
Total	**21**	**12**	**2**

Source: Authors' elaboration

Whereas below the initial target, the sample represents more than 90% of the total production sold by EU glass tableware producers in the period under investigation (Table 61). It is worth mentioning that, in order to increase the response rate, the Research Team sent several rounds of reminders via email to all contacted companies. In addition, the Research Team worked in close cooperation with EDG and FEVE (the relevant sectoral associations) to build trust across stakeholders.

Table 61 Turnover of sampled plants out of total value of production sold by EU producers (%)

Glass tableware	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Turnover %	55	63	65	86	82	82	88	99	92	n.a.
Number of plants disclosing their turnover	8	8	8	11	11	11	11	11	11	10

Note: PRODCOM value for 2017 is not available.
Source: Authors' elaboration on data collected at the plant level and PRODCOM.

International comparison

It is not possible to perform the international comparison in the glass tableware sector for two main reasons. First, the number of EU companies is quite limited and only a very limited number of them manage facilities that are based in third countries; more specifically, in the context of this Assignment, only two producers were willing to share international data with the Research Team and this would not allow such data to be shown due to confidentiality reasons. Second, no reliable private database is available to purchase relevant data.

4.2 Electricity

Table 62 provides an overview of the main indicators concerning electricity prices and costs that are discussed in this Section of the Chapter. Electricity prices and costs (in €/MWh) saw an increasing trend between 2008 and 2017; this is mainly due to an increase in the regulated components of the electricity bill. The small difference between the two indicators is explained by *ex post* reimbursement of a small share of some electricity price components granted to some producers. Electricity costs in €/tonne decreased across the period under investigation and this is partially due to a reduction of the electricity intensity of the production process. In a nutshell, it seems that across the period under investigation EU glass tableware producers decided to rely relatively more on gas than electricity for their production activities.

Table 62 Electricity: summary table (EU) – Simple averages

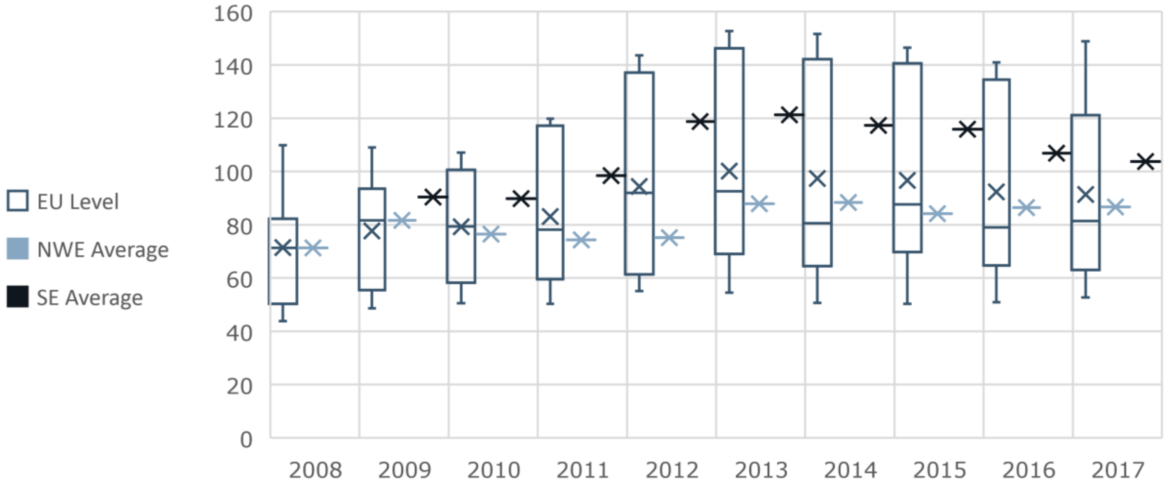
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity prices (€/MWh)	71.5	77.7	79.3	83.1	94.4	100.1	97.4	96.6	92.4	91.3
Electricity costs (€/MWh)	69.2	76.2	77.7	81.8	93.2	98.9	92.6	90.1	85.8	85.1
Electricity costs (€/tonne)	204.8	203.2	140.8	140.9	161.4	152.3	119.4	120.4	108.5	107.7
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: Authors' elaboration

Electricity prices

Figure 50 shows electricity prices paid by producers of glass tableware in the EU. An increasing trend is registered across the period under observation; prices started decreasing, however, after recording a peak in 2013. Electricity prices appear to be higher in the SE region than in the NWE region. Except for 2008 where data for some of the largest plants are missing, weighted averages are well below simple averages, and this indicates that larger buyers of electricity are able to strike better deals with energy suppliers. In fact, when looking at the components of the electricity price (see below), it is apparent that larger consumers: i) benefitted from stronger bargaining power when negotiating electricity prices (lower energy component); and ii) paid 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. The difference is less pronounced in the SE region, where the plants appear to be more homogenous in size than in the NWE region.

Figure 50 Electricity prices (€/MWh) – Box plots and simple averages



Note: data for the SE region in 2008 and for the CEE region in all years cannot be shown due to confidentiality reasons: 7 observations in 2008, 9 observations in 2009, 12 observations in other years.
Source: Authors' elaboration

Table 63 Electricity prices (€/MWh) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	**Weighted**	71.5	64.8	59.2	57.8	59.7	62.4	59.8	56.5	57.0	57.9
	Simple	71.4	81.6	76.5	74.3	75.2	87.9	88.4	84.2	86.5	86.7
SE	**Weighted**	Conf.	95.6	88.5	96.1	119.7	121.6	114.9	114.3	104.1	102.1
	Simple	Conf.	90.4	89.8	98.4	118.8	121.2	117.3	115.9	106.8	103.7
CEE	**Weighted**	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
	Simple	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
EU	**Weighted**	**80.5**	**70.6**	**69.4**	**70.5**	**79.7**	**82.0**	**77.7**	**74.7**	**72.2**	**71.8**
	Simple	**71.5**	**77.7**	**79.3**	**83.1**	**94.4**	**100.1**	**97.4**	**96.6**	**92.4**	**91.3**

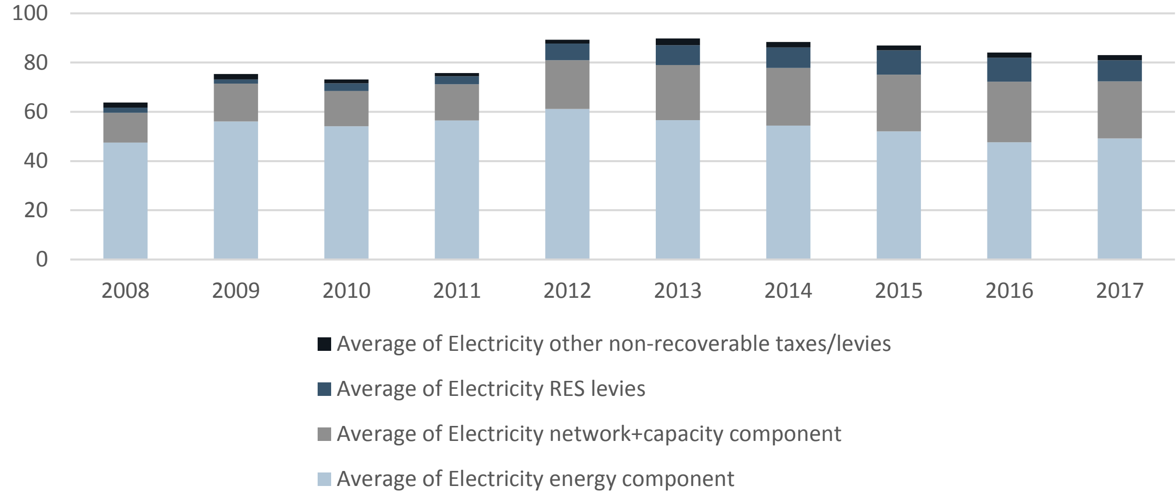
Note: weighting factor: electricity purchased; 7 observations in 2008, 9 observations in 2009, 12 observations in other years.
Source: Authors' elaboration

Components of the electricity price[33]

Whereas the energy component of the price has been decreasing since 2012, regulatory components (especially network costs and RES levies) recorded an increasing trend (Figure 51 and Figure 52). Network costs here also include the capacity market component, which was explicitly reported only by three plants.

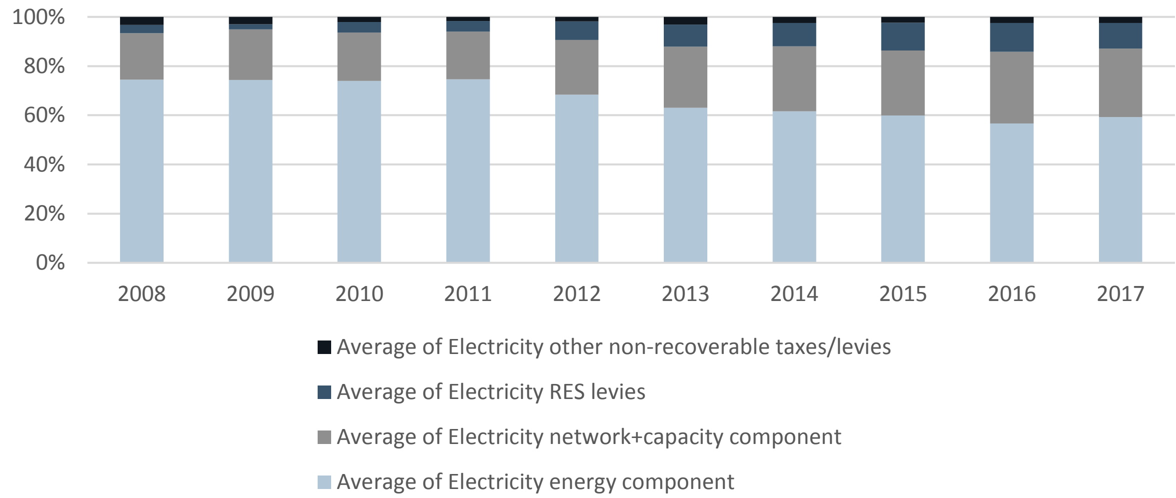
[33] The sum of the electricity bill components does not necessarily add up to the total electricity price mentioned before, as there might be plants that did not provide a breakdown of the electricity bill components while still providing the total electricity price.

Figure 51 Components of the electricity price (€/MWh, EU) – Simple averages



Note: 5 observations in 2008, 8 observations in 2009 and 2012, 9 observations in other years.
Source: Authors' elaboration

Figure 52 Components of the electricity price (%, EU) – Simple averages



Note: 5 observations in 2008, 8 observations in 2009 and 2012, 9 observations in other years.
Source: Authors' elaboration

In line with the analysis presented above, weighted averages for components of the electricity price are generally lower than simple averages, thus confirming better conditions for larger buyers. However, this is not the case in the SE region. This is most likely because plants belonging to the same consumption band (such as those based in the SE region) face fairly rigid costs for regulated components; in other words, while the amount of electricity consumed can help negotiate better prices for the energy component, it has a more limited impact on regulated components within a given consumption band. Interestingly, when it comes to both network costs and RES levies, costs borne by NWE producers are substantially lower than costs experienced in the SE region; hence, regulated components (which to some extent depend on national rules) appear to be the main driver explaining differences in electricity prices across EU region.

Table 64 Components of the electricity price: energy component (€/MWh) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	Weighted	Conf.	49.7	45.9	44.3	Conf.	45.5	45.1	44.5	42.9	43.9
	Simple	Conf.	58.5	53.5	48.5	Conf.	51.6	51.4	48.7	50.8	49.1
SE	Weighted	Conf.	62.9	59.1	68.1	76.4	65.4	61.8	57.1	47.9	49.6
	Simple	Conf.	62.7	59.2	67.4	75.5	64.6	61.8	58.7	48.4	51.2
CEE	Weighted	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
	Simple	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
EU	Weighted	**50.6**	**52.2**	**49.7**	**50.7**	**53.7**	**50.9**	**49.2**	**47.5**	**44.3**	**45.5**
	Simple	**47.5**	**56.1**	**54.2**	**56.5**	**61.1**	**56.7**	**54.4**	**52.1**	**47.6**	**49.2**

Note: weighting factor: electricity purchased; 5 observations in 2008, 8 observations in 2009 and 2012, 9 observations in other years
Source: Authors' elaboration

Table 65 Components of the electricity price: network + capacity component (€/MWh) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	Weighted	Conf.	9.5	8.5	8.6	Conf.	9.5	8.2	5.7	9.6	9.1
	Simple	Conf.	10.2	9.6	8.6	Conf.	10.4	11.2	8.3	11.2	10.7
SE	Weighted	Conf.	32.0	23.6	25.6	34.0	40.5	43.1	42.6	45.2	42.9
	Simple	Conf.	26.5	21.7	23.2	29.6	38.5	41.2	40.2	42.3	39.4
CEE	Weighted	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
	Simple	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
EU	Weighted	**13.3**	**14.4**	**12.7**	**12.8**	**16.1**	**17.5**	**16.4**	**14.1**	**17.4**	**16.2**
	Simple	**12.0**	**15.4**	**14.3**	**14.7**	**19.8**	**22.4**	**23.4**	**23.0**	**24.6**	**23.1**

Note: weighting factor: electricity purchased; 5 observations in 2008, 8 observations in 2009 and 2012, 9 observations in other years
Source: Authors' elaboration

Table 66 Components of the electricity price: RES levies (€/MWh) – Simple and weighted averages

Region	Average	2008	2009	2010	201	2012	2013	2014	2015	2016	2017
NWE	Weighted	Conf.	1.3	0.7	0.2	Conf.	0.5	0.4	0.4	0.4	0.4
	Simple	Conf.	4.3	2.7	0.6	Conf.	1.7	1.7	1.9	1.8	1.8
SE	Weighted	Conf.	0.0	4.0	6.0	15.5	20.2	21.3	23.5	21.0	18.3
	Simple	Conf.	0.0	4.8	6.6	12.7	15.6	15.2	16.7	16.2	14.2
CEE	Weighted	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
	Simple	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
EU	Weighted	**2.4**	**0.9**	**1.6**	**1.7**	**4.5**	**5.8**	**5.8**	**6.1**	**5.7**	**4.7**
	Simple	**2.2**	**1.6**	**3.1**	**3.2**	**6.8**	**8.1**	**8.4**	**9.9**	**9.9**	**8.7**

Note: weighting factor: electricity purchased; 5 observations in 2008, 8 observations in 2009 and 2012, 9 observations in other years
Source: Authors' elaboration

Table 67 Components of the electricity price: Other non-recoverable taxes/levies (€/MWh) – Simple and weighted averages

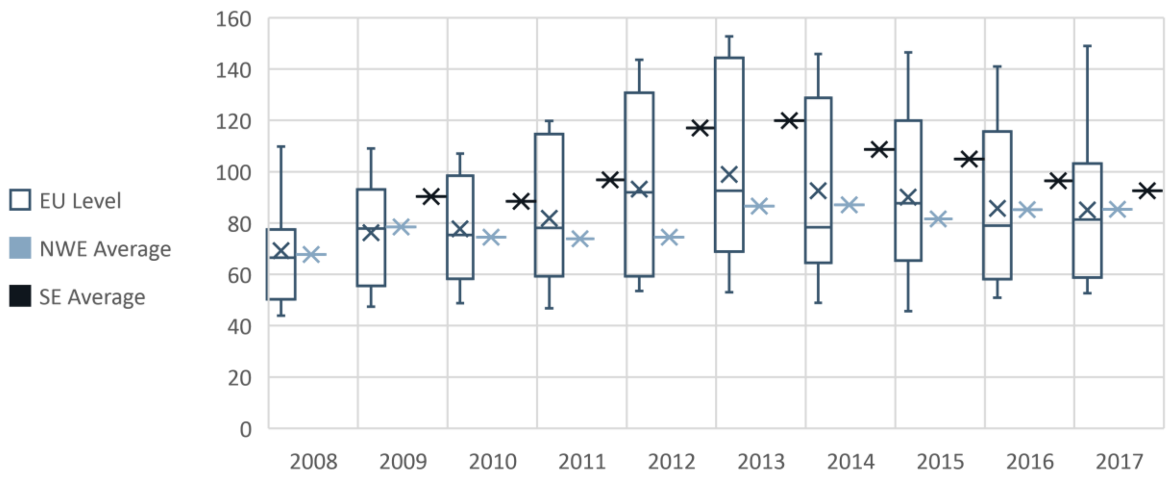
Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	**Weighted**	Conf.	2.6	2.0	1.7	Conf.	2.7	2.8	2.6	1.2	1.2
	Simple	Conf.	3.6	2.7	1.4	Conf.	4.6	4.9	4.5	4.6	4.4
SE	**Weighted**	Conf.	0.8	1.2	1.3	1.3	1.5	0.8	0.9	0.8	0.8
	Simple	Conf.	1.1	1.1	1.5	1.7	1.8	0.7	0.7	0.7	0.7
CEE	**Weighted**	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
	Simple	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
EU	**Weighted**	**2.4**	**2.1**	**1.7**	**1.5**	**1.7**	**2.3**	**2.1**	**2.0**	**1.1**	**1.1**
	Simple	**2.1**	**2.2**	**1.5**	**1.3**	**1.6**	**2.8**	**2.2**	**2.0**	**2.1**	**2.0**

Note: weighting factor: electricity purchased; 5 observations in 2008, 8 observations in 2009 and 2012, 9 observations in other years.
Source: Authors' elaboration

Electricity costs

Whereas no plant is self-generating electricity, two plants participated in flexibility schemes (however, the compensation they received is relatively small compared to their electricity costs) and seven out of 12 plants were reimbursed a small part of the price paid for electricity (especially RES levies). Therefore, the average electricity costs in €/MWh are smaller but largely aligned with electricity prices in €/MWh (see above).[34] The weighted average (by electricity consumption) for this indicator was lower than the simple average, confirming better conditions for larger consumers, especially in the most recent years. When looking at differences between weighted and simple averages for electricity prices and electricity costs in €/MWh, it is apparent that flexibility schemes and *ex post* reimbursement had a similar impact on both large and small consumers.

Figure 53 Electricity costs (€/MWh) – Box plots and simple averages



Note: data for the SE region in 2008 and for the CEE region in all years cannot be shown due to confidentiality reasons, 7 observations in 2008, 9 observations in 2009, 12 observations in other years.
Source: Authors' elaboration

[34] Electricity prices in €/MWh are defined as follows: Total price paid to purchase electricity/Total electricity purchased. Electricity costs in €/MWh are defined 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).

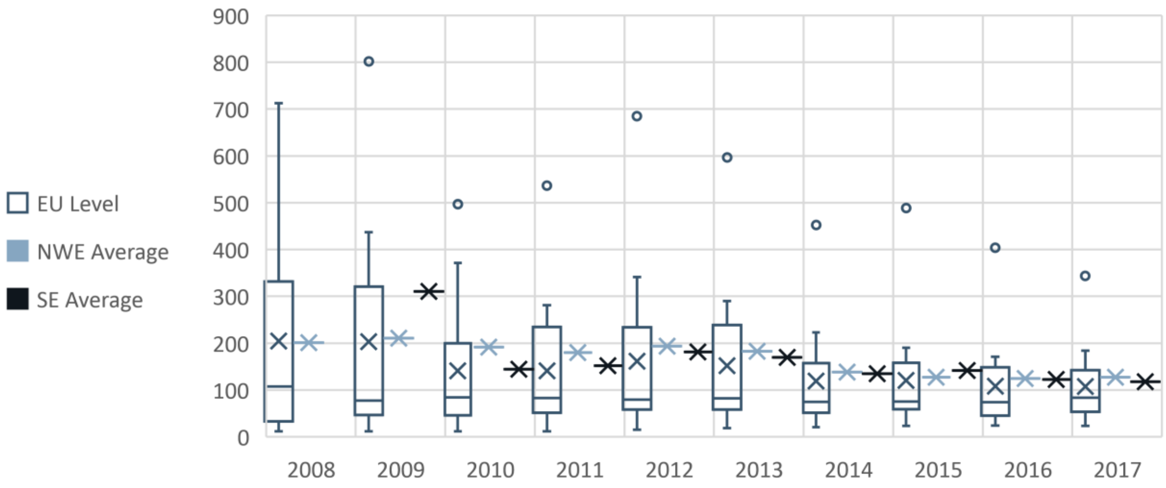
Table 68 Electricity costs (€/MWh) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	Weighted	67.2	63.5	58.5	57.7	59.4	61.9	59.4	52.2	56.7	57.5
	Simple	67.8	78.4	74.5	73.9	74.5	86.6	87.1	81.6	85.2	85.4
SE	Weighted	Conf.	95.6	86.6	93.8	117.2	120.0	106.1	103.0	93.5	90.9
	Simple	Conf.	90.4	88.4	96.8	117.1	120.0	108.7	104.9	96.4	92.6
CEE	Weighted	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
	Simple	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
EU	Weighted	**78.0**	**69.7**	**68.3**	**69.5**	**78.7**	**81.1**	**74.4**	**68.6**	**68.2**	**68.0**
	Simple	**69.2**	**76.2**	**77.7**	**81.8**	**93.2**	**98.9**	**92.6**	**90.1**	**85.8**	**85.1**

Note: weighting factor: total electricity consumption; 7 observations in 2008, 9 observations in 2009, 12 observations in other years.
Source: Authors' elaboration

When it comes to electricity costs in €/tonne, over the period under observation, EU average values declined from about €200/tonne to about €100/tonne (Figure 54). This could be explained by a partial switch from electricity to gas-heated production processes, especially in smaller plants. However, the variance of this indicator is quite high, as sampled plants produce outputs which are somewhat different in terms of both production costs, market price and value added. More specifically, in this sector, some producers make use of electric melting technologies as well as electric boosting for gas-heated furnaces. In this respect, weighted averages are substantially below simple averages (Table 69) for two main reasons: i) larger plants may benefit from economies of scale; ii) electric heated/boosted furnaces are more frequently used for small-scale production of high value added glass tableware. This is also reflected by the electricity intensity of the production process (see below). Electricity costs in the NWE and SE regions are fairly aligned, especially if one looks at data from 2010 onwards, which are based on a larger sample.

Figure 54 Electricity costs (€/tonne) – Box plots and simple averages



Note: data for the SE region in 2008 and for the CEE region in all years cannot be shown due to confidentiality reasons; 7 observations in 2008, 9 observations in 2009, 12 observations in other years.
Source: Authors' elaboration

Table 69 Electricity costs (€/tonne) – Simple and weighted averages

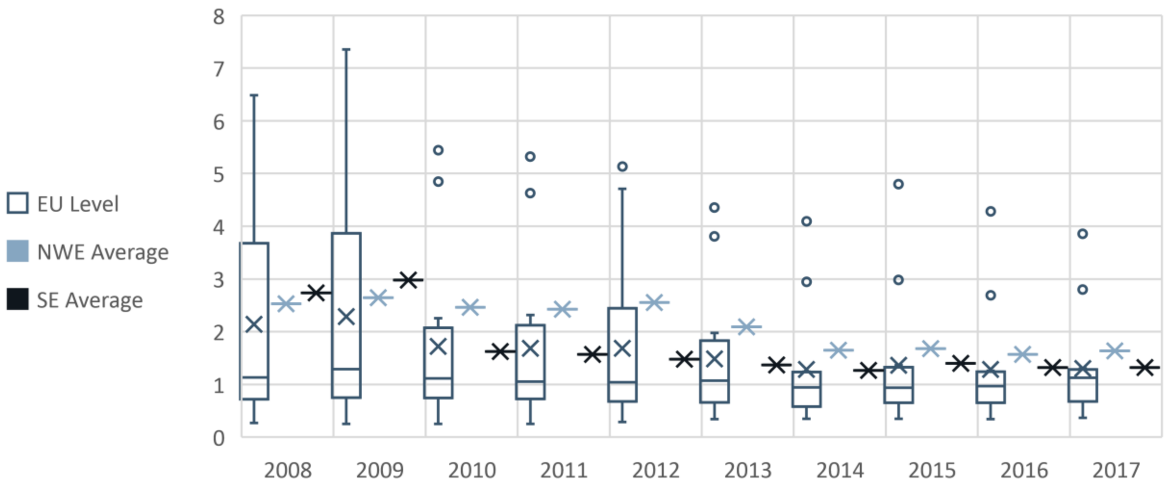
Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	**Weighted**	164.1	91.9	79.4	78.1	86.2	86.6	76.9	72.8	73.5	77.1
	Simple	201.1	210.9	191.7	179.8	194.0	182.5	138.0	127.7	124.9	127.7
SE	**Weighted**	Conf.	141.6	89.0	93.5	108.3	106.4	89.3	88.4	81.1	83.7
	Simple	Conf.	310.4	144.3	151.8	181.6	170.1	135.2	142.0	122.7	118.0
CEE	**Weighted**	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
	Simple	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
EU	**Weighted**	**94.6**	**84.7**	**74.2**	**75.1**	**85.8**	**86.2**	**72.5**	**69.7**	**67.5**	**70.3**
	Simple	**204.8**	**203.2**	**140.8**	**140.9**	**161.4**	**152.3**	**119.4**	**120.4**	**108.5**	**107.7**

Note: weighting factor: production output; 7 observations in 2008, 9 observations in 2009, 12 observations in other years.
Source: Authors' elaboration

Electricity intensity

Variety in production output is also reflected by differences in the electricity intensity of the production process (Figure 55). Whereas the EU average electricity intensity appears to range between 1 MWh/tonne and 2 MWh/tonne, some sampled plants rely relatively more on electric melting and boosting; therefore, the production process of such plants is characterised by much higher electricity intensity. The electricity intensity of plants based in the NWE region is constantly above the EU average from 2010 onwards and this explains why electricity costs (in €/tonne) are somewhat aligned between the two regions, although electricity prices are lower in the NWE region than in the SE region. Finally, it is no surprise that weighted averages are smaller than simple averages; this could derive from both economies of scale (larger plants are more efficient) and reliance on electricity intensive technologies for small-scale production of high value added products. Interestingly, the electricity intensity of the production process (simple average) fell from 2.1 MWh/tonne in 2008 to 1.3 MWh/tonne in 2017; this can be explained by a progressive shift (especially for smaller players) from electric melting to oxy-fuel furnaces, which rely on natural gas while replacing the combustion air with high purity oxygen.

Figure 55 Electricity intensity (MWh/tonne) – Box plots and simple averages



Note: data for the CEE region in all years cannot be shown due to confidentiality reasons; 9 observations in 2008 and 2009, 12 observations in other years.
Source: Authors' elaboration

Table 70 Electricity intensity (MWh/tonne) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	**Weighted**	1.3	1.4	1.4	1.4	1.5	1.4	1.3	1.4	1.3	1.3
	Simple	2.5	2.6	2.5	2.4	2.6	2.1	1.6	1.7	1.6	1.6
SE	**Weighted**	1.4	1.5	1.0	1.0	0.9	0.9	0.8	0.9	0.9	0.9
	Simple	2.7	3.0	1.6	1.6	1.5	1.4	1.3	1.4	1.3	1.3
CEE	**Weighted**	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
	Simple	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
EU	**Weighted**	**1.1**	**1.2**	**1.1**	**1.1**	**1.1**	**1.1**	**1.0**	**1.0**	**1.0**	**1.0**
	Simple	**2.1**	**2.3**	**1.7**	**1.7**	**1.7**	**1.5**	**1.3**	**1.4**	**1.3**	**1.3**

Note: weighting factor: production output; 9 observations in 2008 and 2009, 12 observations in other years.
Source: Authors' elaboration

Additional information

Most of the surveyed plants purchase electricity from energy suppliers. Only one plant buys electricity directly on the wholesale market; another plant has a mixed strategy, with about one-third of the electricity purchased on the wholesale market and two-thirds from a supplier. No plant is using PPA, confirming the limited uptake of this contractual option across the EU. The geographical location of the plant does not seem to affect this type of decision. All plants rely on short-term electricity contracts (below five years); only one plant is bound by a contract of indeterminate duration, which is automatically renewed and can be amended annually. Two plants based in the SE region took part in flexibility schemes in at least one year in the timespan covered by the Assignment. Revenues stemming from these schemes appear to be fairly limited; however, they have been accounted for when computing electricity costs (see above). Interestingly, no plant is self-generating electricity.

When it comes to the continuity of the electricity supply, plants based in the NWE region did not report any outages. By contrast, a number of outages were experienced in the CEE and SE region (Table 71). The number of outages is fairly stable across the period 2015-2017; unplanned outages, which usually have a disruptive impact on the production process, are more frequent.

Table 71 Electricity outages

	Planned outages		Other planned outages		Unplanned outages	
	Total number	Average duration in minutes	Total number	Average duration in minutes	Total number	Average duration in minutes
2015	5	30	0	0	28	71
2016	4	20	1	135	27	6
2017	3	15	3	113	25	37

Note: Planned outages are linked to flexibility schemes; other planned outages are not linked to flexibility schemes, but notified in advance by the energy supplier; unplanned outages are not notified.
Source: Authors' elaboration

4.3 Natural gas

Table 72 summarises the main indicators related to gas prices and costs that are further detailed in this Section of the Chapter. Gas prices and costs fluctuated across the period under observation and underwent a sharp decrease in 2016 and 2017; this is mainly due to a decrease in the energy component of the gas price. The natural gas intensity of the production process recorded a moderate increase between 2013 and 2017, thus only partially compensating for the decrease in electricity intensity. However, natural gas costs in €/tonne were at their minimum in 2017, thanks to exceptionally low natural gas prices.

Table 72 Natural gas: summary table (EU) – Simple averages

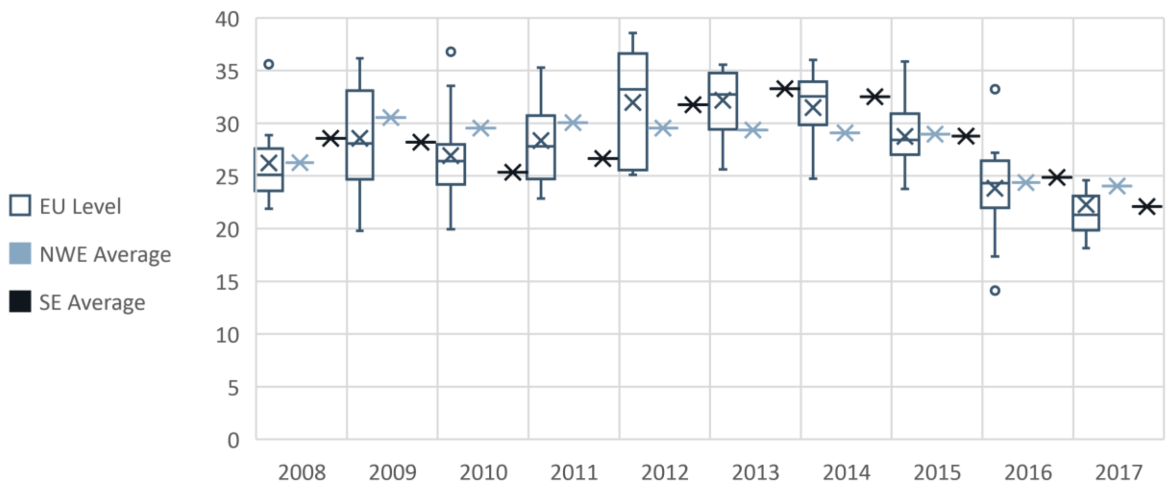
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas prices (€/MWh)	26.2	28.6	26.9	28.4	32.0	32.2	31.5	28.7	23.8	22.3
Natural gas costs (€/tonne)	149.7	170.5	144.1	146.0	162.7	163.4	168.8	159.9	131.9	127.5
Natural gas intensity (MWh/tonne)	5.6	6.2	5.5	5.2	5.2	5.1	5.4	5.5	5.3	5.5

Source: Authors' elaboration

Natural gas prices

After peaking in 2012 and 2013, the average price paid by producers of glass tableware for natural gas decreased sharply, going from over €32/tonne to below €23/MWh (Figure 56). Interestingly, prices paid in the NWE were almost constant between 2009 and 2015 and declined afterwards; by contrast, prices paid in the SE region were more volatile and followed closely the EU level trend. In recent years, the EU weighted average (by purchased gas) was generally below the simple average (Table 73): larger plants were able to strike better deals with gas suppliers (lower energy component) and paid lower network costs as well as other taxes and levies. However, the difference between simple and weighted averages is less pronounced than for electricity prices. Therefore, it seems that quantity discounts and exemptions on regulatory components are less relevant when it comes to negotiating gas prices than electricity prices.

Figure 56 Natural gas prices (€/MWh) – Box plots and simple averages



Note: data for the CEE region in all years cannot be shown due to confidentiality reasons; 9 observations in 2008 and 2009, 12 observations in other years.
Source: Authors' elaboration

Table 73 Natural gas prices (€/MWh) – Simple and weighted averages

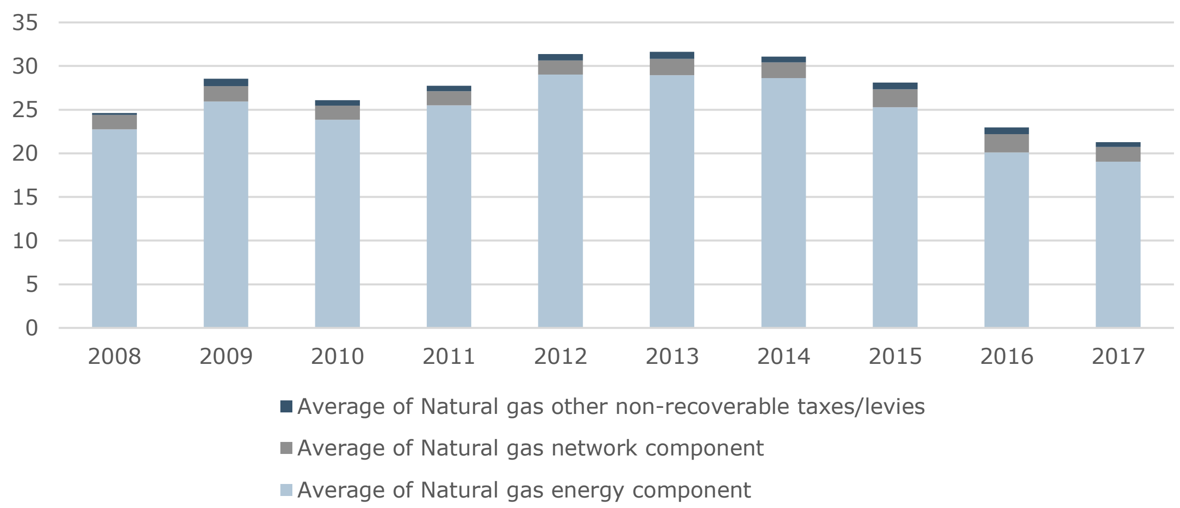
Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	Weighted	25.2	33.1	31.6	33.3	31.1	28.6	26.5	25.1	17.2	19.7
	Simple	26.2	30.5	29.5	30.1	29.5	29.4	29.1	29.0	24.4	24.0
SE	Weighted	26.7	26.7	25.0	26.0	30.1	33.2	32.2	29.2	25.4	22.0
	Simple	28.6	28.2	25.3	26.7	31.8	33.3	32.5	28.8	24.9	22.1
CEE	Weighted	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
	Simple	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
EU	Weighted	**25.1**	**30.7**	**28.8**	**30.5**	**31.5**	**30.9**	**29.4**	**26.7**	**19.8**	**20.3**
	Simple	**26.2**	**28.6**	**26.9**	**28.4**	**32.0**	**32.2**	**31.5**	**28.7**	**23.8**	**22.3**

Note: weighting factor: gas purchased; data for the CEE region in all years cannot be shown due to confidentiality reasons; 9 observations in 2008 and 2009, 12 observations in other years.
Source: Authors' elaboration

Components of the natural gas price[35]

Whereas the energy component of the natural gas price registered a decreasing trend, after peaking in 2012, the regulatory components of the price remained fairly stable, thus representing a relatively larger share (slightly above 10%) of the final price in 2017 than in 2008 (Figure 57, Figure 58). At any rate, regulatory components play a more limited role in the natural gas price than in the electricity price (see above).

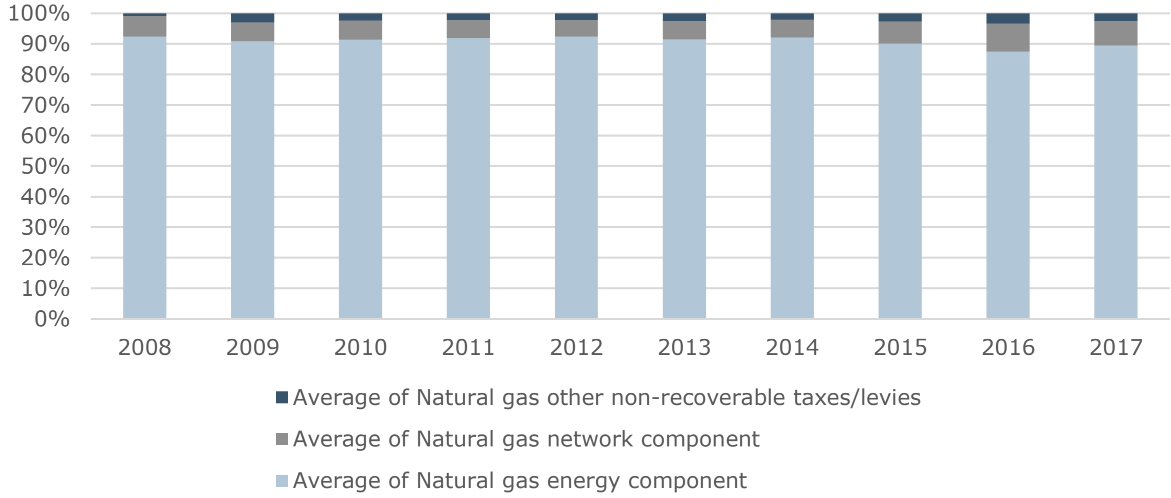
Figure 57 Components of the natural gas price (€/MWh, EU) – Simple averages



Note: 6 observations in 2008, 7 observations in 2009, 9 observations in 2010 and 2011, 10 observations in 2012 and 2013, 11 observations for the period 2014-2017.
Source: Authors' elaboration

[35] The sum of the natural gas bill components does not necessarily add up to the total natural gas price mentioned before, as there might be plants that did not provide a breakdown of the natural gas bill components while still providing the total natural gas price.

Figure 58 Components of the natural gas price (%, EU) – Simple averages



Note: 6 observations in 2008, 7 observations in 2009, 9 observations in 2010 and 2011, 10 observations in 2012 and 2013, 11 observations for the period 2014-2017.
Source: Authors' elaboration

Weighted averages of the energy component of the natural gas price are not always below simple averages (Table 74). This confirms the less pronounced role played by bargaining power when setting gas prices. In addition, differences in gas price components across regions are more limited (in absolute value) than differences in electricity price components (Table 75, Table 76); this indicates that national rules are less relevant to determining gas prices and costs.

Table 74 Components of the natural gas price: energy component (€/MWh) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	**Weighted**	24.0	31.5	30.2	32.0	29.9	27.1	24.6	22.8	14.6	17.8
	Simple	23.7	27.5	25.2	26.5	25.9	25.4	24.9	24.5	19.3	19.5
SE	**Weighted**	Conf.	26.3	22.6	23.1	26.6	30.3	29.8	26.4	22.7	19.6
	Simple	Conf.	26.7	22.8	23.7	28.5	29.8	29.8	25.6	22.0	19.4
CEE	**Weighted**	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
	Simple	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
EU	**Weighted**	**23.6**	**29.5**	**27.5**	**29.2**	**29.7**	**28.8**	**27.5**	**24.5**	**17.4**	**18.3**
	Simple	**22.8**	**25.9**	**23.8**	**25.5**	**29.0**	**29.0**	**28.6**	**25.3**	**20.1**	**19.1**

Note: weighting factor: gas purchased; 5 observations in 2008, 8 observations in 2009 and 2012, 9 observations in other years
Source: Authors' elaboration

Table 75 Components of the natural gas price: network component (€/MWh) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	Weighted	1.0	1.5	1.1	1.1	0.8	0.9	1.0	1.1	0.7	0.7
	Simple	1.3	1.7	1.4	1.3	1.2	1.2	1.4	1.4	1.2	1.2
SE	Weighted	Conf.	1.7	1.6	1.6	1.8	2.1	2.0	2.5	2.3	2.1
	Simple	Conf.	1.2	1.4	1.4	1.6	2.1	1.8	2.2	2.0	1.8
CEE	Weighted	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
	Simple	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
EU	Weighted	**1.2**	**1.6**	**1.4**	**1.3**	**1.3**	**1.4**	**1.4**	**1.6**	**1.5**	**1.3**
	Simple	**1.7**	**1.8**	**1.6**	**1.6**	**1.6**	**1.9**	**1.8**	**2.0**	**2.1**	**1.7**

Note: weighting factor: gas purchased; 5 observations in 2008, 8 observations in 2009 and 2012, 9 observations in other years
Source: Authors' elaboration

Table 76 Components of the natural gas price: Other non-recoverable taxes/levies (€/MWh) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	Weighted	0.1	0.2	0.1	0.2	0.1	0.2	0.3	0.3	0.6	0.2
	Simple	0.4	0.5	0.5	0.6	0.6	0.7	0.6	0.7	1.0	0.3
SE	Weighted	Conf.	1.4	0.4	0.4	0.4	0.5	0.4	0.4	0.4	0.4
	Simple	Conf.	2.2	1.0	1.0	1.0	1.1	0.9	0.9	0.9	0.8
CEE	Weighted	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
	Simple	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
EU	Weighted	**0.1**	**0.2**	**0.2**	**0.2**	**0.2**	**0.3**	**0.3**	**0.3**	**0.4**	**0.2**
	Simple	**0.2**	**0.8**	**0.6**	**0.6**	**0.7**	**0.8**	**0.7**	**0.7**	**0.8**	**0.5**

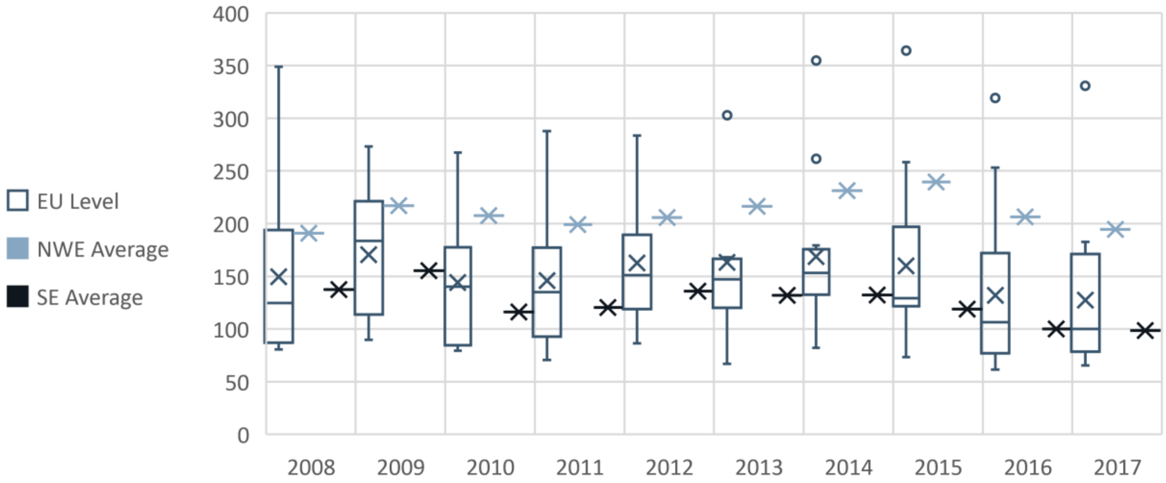
Note: weighting factor: gas purchased; 5 observations in 2008, 8 observations in 2009 and 2012, 9 observations in other years
Source: Authors' elaboration

Natural gas costs

On average, EU producers of glass tableware faced natural gas costs of between €130 and €170/tonne over the period under observation (Figure 59). This indicator fluctuated across years; nevertheless, it registered a decreasing trend with natural gas costs in the area of €130/tonne in 2016 and 2017. This is in line with the reduction of natural gas prices in €/MWh. Likewise, as in electricity costs in €/tonne, the variance of this indicator appears to be quite high, as it accounts for the variety of outputs and differences in gas intensity across sampled plants. Weighted averages are below simple averages; this may indicate economies of scale experienced by plants producing larger quantities of products (see also 'natural gas intensity' and 'production costs' below), which are usually characterised by more limited value added. In addition, larger consumers may benefit from lower natural gas prices (see 'natural gas prices' above).

There was no difference in this sector between natural gas prices and costs in €/MWh for two reasons: i) self-generation of natural gas is not relevant; ii) no plant was taking part in an interruptibility scheme for natural gas. Only one plant bought natural gas on the wholesale market.

Figure 59 Natural gas costs (€/tonne) – Box plots and simple averages



Note: data for the CEE region cannot be shown due to confidentiality reasons; 9 observations in 2008 and 2009, 12 observations in other years.
Source: Authors' elaboration

Table 77 Natural gas costs (€/tonne) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	Weighted	139.4	197.7	184.8	174.1	169.6	165.2	150.7	147.0	91.9	102.0
	Simple	190.9	216.9	207.5	199.1	205.8	216.4	231.4	239.5	206.5	194.5
SE	Weighted	102.7	131.7	106.8	110.3	124.3	130.3	123.5	111.1	96.6	87.9
	Simple	137.3	155.4	116.0	120.3	136.0	132.0	132.3	118.9	100.0	98.6
CEE	Weighted	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
	Simple	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
EU	Weighted	**121.6**	**162.3**	**141.6**	**141.3**	**148.5**	**148.7**	**140.1**	**128.9**	**90.7**	**93.5**
	Simple	**149.7**	**170.5**	**144.1**	**146.0**	**162.7**	**163.4**	**168.8**	**159.9**	**131.9**	**127.5**

Note: weighting factor: production output; 9 observations in 2008 and 2009, 12 observations in other years.
Source: Authors' elaboration

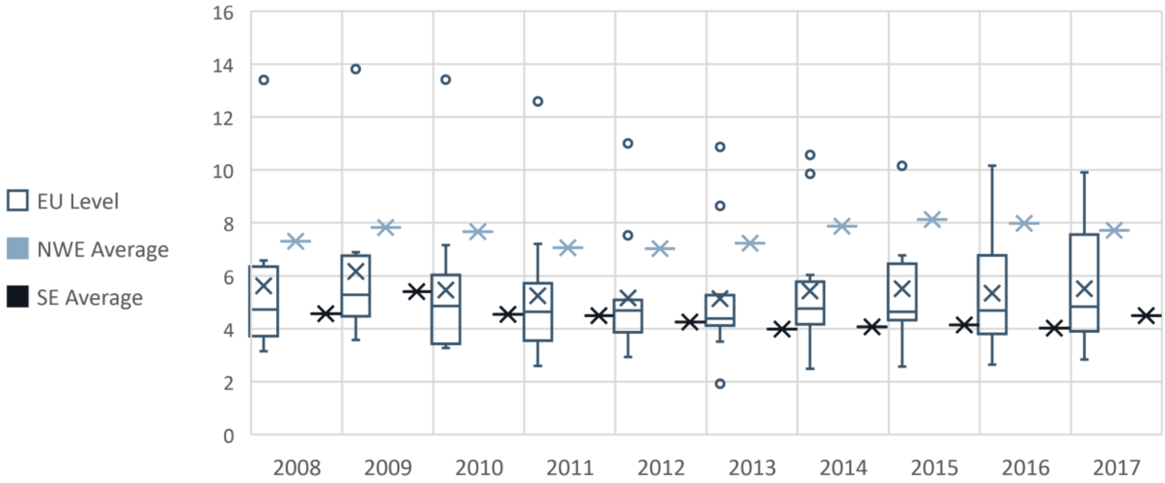
Natural gas intensity

The natural gas intensity in MWh/tonne of EU producers of glass tableware was in the area of 5.5 MWh/tonne in the period under observation (Figure 60). It has been recording a growing trend since 2013, thus partially compensating for the decrease in electricity intensity experienced by some plants. In spite of technical improvements in the natural gas efficiency of the production process, the increase in natural gas intensity is mainly due to two reasons: i) electric furnaces[36] have been progressively replaced by oxy-fuel furnaces (especially by small players), which use natural gas and allow production costs to be reduced; ii) chemical polishing has been progressively replaced by flame polishing, which increases the consumption of natural gas. However, when accounting for both gas and electricity intensity, the overall energy intensity of production decreased between 2008 and 2017 from about

[36] Electric furnaces play a crucial role in the production of lead glass. The substantial reduction in the production of lead glass in the EU favoured the dismissal of electric furnaces.

8 MWh/tonne to about 7 MWh/tonne, thus indicating an increase in the overall energy efficiency of EU glass tableware producers. Interestingly, in the same way as for electricity intensity, NWE plants registered values for natural gas cost intensity above the EU average. This may reveal that the production process of sampled plants that are based in the NWE region is relatively more energy intensive and may be explained by a focus on high-value glass tableware products. Larger plants record lower gas intensity, thus suggesting that the production process is characterised by economies of scale.

Figure 60 Natural gas intensity (MWh/tonne) – Box plots and simple averages



Note: data for the CEE region cannot be shown due to confidentiality reasons; 9 observations in 2008 and 2009, 12 observations in other years.
Source: Authors' elaboration

Table 78 Natural gas intensity (MWh/tonne) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	**Weighted**	5.5	6.0	5.8	5.2	5.5	5.8	5.7	5.9	5.4	5.2
	Simple	7.3	7.8	7.7	7.1	7.0	7.2	7.9	8.1	8.0	7.7
SE	**Weighted**	3.8	4.9	4.3	4.2	4.1	3.9	3.8	3.8	3.8	4.0
	Simple	4.6	5.4	4.5	4.5	4.3	4.0	4.1	4.1	4.0	4.5
CEE	**Weighted**	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
	Simple	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.	Conf.
EU	**Weighted**	**4.8**	**5.3**	**4.9**	**4.6**	**4.7**	**4.8**	**4.8**	**4.8**	**4.6**	**4.6**
	Simple	**5.6**	**6.2**	**5.5**	**5.2**	**5.2**	**5.1**	**5.4**	**5.5**	**5.3**	**5.5**

Note: weighting factor: production output; 9 observations in 2008 and 2009, 12 observations in other years.
Source: Authors' elaboration

Additional information

The vast majority of sampled plants purchase natural gas via energy suppliers and rely on short-term contracts (below five years). Only one plant buys gas on the wholesale market. Only one plant signed a long-term contract (above five years); this plant does not envisage any problem in renewing a similar contract once the current one expires. No plant is taking part in an interruptibility scheme for natural gas. Only one plant reported an interruption in the provision of natural gas, which lasted about eight hours and was notified in advance by the gas provider. Finally, self-production of gas is not relevant to glass tableware producers.

4.4 Competitiveness

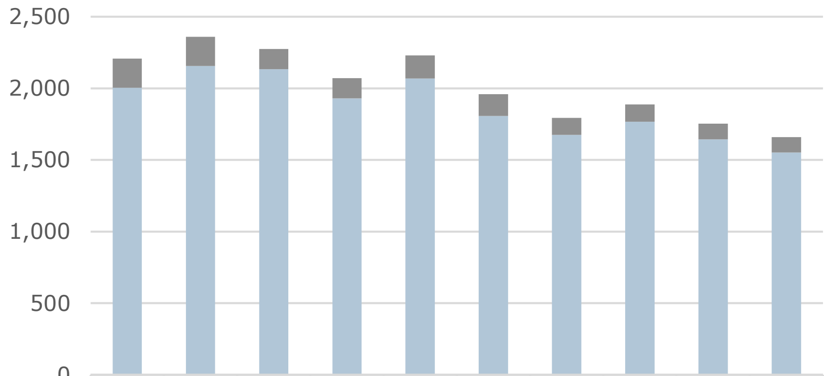
<u>Cost competitiveness</u>

Electricity

Both electricity costs and production costs in €/tonne decreased across the period under observation; however, the share of electricity costs out of total production costs in the EU glass tableware sector declined between 2008 and 2017, from 9.3% to less than 6.5% (Figure 61). This result is in line with an overall reduction of the electricity intensity of the production process. When looking at weighted averages, it is apparent that larger plants face both lower electricity costs and lower production costs in €/tonne and, on average, electricity costs represent a smaller share of production costs in such plants. This is most likely due to three main factors: i) economies of scale; ii) better bargaining power of larger consumers; iii) exemptions on regulatory components of the electricity price; and iv) focus by larger plants on glass tableware products characterised by relatively lower electricity intensity.

It is not possible to show the impact of electricity costs on production costs net of depreciation and amortisation, as only a limited number of plants disclosed this indicator.

Figure 61 Electricity costs as a share of production costs (€/tonne, EU) – Simple averages



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Average of Electricity cost €/tonne	205	203	141	141	161	152	119	120	109	108
Average of other Production costs €/tonne	2,004	2,157	2,134	1,931	2,068	1,808	1,675	1,768	1,644	1,553

Note: electricity costs: 7 observations in 2008, 9 observations in 2009, 12 observations in other years; production costs: 8 observations between 2008 and 2010, 11 observations between 2011 and 2016, 9 observations in 2017.
Source: Authors' elaboration

Table 79 Electricity costs as a share of production costs (EU) – Simple and weighted averages

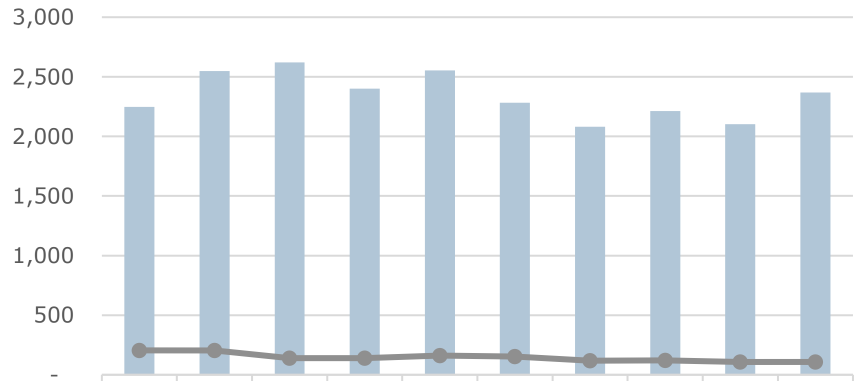
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity costs simple average (€/tonne)	204.8	203.2	140.8	140.9	161.4	152.3	119.4	120.4	108.5	107.7
Electricity costs	94.6	84.7	74.2	75.1	85.8	86.2	72.5	69.7	67.5	70.3

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
weighted average (€/tonne)										
Production costs simple average (€/tonne)	2208.5	2360.4	2274.8	2071.8	2229.3	1960.2	1794.2	1887.9	1752.8	1660.3
Production costs weighted average (€/tonne)	1502.3	1653.9	1655.0	1604.9	1627.2	1527.5	1370.0	1404.8	1284.6	1322.5
Electricity costs as a share of production costs simple averages (%)	9.3%	8.6%	6.2%	6.8%	7.2%	7.8%	6.7%	6.4%	6.2%	6.5%
Electricity costs as a share of production costs weighted averages (%)	6.3%	5.1%	4.5%	4.7%	5.3%	5.6%	5.3%	5.0%	5.3%	5.3%

Note: weighting factor: production output; electricity costs: 7 observations in 2008, 9 observations in 2009, 12 observations in other years; production costs: 8 observations between 2008 and 2010, 11 observations between 2011 and 2016, 9 observations in 2017.
Source: Authors' elaboration

In the same vein, the share of electricity costs in relation to turnover went from about 9.1% in 2008 to 4.5% in 2017 (Figure 62). Weighted averages (Table 80) show that larger plants register lower turnover, thus corroborating the assumption that they tend to focus on products characterised by relatively lower value added. It is worth mentioning that producers based in the NWE region incur production costs above the average. They also register turnover well above the average. This confirms their focus on high-value glass tableware products.

Figure 62 Electricity costs versus turnover (€/tonne, EU) – Simple averages



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Average of Turnover €/tonne	2,247	2,549	2,620	2,400	2,554	2,283	2,080	2,212	2,103	2,368
Average of Electricity cost €/tonne	205	203	141	141	161	152	119	120	109	108

Note: electricity costs: 7 observations in 2008, 9 observations in 2009, 12 observations in other years; turnover: 8 observations between 2008 and 2010, 11 observations between 2011 and 2016, 10 observations in 2017.
Source: Authors' elaboration

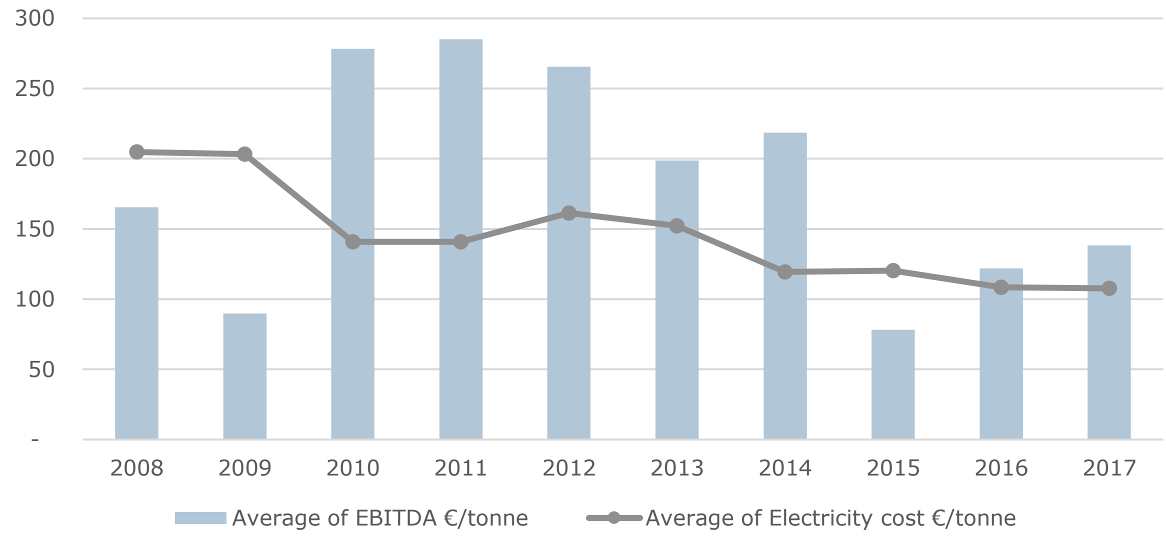
Table 80 Electricity costs versus turnover (EU) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity costs simple average (€/tonne)	204.8	203.2	140.8	140.9	161.4	152.3	119.4	120.4	108.5	107.7
Electricity costs weighted average (€/tonne)	94.6	84.7	74.2	75.1	85.8	86.2	72.5	69.7	67.5	70.3
Turnover simple average (€/tonne)	2247.2	2548.7	2620.2	2400.5	2554.5	2282.9	2080.0	2211.6	2103.1	2367.5
Turnover weighted average (€/tonne)	1960.7	2166.7	2024.5	1949.9	1955.5	1945.6	1703.0	1779.3	1615.0	1819.8
Electricity costs as a share of turnover simple averages (%)	9.1%	8.0%	5.4%	5.9%	6.3%	6.7%	5.7%	5.4%	5.2%	4.5%
Electricity costs as a share of turnover weighted averages (%)	4.8%	3.9%	3.7%	3.8%	4.4%	4.4%	4.3%	3.9%	4.2%	3.9%

Note: weighting factor: production output; electricity costs: 7 observations in 2008, 9 observations in 2009, 12 in other years; turnover: 8 observations between 2008 and 2010, 11 between 2011 and 2016, 10 in 2017.
Source: Authors' elaboration

Whereas electricity costs are in most of the years lower than EBITDA registered by EU producers of glass tableware, they are higher than EBIT, which is negative in all years except 2008, 2010 and 2011. However, it is not possible to draw conclusions about the impact of electricity costs on profitability, as both profitability indicators and electricity costs declined across the period under observation (Figure 63, Figure 64). In the same vein, no strong conclusion can be drawn when looking at weighted margins (Table 81, Table 82), as it seems that profitability does not depend on plant size. Interestingly, earnings of NWE producers are above the EU average, thus confirming their focus on glass tableware products with high costs and high margins.

Figure 63 Electricity costs versus EBITDA (€/tonne, EU) – Simple averages



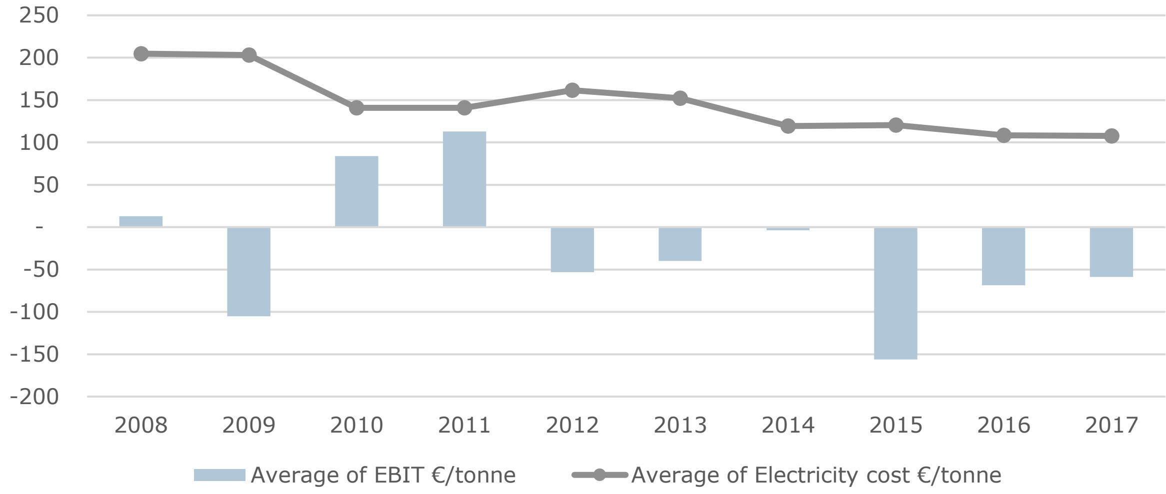
Note: electricity costs: 7 observations in 2008, 9 observations in 2009, 12 observations in other years; EBITDA: 8 observations in 2008 and 2009, 7 observations in 2010, 10 observations in 2011, 11 observations between 2012 and 2016, 10 observations in 2017.
Source: Authors' elaboration

Table 81 Electricity costs versus EBITDA (€/tonne, EU) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity costs simple average (€/tonne)	204.8	203.2	140.8	140.9	161.4	152.3	119.4	120.4	108.5	107.7
Electricity costs weighted average (€/tonne)	94.6	84.7	74.2	75.1	85.8	86.2	72.5	69.7	67.5	70.3
EBITDA simple average (€/tonne)	165.4	89.8	278.2	285.2	265.6	198.6	218.6	78.2	121.8	138.2
EBITDA weighted average (€/tonne)	175.0	46.4	219.2	200.4	145.9	111.1	145.1	38.5	126.9	137.4

Note: weighting factor: production output; electricity costs: 7 observations in 2008, 9 observations in 2009, 12 observations in other years; EBITDA: 8 observations in 2008 and 2009, 7 observations in 2010, 10 observations in 2011, 11 observations between 2012 and 2016, 10 observations in 2017.
Source: Authors' elaboration

Figure 64 Electricity costs versus EBIT (€/tonne, EU) – Simple averages



Note: electricity costs: 7 observations in 2008, 9 observations in 2009, 12 observations in other years; EBIT: 8 observations in 2008 and 2009, 7 observations in 2010, 10 observations in 2011, 11 observations between 2012 and 2016, 10 observations in 2017.
Source: Authors' elaboration

Table 82 Electricity costs versus EBIT (€/tonne, EU) – Simple and weighted averages

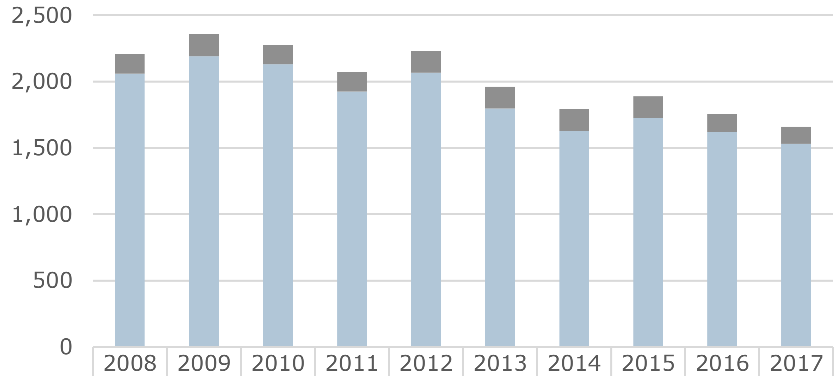
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity costs simple average (€/tonne)	204.8	203.2	140.8	140.9	161.4	152.3	119.4	120.4	108.5	107.7
Electricity costs weighted average (€/tonne)	94.6	84.7	74.2	75.1	85.8	86.2	72.5	69.7	67.5	70.3
EBIT simple average (€/tonne)	12.8	-105.2	83.9	112.8	-53.2	-40.0	-3.6	-156.3	-68.7	-58.7
EBIT weighted average (€/tonne)	43.6	-124.6	60.5	54.1	-39.0	-60.7	-17.2	-121.3	-15.1	-16.7

Note: weighting factor: production output; electricity costs: 7 observations in 2008, 9 observations in 2009, 12 observations in other years; EBIT: 8 observations in 2008 and 2009, 7 observations in 2010, 10 observations in 2011, 11 observations between 2012 and 2016, 10 observations in 2017.
Source: Authors' elaboration

Natural gas

Between 2008 and 2017, both natural gas costs and production costs in €/tonne underwent a major contraction in the EU glass tableware sector (Figure 65). The share of natural gas costs out of total production costs fluctuated across the period under observation between 6.3% and 9.4% when looking at simple averages. Weighted averages reveal that larger plants incur both lower natural gas costs and lower production costs in €/tonne, thus confirming that the production of glass tableware features economies of scale (Table 83). Nonetheless, natural gas costs represent a larger share of production costs in larger plants, except for years when the natural gas price in €/MWh is exceptionally low (2016, 2017). In other words, when producing a larger quantity of output, plants experience a reduction in costs of other production inputs that is relatively stronger than the contraction of natural gas costs; this is in line with the evidence above showing that quantity discounts are less relevant when comes to negotiating gas prices than electricity prices.

Figure 65 Natural gas costs as a share of production costs (€/tonne, EU) – Simple averages



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Average of Natural gas cost €/tonne	150	171	144	146	163	163	169	160	132	128
Average of other Production costs €/tonne	2,059	2,190	2,131	1,926	2,067	1,797	1,625	1,728	1,621	1,533

Note: natural gas costs: 9 observations in 2008 and 2009, 12 observations in other years; production costs: 8 observations between 2008 and 2010, 12 between 2011 and 2016, 9 in 2017.

Source: Authors' elaboration

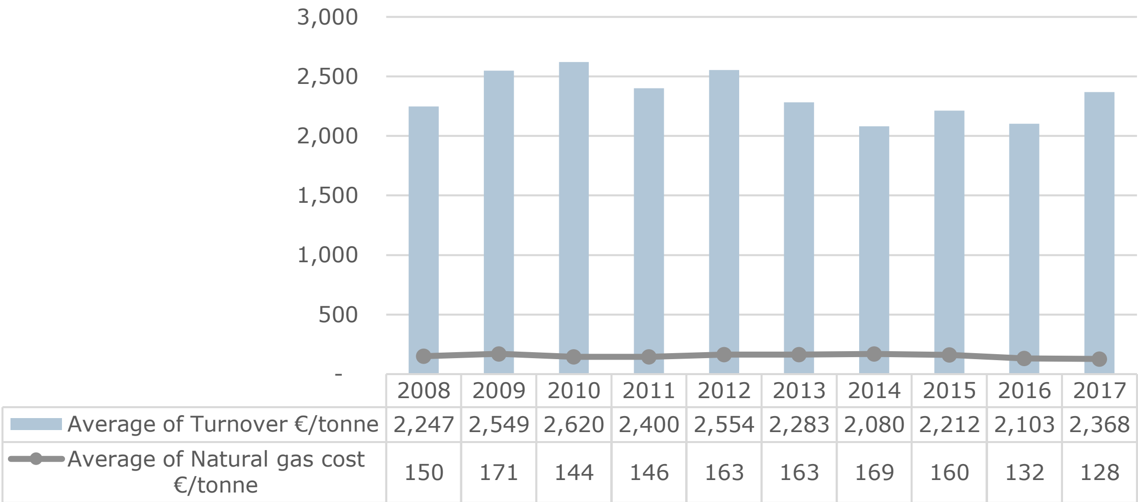
Table 83 Natural gas costs as a share of production costs (€/tonne, EU) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas costs simple average (€/tonne)	149.7	170.5	144.1	146	162.7	163.4	168.8	159.9	131.9	127.5
Natural gas costs weighted average (€/tonne)	121.6	162.3	141.6	141.3	148.5	148.7	140.1	128.9	90.7	93.5
Production costs simple average (€/tonne)	2208.5	2360.4	2274.8	2071.8	2229.3	1960.2	1794.2	1887.9	1752.8	1660.3
Production costs weighted average (€/tonne)	1502.3	1653.9	1655	1604.9	1627.2	1527.5	1370	1404.8	1284.6	1322.5
Natural gas costs as a share of production costs simple averages (%)	6.7%	7.2%	6.3%	7.0%	7.3%	8.3%	9.4%	8.4%	7.5%	7.6%
Natural gas costs as a share of production costs weighted averages (%)	8.0%	9.8%	8.5%	8.8%	9.1%	9.7%	10.2%	9.1%	7.0%	7.0%

Note: weighting factor: production output; natural gas costs: 9 observations in 2008 and 2009, 12 observations in other years; production costs: 8 observations between 2008 and 2010, 12 between 2011 and 2016, 9 in 2017.
Source: Authors' elaboration

Natural gas costs are between 5.4% (2017) and 8.1% (2014) of the average sectoral turnover (Figure 66). Again, this share is larger in plants producing more tonnes of output per year (Table 84), except for years when average natural gas price in €/MWh is very low (2008, 2016 and 2017).

Figure 66 Natural gas costs versus turnover (€/tonne, EU) – Simple averages



Note: natural gas costs: 9 observations in 2008 and 2009, 12 observations in other years; turnover: 9 observations between 2008 and 2010, 11 observations between 2011 and 2015, 10 observations in 2017.
Source: Authors' elaboration

Table 84 Natural gas costs versus turnover (€/tonne, EU) – Simple and weighted averages

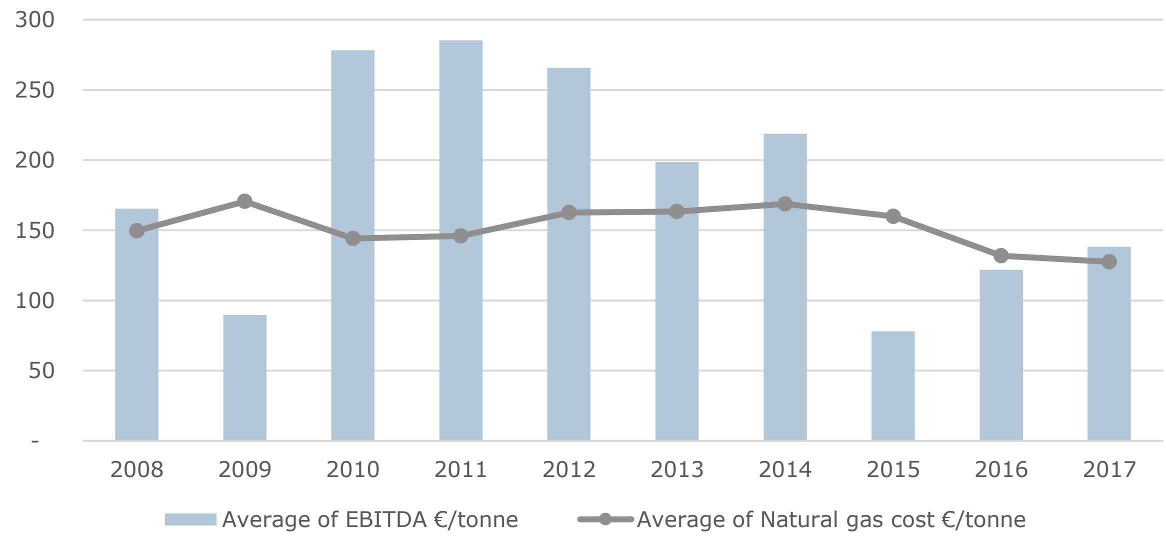
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas costs simple average (€/tonne)	149.7	170.5	144.1	146.0	162.7	163.4	168.8	159.9	131.9	127.5
Natural gas costs weighted average (€/tonne)	121.6	162.3	141.6	141.3	148.5	148.7	140.1	128.9	90.7	93.5
Turnover simple average (€/tonne)	2247.2	2548.7	2620.2	2400.5	2554.5	2282.9	2080.0	2211.6	2103.1	2367.5
Turnover weighted	1960.7	2166.7	2024.5	1949.9	1955.5	1945.6	1703.0	1779.3	1615.0	1819.8

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
average (€/tonne)										
Natural gas costs as a share of turnover simple averages (%)	6.7%	6.7%	5.5%	6.1%	6.4%	7.2%	8.1%	7.2%	6.3%	5.4%
Natural gas costs as a share of turnover weighted averages (%)	6.2%	7.5%	7.0%	7.2%	7.6%	7.6%	8.2%	7.2%	5.6%	5.1%

Note: weighting factor: production output; natural gas costs: 9 observations in 2008 and 2009, 12 observations in other years; turnover: 9 observations between 2008 and 2010, 11 observations between 2011 and 2015, 10 observations in 2017.
Source: Authors' elaboration

Except for a few exceptions, natural gas costs are lower than EBITDA and higher than EBIT registered by EU producers of glass tableware; however, trends in natural gas costs and margins appear uncorrelated (Figure 67, Figure 68). In addition, as mentioned above, no conclusion can be drawn when considering weighted margins (Table 85, Table 86); in fact, profitability most likely depends on plant-specific factors other than quantity of output.

Figure 67 Natural gas costs versus EBITDA (€/tonne, EU) – Simple averages



Note: natural gas costs: 9 observations in 2008 and 2009, 12 observations in other years; EBITDA: 8 observations in 2008 and 2009, 7 observations in 2010, 10 observation sin 2011, 11 observations between 2012 and 2016, 10 observations in 2017.
Source: Authors' elaboration

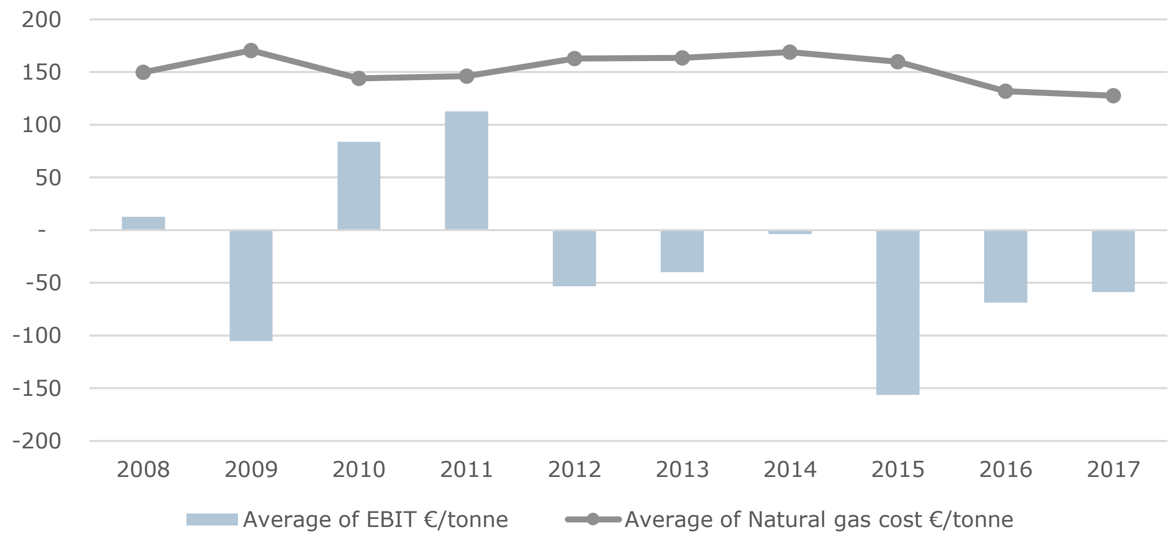
Table 85 Natural gas costs versus EBITDA (€/tonne, EU) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas costs simple average (€/tonne)	149.7	170.5	144.1	146.0	162.7	163.4	168.8	159.9	131.9	127.5
Natural gas costs weighted average (€/tonne)	121.6	162.3	141.6	141.3	148.5	148.7	140.1	128.9	90.7	93.5
EBITDA simple average (€/tonne)	165.4	89.8	278.2	285.2	265.6	198.6	218.6	78.2	121.8	138.2
EBITDA weighted average (€/tonne)	175.0	46.4	219.2	200.4	145.9	111.1	145.1	38.5	126.9	137.4

Note: weighting factor: production output; natural gas costs: 9 observations in 2008 and 2009, 12 observations in other years; EBITDA: 8 observations in 2008 and 2009, 7 observations in 2010, 10 observations in 2011, 11 observations between 2012 and 2016, 10 observations in 2017.

Source: Authors' elaboration

Figure 68 Natural gas costs versus EBIT (€/tonne, EU) – Simple averages



Note: natural gas costs: 9 observations in 2008 and 2009, 12 observations in other years; EBIT: 8 observations in 2008 and 2009, 7 observations in 2010, 10 observations in 2011, 11 observations between 2012 and 2016, 10 observations in 2017.

Source: Authors' elaboration

Table 86 Natural gas costs versus EBIT (€/tonne, EU) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas costs simple average (€/tonne)	149.7	170.5	144.1	146.0	162.7	163.4	168.8	159.9	131.9	127.5

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas costs weighted average (€/tonne)	121.6	162.3	141.6	141.3	148.5	148.7	140.1	128.9	90.7	93.5
EBIT simple average (€/tonne)	12.8	-105.2	83.9	112.8	-53.2	-40.0	-3.6	-156.3	-68.7	-58.7
EBIT weighted average (€/tonne)	43.6	-124.6	60.5	54.1	-39.0	-60.7	-17.2	-121.3	-15.1	-16.7

Note: weighting factor: production output; natural gas costs: 9 observations in 2008 and 2009, 12 observations in other years; EBIT: 8 observations in 2008 and 2009, 7 observations in 2010, 10 observations in 2011, 11 observations between 2012 and 2016, 10 observations in 2017.

Source: Authors' elaboration

5 Packaging glass

Box 7 Highlights – Packaging glass

In the EU packaging glass sector, while electricity costs represented on average 8% of total production costs (simple average) between 2008 and 2017, natural gas represented on average 15% of total production costs (simple average).

Electricity

- Electricity prices and costs in €/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.
- **Electricity prices** (simple average) went from €77/MWh in 2008 to €75/MWh in 2017, with a peak in 2012 at €83/MWh. The weighted average (by purchased electricity) for this indicator was below the simple average. In fact, when looking at the components of the electricity price, it is apparent that larger consumers paid 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. No plant bought electricity directly on the wholesale market.
- **Electricity costs in €/MWh** (simple average) increased from €75/MWh in 2008 to €79/MWh in 2012 and then decreased to €65/MWh in 2017. The increasing difference between electricity prices and costs (rising up to €10/MWh in 2017) can be explained by the following factors: i) five plants participated in flexibility schemes; and ii) 50% of the plants were reimbursed *ex post* for some components of their electricity price (mainly RES levies and other taxes). Both compensation for flexibility schemes and *ex post* reimbursement grew in the most recent years. No plant was self-generating electricity throughout the period under observation. The weighted average (by electricity consumption) for this indicator was lower than the simple average, confirming better conditions for larger consumers. When looking at differences between weighted and simple averages for electricity prices and electricity costs in €/MWh, it is apparent that larger consumers benefitted the most from flexibility schemes and *ex post* reimbursement (expect for the last two years under observation).
- **Electricity costs in €/tonne** (simple average) also increased from €24/tonne in 2008 to €26/tonne in 2012 and, subsequently, declined to €21/tonne in 2017; this is mainly due to the recent decline in electricity prices. The **electricity intensity** of the production process (simple average) remained stable over the 10-year period, ranging between 0.32 MWh/tonne and 0.34 MWh/tonne. The weighted averages (by production output) for both electricity costs in €/tonne and electricity intensity were slightly below simple averages; this may indicate that besides facing lower electricity prices, larger producers benefitted from economies of scale.

Natural gas

- 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, which is linked to wholesale prices.
- After peaking in 2012 and 2013, the **natural gas price** (simple average) decreased sharply, falling from almost €32/MWh to €21/MWh in 2017. The EU weighted average (by purchased gas) was very close to the simple average; therefore, there is no difference between prices paid by large and small consumers.

- **Natural gas costs** (simple average) ranged between €44 and €53/tonne between 2008 and 2015. They decreased in recent years, falling to around €35/tonne in 2016 and 2017. The **natural gas intensity** in MWh/tonne 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. The EU weighted averages (by production output) for both indicators was slightly below the simple averages, suggesting that larger producers benefit from economies of scale.

Competitiveness

- The share of **electricity costs** in **total production costs** (simple average) declined between 2008 and 2017, from 8% to 7%. In fact, whereas electricity costs in €/tonne decreased after 2012, production costs in €/tonne followed a slightly rising trend. Larger plants faced both lower electricity costs and lower production costs in €/tonne. This is most likely due to: i) economies of scale; ii) *ex ante* exemptions and *ex post* reimbursement of regulatory components of the electricity price; and iii) revenues from flexibility schemes. The share of electricity costs related to total production costs is, however, very similar in large and small plants.
- The share of **natural gas costs** in **total production costs** (simple average) ranged between 16% and 17% from 2008 to 2014, but **decreased significantly** thereafter, falling from 15% in 2015 to 11% in 2017. Natural gas costs represented on average a larger share of production costs in larger plants; this is in line with the evidence above showing that larger consumers do not benefit from lower prices for natural gas.
- The share of electricity costs relative to **turnover** (simple average) declined from about 6% in 2008 to less than 5% in 2017. Natural gas costs fell from more than 12% (2008) to less than 8% (2017) of the average sectoral turnover (simple average). Trends in turnover were similar to trends in production costs.
- Electricity and natural gas costs are lower than **EBITDA** for all years under observation. While electricity costs are also lower than **EBIT**, natural gas costs are lower than EBIT for some years and higher than this profitability indicator for other years. However, it is not possible to draw conclusions about the impact of electricity and natural gas costs on profitability by looking at trends in costs and margins (more details on this point are provided in Annex B to this Study).

Sample and limitations

- The **sample** includes 24 plants representing about **17% of the total production sold** by EU packaging glass producers (in value). Sampled plants are equally distributed across the NWE, SE and CEE regions; hence, while the NWE region is most likely under-represented (almost 60% of the EU production value is generated by NWE Member States), the CEE region appears to be over-represented (less than 15% of the EU production value is generated in this region). All plants belong to large companies and this fully reflects the population of EU producers of packaging glass.
- 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.
- For some indicators, the number of available observations varies between years; the trends may therefore be affected by **changes in the sample size**. More details about the number of observations are provided beneath each figure and table.

5.1 *Composition of the sample*

Sampling strategy

To segment the EU population of packaging glass producers (NACE 23.13) into homogenous groups, the following sampling criteria need to be taken into account:

- Production technology/product range (subsectors)
- Geographical distribution.

Whereas technologies adopted in the hollow glass sector are fairly homogenous irrespective of the final shape of the products (e.g. bottles, jars, drinking glasses), the Cumulative Cost Assessment of the EU Glass Industry[37] identified important elements of heterogeneity (in terms of production costs, margins and energy intensity) between packaging glass, e.g. bottles and jars, flacons and glass tableware, e.g. drinking glasses. Therefore, the present Assignment reflects this heterogeneity and relies on two different sample for the two sectors.

The samples for packaging glass are divided into three geographical regions, to take into account differences in energy prices and costs stemming from the plant location.

In addition, it is worth remarking that within the packaging glass sector additional elements of heterogeneity exist. In fact, producers of flacons represent a small segment (in volume) characterised by high costs and high margins; therefore, data collected from plants operating in this segment cannot be averaged with those collected from producers of bottles and jars. The very limited number of plants producing flacons in the EU does not allow for collecting and presenting figures for this segment.

The packaging glass sector is almost entirely composed of large companies. This was confirmed by the relevant EU industry association (FEVE), and it is coherent with Eurostat SBS data. When it comes to the value chain configuration, in the packaging glass value chain, downstream activities appear to play a minor role and, with few exceptions, e.g. some decorating and/or labelling activities, are performed within the same plant producing packaging glass. Any impact of plant size on energy prices and costs is assessed when comparing weighted and simple averages.

Against this background and in light of the methodology presented in the Inception Report, Table 87 shows the target sample for this Assignment.

Table 87 Minimum number of plants to be surveyed

Geographical regions	Packaging glass
Southern Europe	5
Central-Eastern Europe	5
North-Western Europe	5
Total	**15**

Source: Authors' elaboration

Box 8 Key features of the packaging glass sector

- Key statistics pertaining to the packaging glass sector (part of NACE 23.13) are presented as follows:
  - Production value (2015): €8,888 million
  - Number of plants (2016, FEVE data): fewer than 200

[37] CEPS et al. (2017), Cumulative Cost Assessment of the EU glass industry.

- Top five European packaging glass producers (2016, production value): France (21%), Italy (21%), Germany (19%), United Kingdom (11%), and Spain (11%)
- Intra-EU vs extra-EU trade (2017): intra-EU trade accounts for more than 80% of the total trade value. With regard to international trade, the EU is a net exporter of packaging glass.
- The main importers of European packaging glass (2017) are the United States, Switzerland, Canada, Russia and Serbia.
- The main exporters to the EU of packaging glass (2017) are China, Ukraine, Switzerland, India and the United Arab Emirates.

- The sector is mostly composed of large companies owning multiple production sites in the EU and third countries. The production process of the hollow glass sector (glass tableware and packaging glass) entails the following activities:
  - Preparation of the raw materials (batching and mixing)
  - Melting and refining
  - Forming (blow-and-blow and press-and-blow process)
  - Annealing and (online) coating
  - Inspection
- Most of the plants included in this study tend to fall in the following ranges (first quartile – third quartile range) for the indicators presented:
  - Electricity consumption: from 32,000 MWh to 67,500 MWh per year;
  - Electricity intensity: 0.27 MWh/tonne and 0.37 MWh/tonne
  - Natural gas consumption: from 174,000 MWh to 340,000 MWh per year;
  - Natural gas intensity: 1.4 MWh/tonne and 2.1 MWh/tonne

For additional details pertaining to the production process and sector information, please refer to Annex A.

<u>Sample statistics</u>

In order to perform the Assignment, the Research Team shared the questionnaire with 106 plants producing packaging in the EU (Table 88). The questionnaire was eventually completed by 24 plants. Data confidentiality issues were assessed on a case-by-case basis, by taking into account the number of observations available for each indicator. None of the surveyed plants accepted sharing supporting evidence; however, the main findings were crosschecked with data on packaging glass published by the Commission in the Cumulative Cost Assessment of the EU Glass Industry.

Table 88 Plants participating in the survey

Geographical regions	Packaging glass		
	Plants contacted	Questionnaires collected	Number of plants sharing supporting evidence
Southern Europe	38	8	0
Central-Eastern Europe	16	8	0
North-Western Europe	52	8	0
Total	**106**	**24**	**0**

Source: Authors' elaboration

The sample represents more than 17% of the total turnover sold by EU packaging glass producers in the period under investigation (Table 89). However, the true coverage of the EU population is expected to be higher as some plants did not provide their turnover. It is worth mentioning that, in order to increase the response rate, the Research Team sent several rounds of reminders via email to all contacted companies.

Table 89 Turnover of sampled plants out of total value of production sold by EU producers (%)

Packaging glass	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Turnover %	16	17	16	16	17	16	16	17	17	n.a.
Number of plants disclosing their turnover	22	22	22	22	22	22	22	22	22	15

Note: PRODCOM value for 2017 is not available.
Source: Authors' elaboration on data collected at the plant level and PRODCOM.

International comparison

It is not possible to perform the international comparison in the packaging glass sector for two main reasons. First, the number of EU companies is fairly limited and only some of them manage facilities that are based in third countries; more specifically, in the context of this Assignment, only two producers were willing to share international data with the Research Team and this would not allow such data to be shown due to confidentiality reasons. Second, no reliable private database is available to purchase relevant data.

5.2 Electricity

Table 90 summarises the main indicators detailing electricity prices and costs in the EU packaging glass sector. Electricity prices and costs (in €/MWh) remained relatively stable between 2008 and 2017; this is mainly due to an increase in the regulated components of the electricity price that compensated for decreasing electricity wholesale prices. The increasing difference between electricity prices and costs (rising up to €10/MWh in 2017) can be explained by the following factors: i) five plants participated in flexibility schemes; and ii) 50% of the plants were reimbursed *ex post* for some components of their electricity price (mainly RES levies and other taxes). Electricity costs in €/tonne decreased slightly across the period under investigation.

Table 90 Electricity: summary table (EU, simple averages)

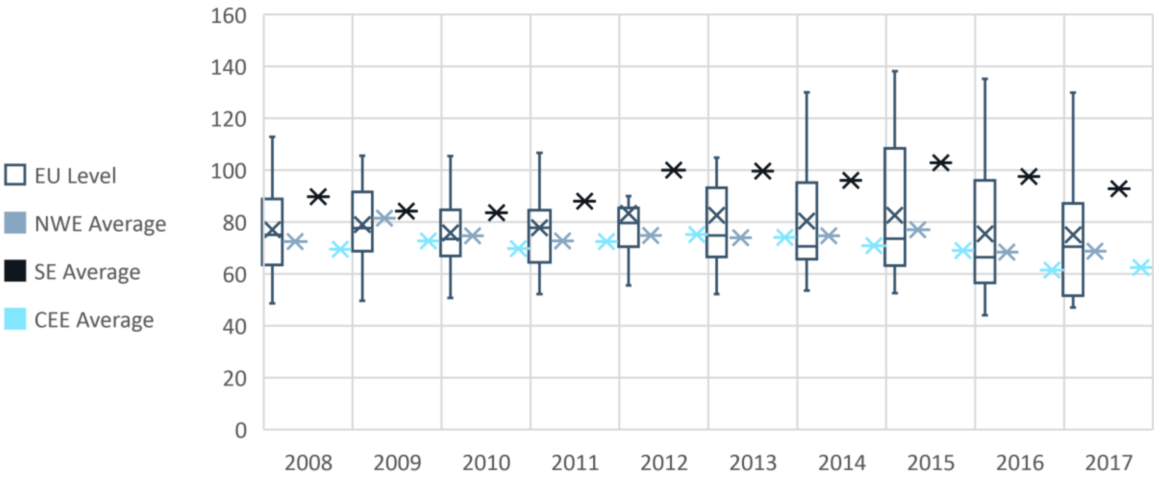
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity prices (€/MWh)	77.0	79.0	75.8	77.7	83.3	82.5	80.3	82.6	75.4	75.0
Electricity costs (€/MWh)	75.3	77.3	74.1	73.5	79.1	77.0	73.1	76.0	68.9	64.8
Electricity costs (€/tonne)	24.3	26.0	24.5	24.2	26.2	25.6	23.2	24.5	22.1	20.6
Electricity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

Source: Authors' elaboration

Electricity prices

Electricity prices paid by packaging glass producers varied over the 2008-2017 period, with a peak in 2012/2013 and then decreased by 2017 to their lowest value during the period under observation (EU simple average of €75.0/MWh in 2017) (Table 91 and Figure 69). However, electricity prices appear to be much higher in the SE region than in the NWE and CEE regions, and well above the EU average (SE simple average of €92.8/MWh in 2017). The weighted average (by purchased electricity; Table 91) for this indicator was below the simple average.[38] In fact, when looking at the components of the electricity price (see below), it is apparent that larger consumers paid 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.

Figure 69 Electricity prices (€/MWh) – Box plots and simple averages



Note: Based on observations from 24 plants except for 2017 where observations from only 20 plants were available.
Source: Authors' elaboration

Table 91 Electricity prices (€/MWh) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	Weighted	70.5	80.1	75.9	68.2	70.0	67.8	66.4	67.1	57.5	64.9
	Simple	71.7	81.8	74.4	71.0	73.1	72.3	72.5	74.4	65.3	68.7
SE	Weighted	90.3	83.2	82.2	87.0	97.3	94.3	89.7	97.1	91.7	89.9
	Simple	89.7	84.1	83.5	88.0	99.9	99.6	96.0	102.9	97.5	92.8
CEE	Weighted	69.2	71.5	69.1	73.7	77.2	76.9	71.7	69.9	62.9	61.6
	Simple	69.7	71.1	69.5	74.1	76.9	75.6	72.5	70.5	63.5	62.4
EU	Weighted	**76.4**	**78.5**	**75.8**	**76.4**	**81.5**	**79.5**	**75.8**	**77.9**	**70.7**	**73.6**
	Simple	**77.0**	**79.0**	**75.8**	**77.7**	**83.3**	**82.5**	**80.3**	**82.6**	**75.4**	**75.0**

Note: weighting factor: electricity purchased; based on observations from 24 plants except for 2017 where observations from only 20 plants were available.
Source: Authors' elaboration

Components of the electricity price[39]

Table 92 and Figure 70 and Figure 71 show the components of the electricity prices for producers of packaging glass in the EU. These are distributed across the following categories: energy component, network and capacity component, RES levies, and other non-recoverable

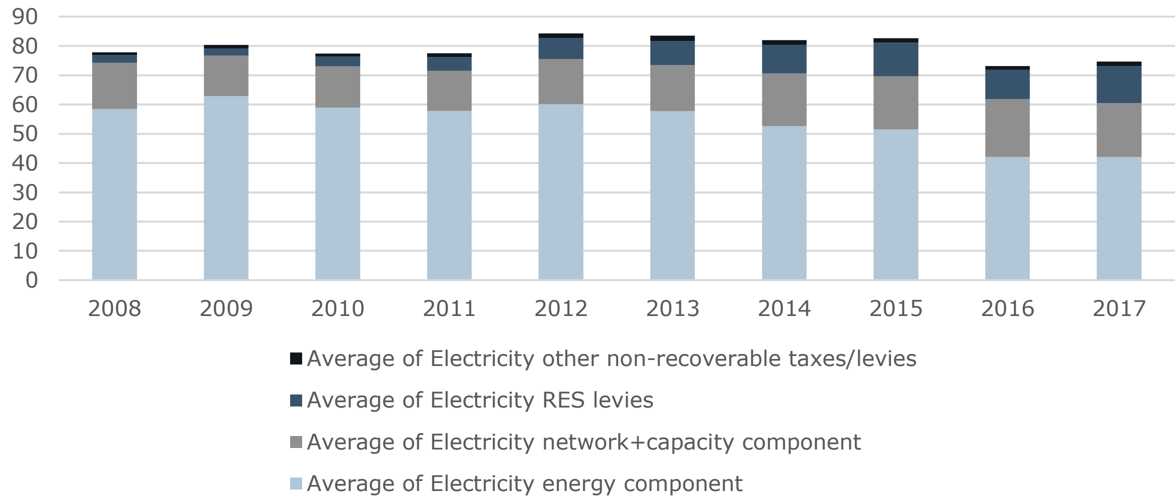
[38] Interestingly, this difference is less pronounced than in the glass tableware sector. This is because the packaging glass sector is composed of plants that are more homogenous in size than glass tableware plants; therefore, the difference in terms of electricity consumption between large and small plants is more limited than in the glass tableware sector.

[39] The sum of the electricity bill components does not necessarily add up to the total electricity price mentioned before, as there might be plants that did not provide a breakdown of the electricity bill components while still providing the total electricity price.

taxes and levies. Average electricity network costs and RES levies increased in electricity prices over the period studied, while during the same period the energy component decreased. No sampled packaging glass producer reported having capacity market costs within their electricity price.

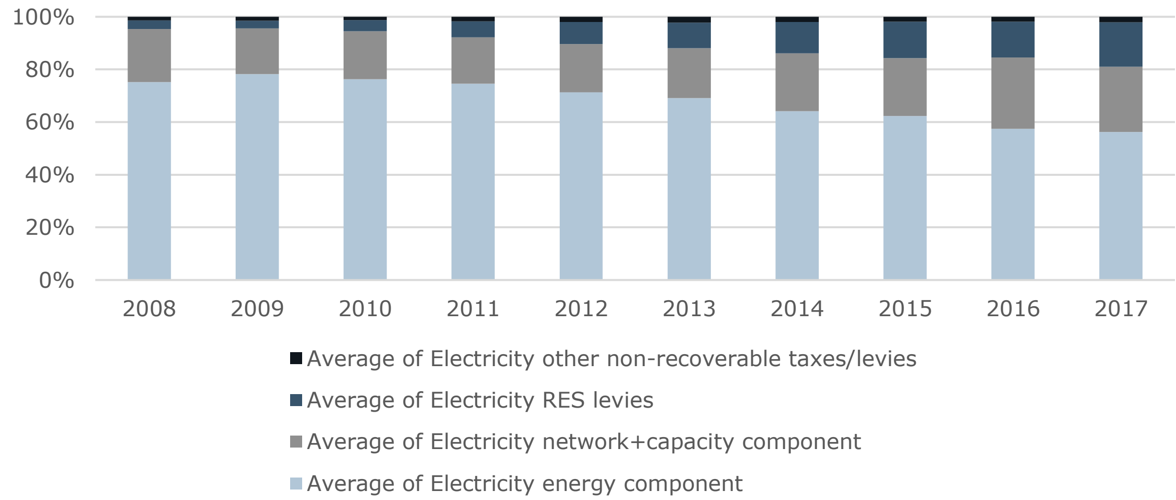
Figure 71 shows the relative share of different price components in electricity prices. The visual representation shows more clearly the increase in the share of regulatory costs on electricity prices and the decreasing share of the energy component. Table 92, Table 93, Table 94 and Table 95 show the simple as well as weighted average for each component. For network costs, weighted averages are below simple averages showing that larger consumers in general pay slightly less for this component. As for the RES levy component, weighted averages are up to 20% below simple averages, showing the larger consumers most likely receive a higher share of RES levy exemptions compared to smaller consumers.

Figure 70 Components of the electricity price (€/MWh, EU) – Simple averages



Note: based on observations from 18 plants in 2008-2012, 20 in 2013-2015, 19 in 2016 and 16 observations in 2017.
Source: Authors' elaboration

Figure 71 Components of the electricity price (€/MWh, EU) – Simple averages



Note: based on observations from 18 plants in 2008-2012, 20 in 2013-2015, 19 in 2016 and 16 observations in 2017.
Source: Authors' elaboration

Table 92 Components of the electricity price: energy component (€/MWh) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	Weighted	54.3	65.7	65.1	55.7	57.9	58.1	51.5	50.7	38.6	36.8
	Simple	56.9	68.7	64.3	57.4	59.4	61.9	53.2	52.8	40.6	38.4
SE	Weighted	77.2	74.6	67.9	71.7	74.8	67.3	63.2	65.9	48.7	57.7
	Simple	75.9	75.2	68.7	72.7	75.1	69.0	63.5	63.3	48.9	56.4
CEE	Weighted	50.4	52.3	47.8	47.7	50.8	47.4	44.7	42.8	38.7	36.4
	Simple	51.0	52.4	48.9	48.8	51.2	46.9	45.3	43.0	38.8	36.5
EU	Weighted	**57.6**	**61.9**	**58.5**	**56.8**	**59.6**	**56.5**	**51.9**	**51.6**	**41.3**	**42.8**
	Simple	**58.5**	**62.9**	**59.0**	**57.9**	**60.1**	**57.7**	**52.6**	**51.5**	**42.1**	**42.1**

Note: weighting factor: electricity purchased; based on observations from 18 plants in 2008-2012, 20 in 2013-2015, 19 in 2016 and 16 observations in 2017.
Source: Authors' elaboration

Table 93 Components of the electricity price: network + capacity component (€/MWh) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	Weighted	7.5	7.6	7.9	5.3	5.3	5.4	8.4	8.6	7.1	12.7
	Simple	7.0	7.2	7.2	6.1	6.1	6.1	11.3	11.6	9.3	14.0
SE	Weighted	22.8	16.4	15.7	10.5	15.7	19.4	20.5	20.0	28.4	20.5
	Simple	24.4	16.0	15.2	10.4	17.9	23.3	24.5	25.4	32.9	20.8
CEE	Weighted	17.9	18.2	19.0	20.3	19.6	20.1	19.6	18.6	18.9	19.4
	Simple	18.0	17.9	18.6	20.3	19.8	19.6	19.9	19.3	19.5	20.3
EU	Weighted	**15.5**	**14.1**	**14.7**	**12.9**	**13.7**	**14.3**	**15.5**	**15.1**	**17.3**	**18.1**
	Simple	**15.7**	**13.9**	**14.1**	**13.6**	**15.5**	**15.8**	**18.0**	**18.1**	**19.8**	**18.4**

Note: weighting factor: electricity purchased; based on observations from 18 plants in 2008-2012, 20 in 2013-2015, 19 in 2016 and 16 observations in 2017.
Source: Authors' elaboration

Table 94 Components of the electricity price: RES levies (€/MWh) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	Weighted	5.2	2.7	3.0	3.7	2.1	1.8	3.9	5.4	4.6	11.9
	Simple	3.5	2.6	3.0	3.9	2.1	2.4	6.2	8.4	7.2	13.6
SE	Weighted	5.6	5.8	6.6	9.0	14.4	14.6	15.4	17.1	17.9	18.3
	Simple	5.0	5.3	6.0	9.0	14.7	16.0	19.2	21.8	21.7	24.6
CEE	Weighted	0.8	0.9	2.1	2.8	6.1	8.7	6.9	7.9	4.6	5.2
	Simple	0.6	0.7	1.8	2.6	5.2	8.3	6.8	7.6	4.7	5.2
EU	Weighted	**3.3**	**2.6**	**3.6**	**4.7**	**7.0**	**7.6**	**7.9**	**9.2**	**8.1**	**10.7**
	Simple	**2.6**	**2.4**	**3.3**	**4.7**	**7.0**	**8.2**	**9.7**	**11.4**	**9.9**	**12.7**

Note: weighting factor: electricity purchased; based on observations from 18 plants in 2008-2012, 20 in 2013-2015, 19 in 2016 and 16 observations in 2017.
Source: Authors' elaboration

Table 95 Components of the electricity price: Other non-recoverable taxes/levies (€/MWh) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	Weighted	1.4	1.2	1.7	1.5	2.2	2.0	2.1	1.8	1.5	2.2
	Simple	1.3	1.1	1.6	1.5	2.1	1.9	2.0	1.6	1.5	2.2
SE	Weighted	2.7	3.8	1.8	1.9	2.5	2.9	2.5	2.7	2.3	2.1
	Simple	2.4	3.6	1.6	2.2	2.8	3.3	3.0	2.9	2.5	2.4
CEE	Weighted	0.1	0.1	0.1	0.7	0.7	0.7	0.5	0.7	0.6	0.6
	Simple	0.1	0.1	0.1	0.7	0.7	0.8	0.5	0.6	0.5	0.6
EU	Weighted	**1.1**	**1.3**	**1.1**	**1.3**	**1.7**	**1.7**	**1.6**	**1.6**	**1.4**	**1.5**
	Simple	**1.0**	**1.2**	**1.0**	**1.3**	**1.7**	**1.8**	**1.7**	**1.5**	**1.4**	**1.5**

Note: weighting factor: electricity purchased; based on observations from 18 plants in 2008-2012, 20 in 2013-2015, 19 in 2016 and 16 observations in 2017.
Source: Authors' elaboration

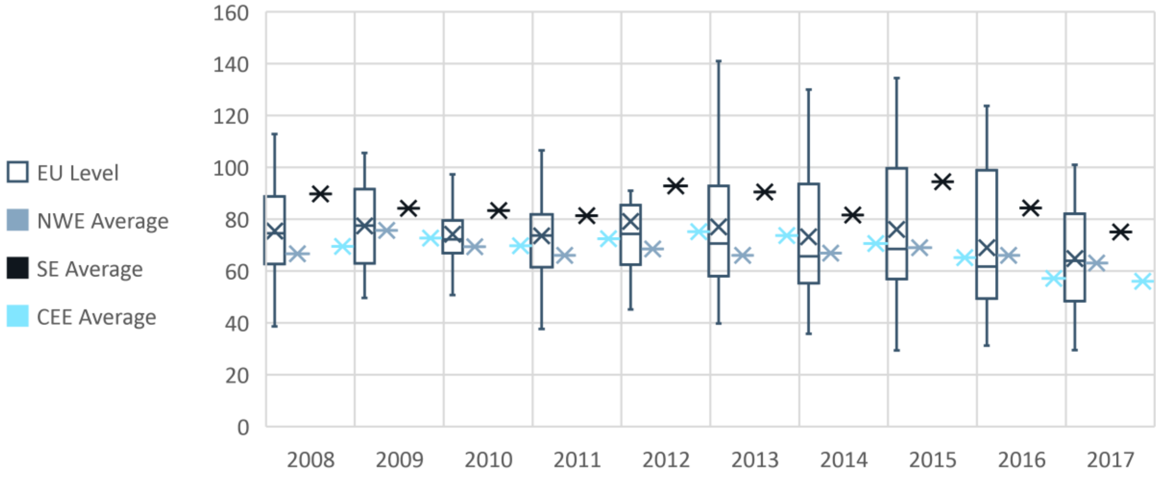
Electricity costs

Table 96 and Figure 72 show the electricity costs borne by producers of packaging glass in the EU in €/MWh.[40] Electricity costs in the SE region are well above the EU average. This can be explained by higher electricity prices in the SE region (see above Table 91 and Figure 69). The trend of electricity costs for packaging glass producers is very similar to electricity prices. However, the increasing difference between electricity prices and costs (rising up to €10/MWh in 2017) can be explained by the following factors: i) five plants participated in flexibility schemes; and ii) 50% of the plants were reimbursed *ex post* for some components of their electricity price (mainly RES levies and other taxes). Both compensation for flexibility schemes and *ex post* reimbursement grew in the most recent years.

Table 96 shows simple and weighted averages of packaging glass producers' electricity costs in €/MWh. The weighted average (by electricity consumption) for this indicator was lower than the simple average, confirming better conditions for larger consumers. When looking at differences between weighted and simple averages for electricity prices and electricity costs in €/MWh, it is apparent that larger consumers benefitted the most from flexibility schemes and *ex post* reimbursement (expect for the last two years under observation).

[40] Electricity prices in €/MWh are defined as follows: Total price paid to purchase electricity/Total electricity purchased. Electricity costs in €/MWh are defined 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).

Figure 72 Electricity costs (€/MWh) – Box plots and simple averages



Note: based on observations from 24 plants except for 2016 where observations from only 23 plants were available and 2017 where observations from 20 plants were available.
Source: Authors' elaboration

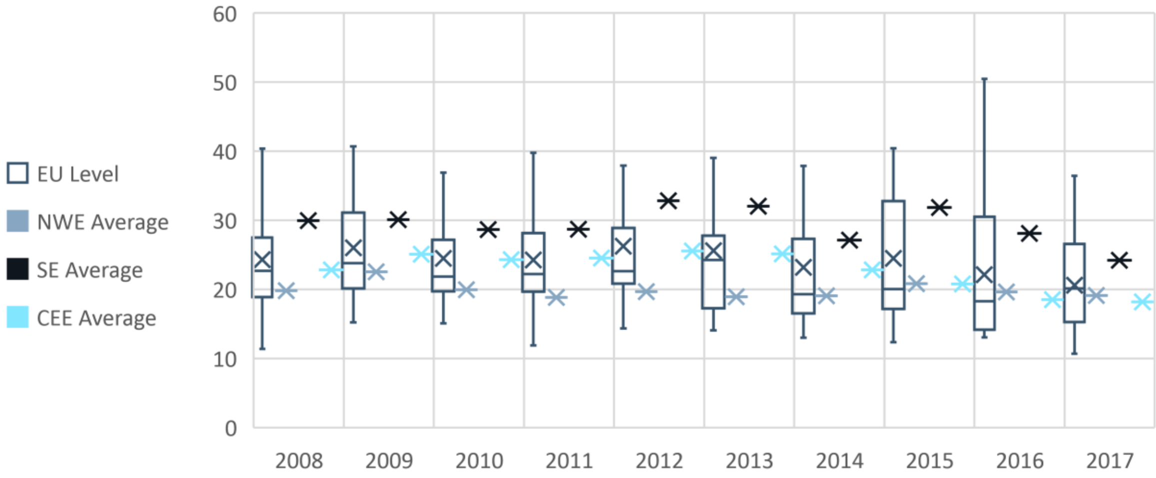
Table 96 Electricity costs (€/MWh) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	Weighted	64.7	73.9	70.0	60.2	62.7	59.2	57.8	58.6	56.4	58.0
	Simple	66.7	76.7	69.7	65.1	67.6	65.3	65.6	67.3	62.9	63.1
SE	Weighted	90.3	83.2	81.9	80.0	89.6	84.9	76.1	88.6	79.7	74.7
	Simple	89.7	84.1	83.3	81.4	92.8	90.4	81.5	94.4	84.3	75.1
CEE	Weighted	69.2	71.5	69.1	73.7	77.2	76.7	71.4	65.4	57.7	54.6
	Simple	69.7	71.1	69.5	74.1	76.9	75.3	72.3	66.3	58.8	56.0
EU	Weighted	**74.3**	**76.3**	**73.7**	**71.4**	**76.4**	**73.2**	**68.1**	**70.7**	**65.3**	**63.4**
	Simple	**75.3**	**77.3**	**74.1**	**73.5**	**79.1**	**77.0**	**73.1**	**76.0**	**68.9**	**64.8**

Note: weighting factor: total electricity consumption; based on observations from 24 plants except for 2016 where observations from only 23 plants were available and 2017 where observations from 20 plants were available.
Source: Authors' elaboration

Table 97 and Figure 73 show electricity costs borne by producers of packaging glass in the EU in €/tonne. Similar to previous graphs, plants operating in the SE region bear higher costs. The trends in electricity costs in €/tonne and €/MWh are similar: both indicators have been decreasing in recent years, after peaking in 2012. This decrease is mainly due to a decline in electricity prices, rather than an increase in the electricity efficiency of the production process (see below). Weighted averages (see Table 97) appear to be still lower than simple averages, thus confirming some cost advantage for larger plants.

Figure 73 Electricity costs (€/tonne) – Box plots and simple averages



Note: based on observations from 24 plants except for 2016 where observations from only 23 plants were available and 2017 where observations from 20 plants were available.
Source: Authors' elaboration

Table 97 Electricity costs (€/tonne) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	016	2017
NWE	Weighted	20.1	23.4	21.4	18.4	19.3	18.4	17.7	18.5	16.9	17.5
	Simple	20.3	23.6	20.8	19.2	19.8	19.2	19.0	20.5	18.7	19.1
SE	Weighted	29.0	28.4	27.2	27.3	29.7	27.9	23.5	28.1	25.0	23.7
	Simple	29.9	30.1	28.6	28.7	32.8	32.0	27.1	31.9	28.1	24.2
CEE	Weighted	22.2	24.0	23.4	24.3	25.4	25.0	22.8	20.5	18.2	17.4
	Simple	22.7	24.3	23.9	24.8	26.1	25.6	23.4	21.1	19.1	18.2
EU	Weighted	**23.5**	**25.2**	**23.9**	**23.2**	**24.6**	**23.5**	**21.2**	**22.3**	**20.3**	**19.9**
	Simple	**24.3**	**26.0**	**24.5**	**24.2**	**26.2**	**25.6**	**23.2**	**24.5**	**22.1**	**20.6**

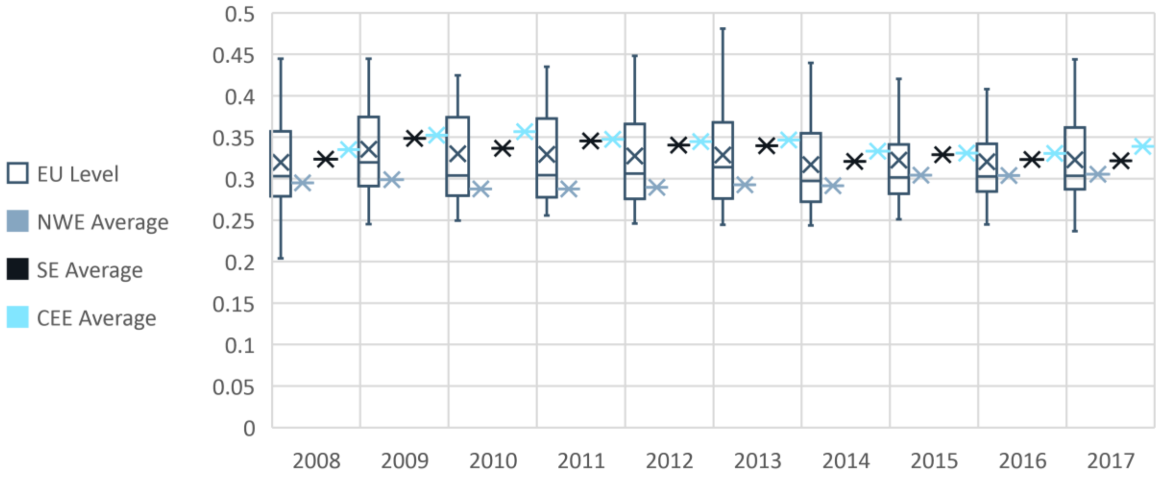
Note: weighting factor: production output; based on observations from 24 plants except for 2016 where observations from only 23 plants were available and 2017 where observations from 20 plants were available.
Source: Authors' elaboration

Electricity intensity

Table 98 and Figure 74 show the electricity intensity of packaging glass production in the EU in MWh/tonne. Most plants across the EU reported similar electricity intensities in the packaging glass sector, showing a relatively small standard deviation during the period under observation. This is likely due to the similar production process across plants in all regions. However, the NWE region shows slightly lower electricity intensity compared to the SE and CEE regions during the period under observation.

Electricity intensity remained stable over the period. This may indicate that technical improvements in the electricity efficiency of the production process were more limited than those related to natural gas efficiency (see below). The weighted averages (by production output) for electricity intensity were slightly below simple averages; therefore, besides facing lower electricity prices, larger producers benefitted (to some extent) from economies of scale.

Figure 74 Electricity intensity (MWh/tonne) – Box plots and simple averages



Note: based on observations from 24 plants except for the year 2017 where observations from only 20 plants were available.
Source: Authors' elaboration

Table 98 Electricity intensity (MWh/tonne) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	**Weighted**	0.31	0.32	0.31	0.31	0.31	0.31	0.31	0.32	0.31	0.30
	Simple	0.30	0.31	0.30	0.30	0.30	0.30	0.30	0.31	0.30	0.31
SE	**Weighted**	0.32	0.34	0.33	0.34	0.33	0.33	0.31	0.32	0.31	0.32
	Simple	0.32	0.35	0.34	0.35	0.34	0.34	0.32	0.33	0.32	0.32
CEE	**Weighted**	0.32	0.34	0.34	0.33	0.33	0.33	0.32	0.31	0.31	0.32
	Simple	0.33	0.35	0.35	0.34	0.34	0.35	0.33	0.33	0.33	0.34
EU	**Weighted**	**0.32**	**0.33**	**0.32**	**0.32**	**0.32**	**0.32**	**0.31**	**0.32**	**0.31**	**0.31**
	Simple	**0.32**	**0.34**	**0.33**	**0.33**	**0.33**	**0.33**	**0.32**	**0.32**	**0.32**	**0.32**

Note: weighting factor: production output; based on observations from 24 plants except for the year 2017 where observations from only 20 plants were available.
Source: Authors' elaboration

Additional information

All 24 packaging glass plants included in the Final Report reported that they purchased their electricity through an electricity provider, and that they have contracts with their electricity provider for up to five years. Of those 24 plants, five answered that they take part in an interruptibility scheme.

Several plants reported experiencing planned outages in relation to interruptibility schemes; however, the duration of these outages was quite low. Fourteen plants reported experiencing unplanned outages over the period 2015 to 2017; four plants reported experiencing a very high number of unplanned outages in the same period. The reasons for these unplanned outages have not been described by plants in the questionnaires. No packaging glass producers reported as self-generating electricity, therefore the difference between electricity prices and electricity costs in €/MWh is due to compensation for flexibility schemes and *ex post* reimbursement.

Table 99: Electricity outages

	Planned outages		Other planned outages		Unplanned outages	
	Total number	Average duration	Total number	Average duration	Total number	Average duration
2015	7	34	0	0	91	399
2016	9	32	1	13	81	117
2017	4	30	1	14	39	135

Note: Planned outages are linked to flexibility schemes; other planned outages are not linked to flexibility schemes, but notified in advance by the energy supplier; unplanned outages are not notified.
Source: Authors' elaboration

5.3 Natural gas

Table 100 recaps the main indicators related to natural gas prices and costs in the EU packaging glass sector. Gas prices and costs fluctuated across the period under observation and underwent a sharp decrease in 2016 and 2017; this was mainly due to a decrease in the energy component of the gas price. The natural gas intensity of the production process recorded a moderate decrease between 2008 and 2017 and natural gas costs in €/tonne were at their minimum in 2017, as a result of the exceptionally low natural gas price in that year.

Table 100 Natural gas: summary table (EU, simple averages)

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas prices (€/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

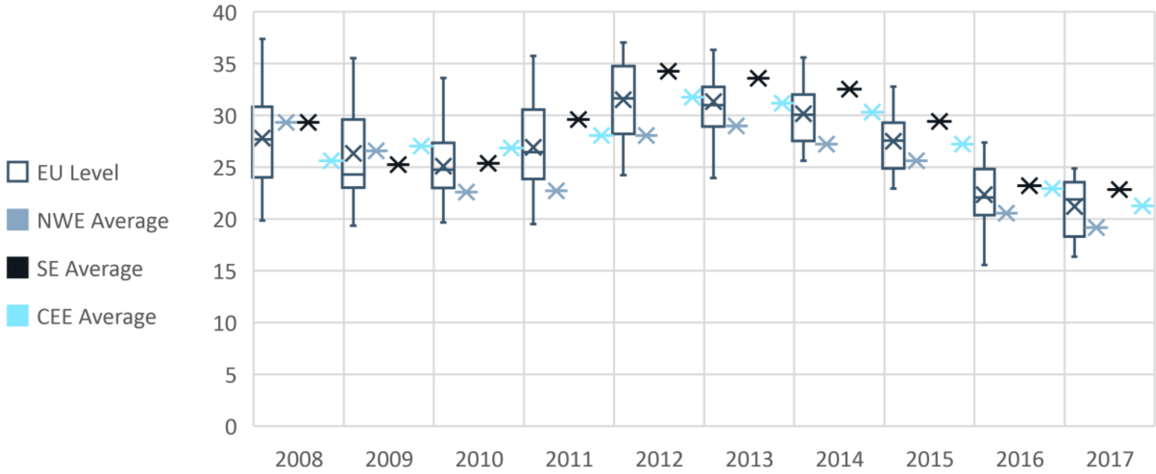
Source: Authors' elaboration

Natural gas prices

Table 101 and Figure 75 show that, after peaking in 2012 and 2013, the average price paid by producers of packaging glass for natural gas decreased sharply, especially in 2016 and 2017, reaching as low as €21.2/MWh (EU weighted average) in 2017. The price of natural gas reported by all plants did not deviate significantly from the mean. Plants in the SE region reported on average higher natural gas prices than in the NWE region.

Table 101 shows simple and weighted averages of natural gas prices reported by packaging glass producers. In general, the EU weighted average (by purchased gas) is very close to the simple average; therefore, there is no difference between prices paid by large and small consumers. This may be related to the limited variance in natural gas consumption across plants, which are more homogenous than those operating in other sectors. For the CEE and SE regions it is not always the case that weighted averages are below simple averages. This may reveal that gas prices are more rigid than electricity prices and bargaining power does not always help obtain better tariffs. In fact, it does not help in the regions where the gas prices are the highest (SE and CEE).

Figure 75 Natural gas prices (€/MWh) – Box plots and simple averages



Note: based on observations from 24 plants for 2012-2016, except for 2008 where observations from only 22 plants were available, 2009-2011 where observations from 23 plants were available and 2017 where observations from only 20 plants were available.
Source: Authors' elaboration

Table 101 Natural gas prices (€/MWh) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	**Weighted**	28.4	28.5	22.9	22.9	28.6	29.5	27.6	25.9	20.7	19.0
	Simple	28.5	27.7	22.9	23.1	28.4	29.3	27.6	26.1	20.9	19.2
SE	**Weighted**	28.5	24.4	25.2	29.7	34.2	33.3	32.8	29.3	22.8	22.6
	Simple	29.3	25.2	25.4	29.6	34.2	33.6	32.5	29.4	23.2	22.8
CEE	**Weighted**	25.4	25.8	27.7	28.8	31.9	31.5	30.4	27.0	23.6	21.7
	Simple	25.8	25.9	27.1	28.3	31.8	31.1	30.3	26.9	22.9	21.3
EU	**Weighted**	**27.2**	**26.5**	**25.2**	**26.8**	**31.4**	**31.3**	**30.2**	**27.5**	**22.3**	**21.2**
	Simple	**27.8**	**26.3**	**25.1**	**26.9**	**31.5**	**31.3**	**30.1**	**27.5**	**22.3**	**21.2**

Note: weighting factor: gas purchased; based on observations from 24 plants for 2012-2016, except for 2008 where observations from only 22 plants were available, 2009-2011 where observations from 23 plants were available and 2017 where observations from only 20 plants were available.
Source: Authors' elaboration

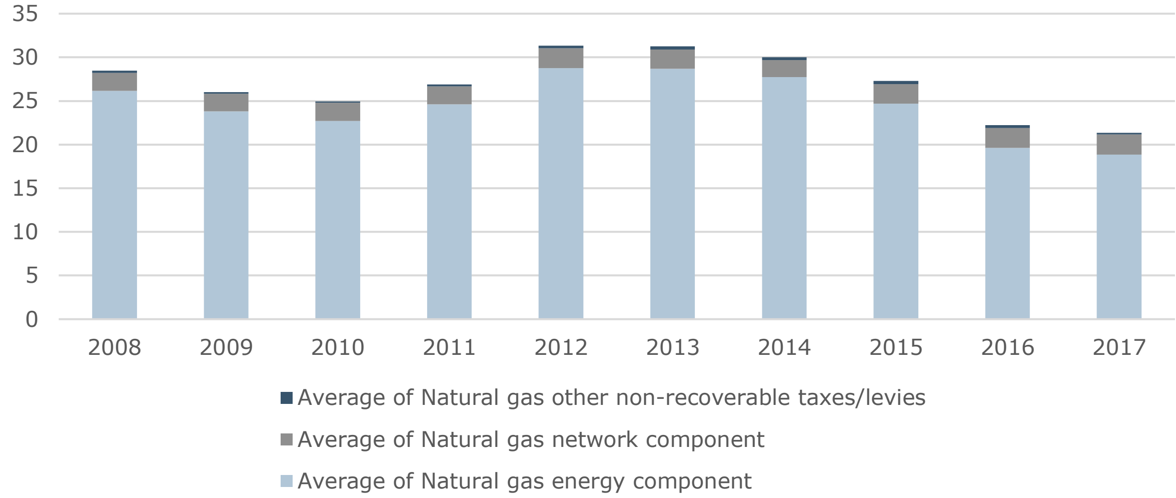
Components of the natural gas price[41]

Whereas the energy component of the gas price registered a decreasing trend after peaking in 2012-2013, the other components of the price (network component and other non-recoverable taxes and levies) remained fairly stable, with only mild fluctuations. As a result, the non-energy components represent a larger share of the final price in 2017 than in 2008. However, regulatory components play a more limited role in the gas price than in the electricity price. The relative share of regulatory components in natural gas prices, reported by plants, is between 7-11%. Network costs make up the largest share of the regulatory costs.

[41] The sum of the natural gas bill components does not necessarily add up to the total natural gas price mentioned before, as there might be plants that did not provide a breakdown of the natural gas bill components while still providing the total natural gas price.

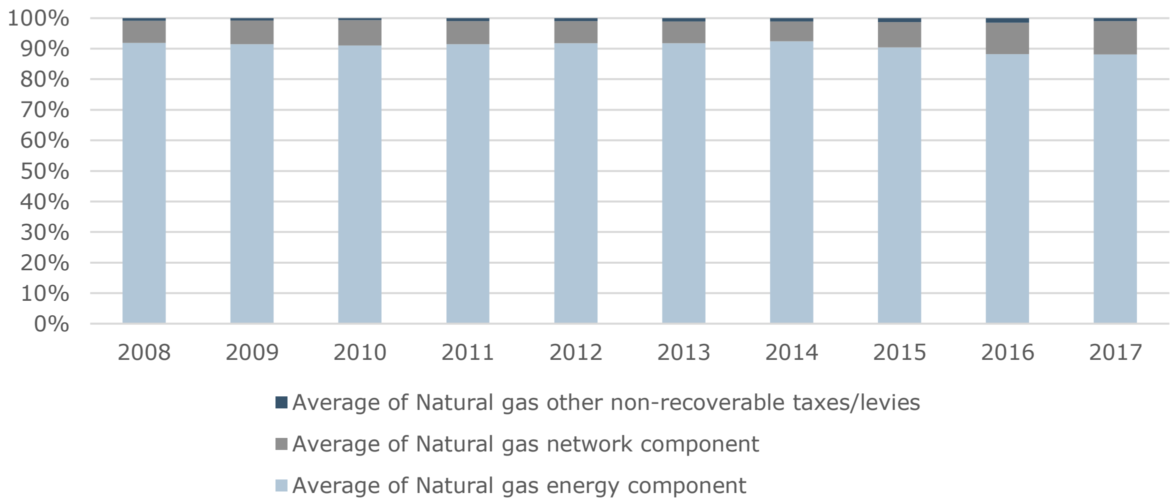
Table 102, Table 103 and Table 104 show simple and weighted averages of components of the natural gas price reported by packaging glass producers. In general, weighted averages follow simple averages very closely, which is consistent with similar prices for smaller and larger consumers.

Figure 76 Components of the natural gas price (€/MWh, EU) – Simple averages



Note: based on observations from 22 plants except for 2008 where observations from only 15 plants were available, 2009-2010 where observations from only 19 plants were available and 2017 where observations from only 16 plants were available.
Source: Authors' elaboration

Figure 77 Components of the natural gas price (%, EU) – Simple averages



Note: based on observations from 22 plants except for 2008 where observations from only 15 plants were available, 2009-2010 where observations from only 19 plants were available and 2017 where observations from only 16 plants were available.
Source: Authors' elaboration

Table 102 Components of the natural gas price: energy component (€/MWh) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	Weighted	28.2	26.1	21.6	21.8	27.3	28.2	26.4	24.0	19.2	17.9
	Simple	28.0	25.3	21.7	21.9	27.1	28.0	26.3	24.0	19.4	18.0
SE	Weighted	27.1	22.3	21.8	27.4	31.0	30.7	30.4	26.0	19.0	19.2
	Simple	28.8	23.0	22.4	28.0	31.6	31.4	30.2	26.3	19.2	19.5
CEE	Weighted	24.0	22.8	24.5	25.8	28.4	28.0	27.5	24.2	20.8	19.3
	Simple	23.7	22.8	23.8	25.1	28.4	27.7	27.3	24.0	20.1	18.8
EU	Weighted	**26.0**	**24.0**	**22.9**	**24.6**	**28.7**	**28.7**	**27.8**	**24.6**	**19.7**	**18.9**
	Simple	**26.2**	**23.8**	**22.7**	**24.6**	**28.8**	**28.7**	**27.7**	**24.7**	**19.6**	**18.8**

Note: weighting factor: natural gas purchased; based on observations from 22 plants except for 2008 where observations from only 15 plants were available, 2009-2010 where observations from only 19 plants were available and 2017 where observations from only 16 plants were available.

Source: Authors' elaboration

Table 103 Components of the natural gas price: network component (€/MWh) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	Weighted	0.9	0.6	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.8
	Simple	0.9	0.7	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.8
SE	Weighted	2.1	2.3	3.1	2.8	3.4	3.5	2.6	3.5	3.5	3.3
	Simple	1.8	2.2	2.8	2.7	3.0	3.1	2.5	3.3	3.4	3.3
CEE	Weighted	2.8	3.0	2.9	3.0	3.5	3.5	2.9	2.8	2.8	2.4
	Simple	3.0	3.1	3.1	3.2	3.5	3.4	3.0	2.9	2.8	2.5
EU	Weighted	**2.0**	**1.9**	**2.0**	**2.0**	**2.3**	**2.2**	**1.9**	**2.2**	**2.2**	**2.4**
	Simple	**2.0**	**2.0**	**2.1**	**2.0**	**2.3**	**2.2**	**2.0**	**2.3**	**2.3**	**2.3**

Note: weighting factor: natural gas purchased; based on observations from 22 plants except for 2008 where observations from only 15 plants were available, 2009-2010 where observations from only 19 plants were available and 2017 where observations from only 16 plants were available.

Source: Authors' elaboration

Table 104 Components of the natural gas price: Other non-recoverable taxes/levies (€/MWh) – Simple and weighted averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	Weighted	0.7	0.5	0.4	0.6	0.8	0.8	0.7	0.9	0.8	0.6
	Simple	0.7	0.6	0.5	0.6	0.9	0.9	0.8	1.0	0.9	0.7
SE	Weighted	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1
	Simple	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1
CEE	Weighted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Simple	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EU	Weighted	**0.3**	**0.2**	**0.2**	**0.2**	**0.3**	**0.3**	**0.3**	**0.4**	**0.3**	**0.2**
	Simple	**0.3**	**0.2**	**0.2**	**0.2**	**0.3**	**0.3**	**0.3**	**0.4**	**0.3**	**0.2**

Note: weighting factor: natural gas purchased; based on observations from 22 plants except for 2008 where observations from only 15 plants were available, 2009-2010 where observations from only 19 plants were available and 2017 where observations from only 16 plants were available.

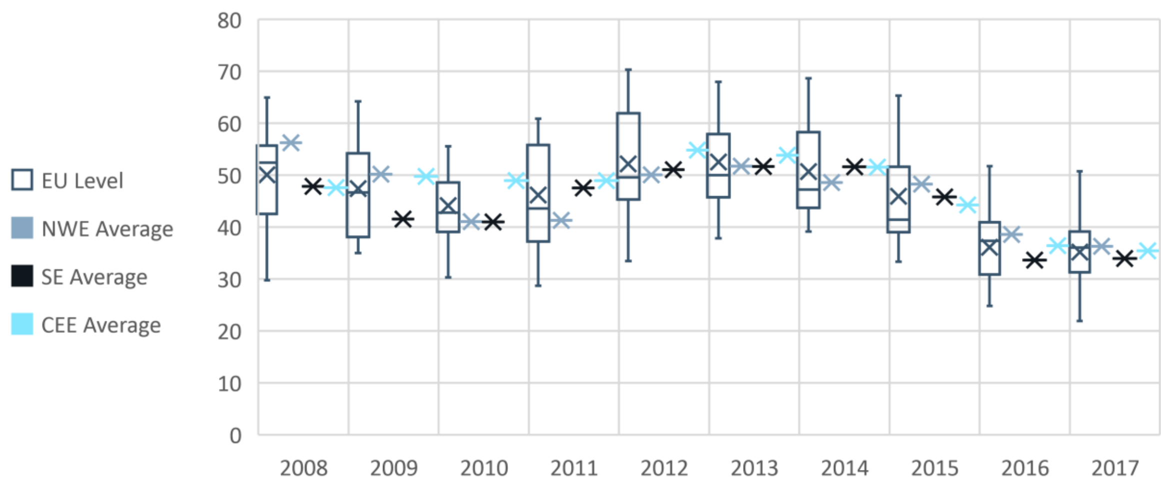
Source: Authors' elaboration

Natural gas costs

On average, EU producers of packaging glass experienced a decrease in natural gas costs from €50/tonne in 2008 to €35.2/tonne in 2017 (see EU weighted average in Table 105). This decrease can be mainly explained by decreasing natural gas prices. The variance of natural gas costs from sampled EU packaging glass producers is limited, meaning that the majority of natural gas costs provided by plants are comparable. This is coherent with results above and illustrates the homogeneity of the production process across plants and regions.

Table 105 shows that in many years weighted averages are above simple averages. Therefore, economies of scale, if any, do not necessarily reduce gas costs.

Figure 78 Natural gas costs (€/tonne) – Box plots and simple averages



Note: based on observations from 24 plants, except for 2008 where observations from only 22 plants were available, 2009-2011 where observations from 23 plants were available and 2017 where observations from only 20 plants were available.
Source: Authors' elaboration

Table 105 Natural gas costs (€/tonne) – Simple and weighted averages

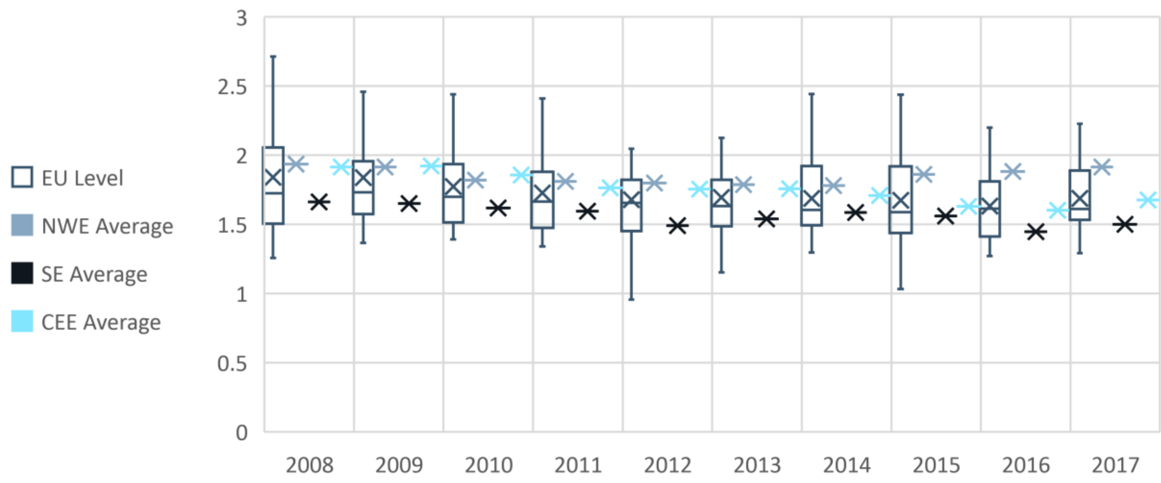
Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	**Weighted**	48.9	48.6	38.3	38.2	46.4	48.1	45.1	43.2	34.7	35.1
	Simple	52.4	50.0	40.2	40.4	48.7	50.4	47.4	46.9	37.4	36.3
SE	**Weighted**	46.0	40.3	41.1	47.9	51.1	51.6	52.4	45.9	33.1	33.6
	Simple	47.8	41.5	40.9	47.5	51.1	51.7	51.6	45.8	33.6	33.9
CEE	**Weighted**	48.6	49.7	50.6	49.3	54.7	53.4	50.5	42.8	36.7	33.8
	Simple	49.8	49.9	50.7	50.7	56.8	55.5	53.1	45.1	37.3	35.4
EU	**Weighted**	**47.9**	**46.6**	**43.2**	**44.8**	**50.5**	**50.9**	**49.2**	**44.0**	**34.8**	**34.0**
	Simple	**50.0**	**47.4**	**44.1**	**46.2**	**52.2**	**52.5**	**50.7**	**45.9**	**36.1**	**35.2**

Note: weighting factor: production output; based on observations from 24 plants, except for 2008 where observations from only 22 plants were available, 2009-2011 where observations from 23 plants were available and 2017 where observations from only 20 plants were available.
Source: Authors' elaboration

Natural gas intensity

The natural gas intensity in MWh/tonne 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. It remained stable in the NWE region during the period covered by this study, and at a value higher than the EU average (1.9 MWh/tonne in 2017). Natural gas intensity decreased in both the CEE region and the SE region, which showed a simple average of 1.5 MWh/tonne in 2017. The EU weighted averages (by production output) for natural gas intensity was slightly below the simple averages, suggesting that larger producers benefit from economies of scale.

Figure 79 Natural gas intensity (MWh/tonne) – Box plots and simple averages



Note: based on observations from 24 plants, except for 2008 where observations from only 22 plants were available, 2009-2011 where observations from 23 plants were available and 2017 where observations from only 20 plants were available.
Source: Authors' elaboration

Table 106 Natural gas intensity (MWh/tonne) – Box plots and simple averages

Region	Average	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE	**Weighted**	1.7	1.7	1.7	1.7	1.6	1.6	1.6	1.7	1.7	1.8
	Simple	1.8	1.8	1.8	1.8	1.7	1.7	1.7	1.8	1.8	1.9
SE	**Weighted**	1.6	1.7	1.6	1.6	1.5	1.5	1.6	1.6	1.4	1.5
	Simple	1.7	1.7	1.6	1.6	1.5	1.5	1.6	1.6	1.4	1.5
CEE	**Weighted**	1.9	1.9	1.8	1.7	1.7	1.7	1.7	1.6	1.6	1.6
	Simple	2.0	2.0	1.9	1.8	1.8	1.8	1.8	1.7	1.6	1.7
EU	**Weighted**	**1.8**	**1.8**	**1.7**	**1.7**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**
	Simple	**1.8**	**1.8**	**1.8**	**1.7**	**1.7**	**1.7**	**1.7**	**1.7**	**1.6**	**1.7**

Note: weighting factor: production output; based on observations from 24 plants, except for 2008 where observations from only 22 plants were available, 2009-2011 where observations from 23 plants were available and 2017 where observations from only 20 plants were available.
Source: Authors' elaboration

Additional information

Only two plants reported that they purchase a share of their gas demand from the wholesale market; the same two plants also have a contract with natural gas providers that provide the remaining share. All other plants reported that they only purchase natural gas through a provider. All packaging glass producers included in the Study reported that they have contracts with their gas suppliers with a duration of up to five years. Three plants reported taking part in a natural gas flexibility or interruptibility scheme.

As for outages[42], one plant reported experiencing an unplanned natural gas outage in 2016 that lasted for nine minutes. Another plant reported experiencing an unplanned outage for all three years (2015-2017) for a period of just over 200 minutes per outage. All other plants experienced no outages over the same period. Self-production of gas is not part of the production process adopted by packaging glass producers.

5.4 Competitiveness

Cost competitiveness

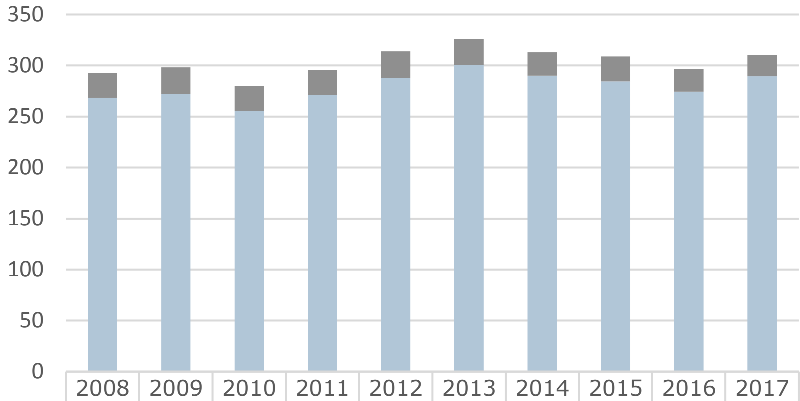
Electricity

The next five graphs provide an overview of the cost competitiveness of the sector in relation to electricity costs. Electricity costs in €/tonne have fluctuated over the period under observation with a decline in the latter years. The share of electricity costs out of total production costs (simple averages) in the EU packaging glass sector declined from around 8.3% in 2008 to 6.6% in 2017 (Figure 80). Similarly, the share of electricity costs in relation to turnover went from around 5.9% in 2008 to 4.6% in 2017 (Figure 82). It is important to point out that the average turnover value was higher in 2017, which is a result of the difference in the number of observations in 2017 compared to previous years. Electricity costs as a share of productions costs net of depreciation and amortisation is shown in Figure 81. These results are based on less than half the packaging glass plants that are included in this Study; electricity costs as a share of production costs net of depreciation and amortisation decreased from 8.6% in 2008 to 7.1% in 2017. Electricity costs are lower than EBIT and EBITDA and it is not possible to draw conclusions about their impact on margins.

Weighted average production costs are below simple averages, which may reveal economies of scale. As for turnover, the weighted averages are also below simple averages, which may reveal that plants experiencing lower costs, i.e. larger plants, could transfer this cost advantage to customers by applying lower prices. No clear trend for weighted and simple averages can be seen for the EBITDA and EBIT data provided by packaging glass producers, hence, plant size is not a determinant of profitability.

[42] Planned outages are linked to flexibility schemes; other planned outages are not linked to flexibility schemes, but notified in advance by the energy supplier; unplanned outages are not notified.

Figure 80 Electricity costs as a share of production costs (€/tonne, EU) – Simple averages



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Average of Electricity cost €/tonne	24.3	26.0	24.5	24.2	26.2	25.6	23.2	24.5	22.1	20.6
Average of other Production costs €/tonne	268	272	255	271	288	300	290	284	274	289

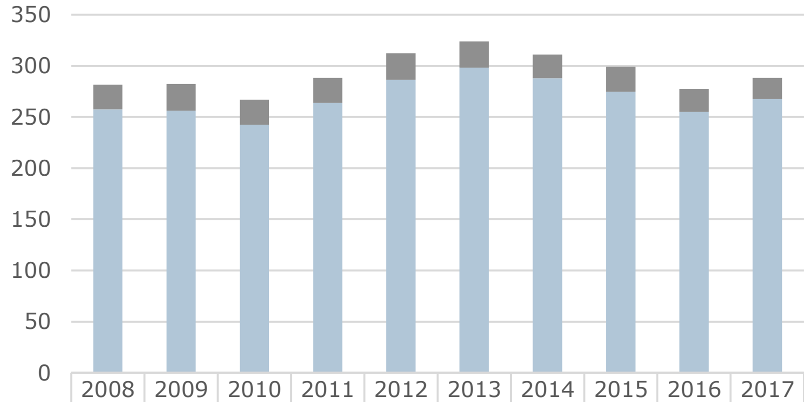
Note: electricity costs in this graph are based on observations from 24 plants except for 2016 where observations from 23 plants were available and 2017 where observations from only 20 plants were available. Production costs are based on observations from 22 plants except for 2017 where observations from only 15 plants were available.
Source: Authors' elaboration

Table 107 Electricity costs as a share of production costs (€/tonne, EU) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity costs simple average (€/tonne)	24.3	26.0	24.5	24.2	26.2	25.6	23.2	24.5	22.1	20.6
Electricity costs weighted average (€/tonne)	23.5	25.2	23.9	23.2	24.6	23.5	21.2	22.3	20.3	19.9
Production costs simple average (€/tonne)	292.6	298.3	279.7	295.6	314.0	326.0	313.1	308.8	296.4	310.1
Production costs weighted average (€/tonne)	276.6	279.3	265.4	275.4	291.5	295.7	290.3	282.5	273.3	290.3
Electricity costs as a share of production costs simple averages (%)	8.3%	8.7%	8.7%	8.2%	8.4%	7.9%	7.4%	7.9%	7.5%	6.6%
Electricity costs as a share of production costs weighted averages (%)	8.5%	9.0%	9.0%	8.4%	8.4%	8.0%	7.3%	7.9%	7.4%	6.8%

Note: weighting factor: production output; electricity costs in this graph are based on observations from 24 plants except for 2016 where observations from 23 plants were available and 2017 where observations from only 20 plants were available. Production costs are based on observations from 22 plants except for 2017 where observations from only 15 plants were available.
Source: Authors' elaboration

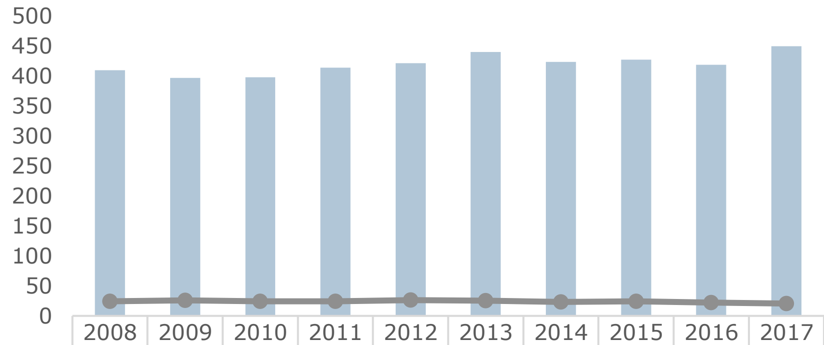
Figure 81 Electricity costs as a share of production costs net of depreciation and amortisation (€/tonne, EU) – Simple averages



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Average of Electricity cost €/tonne	24.3	26.0	24.5	24.2	26.2	25.6	23.2	24.5	22.1	20.6
Average of other Production costs net dep/am €/tonne	257	256	242	264	286	298	288	275	255	268

Note: electricity costs in this graph are based on observations from 24 plants except for 2016 where observations from 23 plants were available and 2017 where observations from only 20 plants were available. Productions costs net of dep/am are based on observations from 15 plants except for 2017 where observations from only 12 plants were available.
Source: Authors' elaboration

Figure 82 Electricity costs versus turnover (€/tonne, EU) – Simple averages



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Average of Turnover €/tonne	410	397	398	414	421	440	424	427	419	450
Average of Electricity cost €/tonne	24	26	24	24	26	26	23	24	22	21

Average of Turnover €/tonne   Average of Electricity cost €/tonne

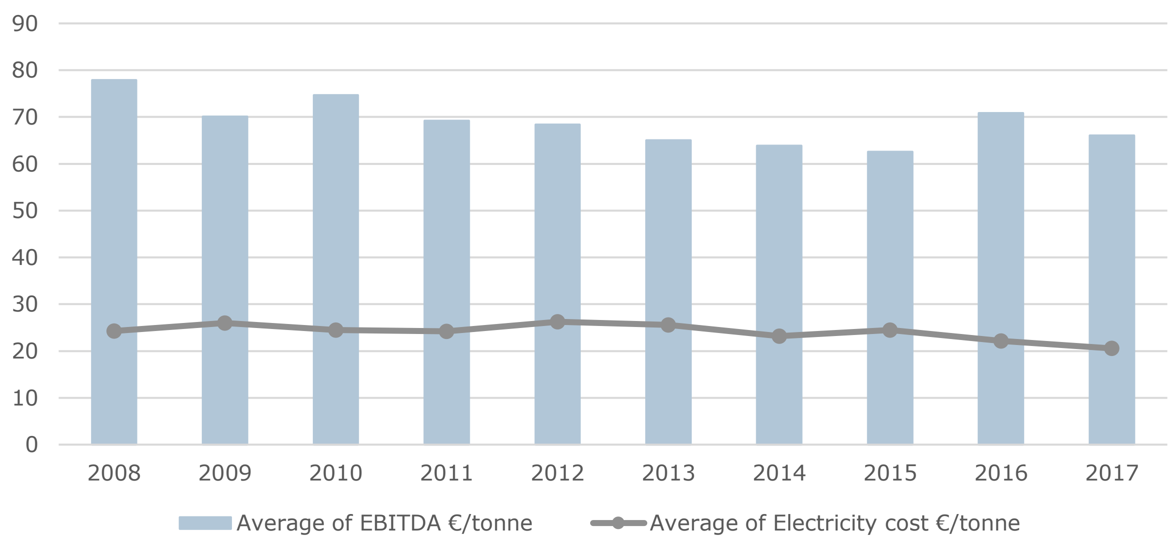
Note: electricity costs in this graph are based on observations from 24 plants except for 2016 where observations from 23 plants were available and 2017 where observations from only 20 plants were available. Turnover is based on observations from 22 plants except for 2017 where observations from only 15 plants were available.
Source: Authors' elaboration

Table 108 Electricity costs versus turnover (EU) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity costs simple average (€/tonne)	24.3	26.0	24.5	24.2	26.2	25.6	23.2	24.5	22.1	20.6
Electricity costs weighted average (€/tonne)	23.5	25.2	23.9	23.2	24.6	23.5	21.2	22.3	20.3	19.9
Turnover simple average (€/tonne)	409.7	396.7	397.8	414.0	421.2	440.0	423.5	426.9	418.5	449.6
Turnover weighted average (€/tonne)	392.7	385.8	387.0	391.8	397.3	405.1	401.5	402.1	395.9	429.1
Electricity costs as a share of turnover simple averages (%)	5.9%	6.6%	6.1%	5.9%	6.2%	5.8%	5.5%	5.7%	5.3%	4.6%
Electricity costs as a share of turnover weighted averages (%)	6.0%	6.5%	6.2%	5.9%	6.2%	5.8%	5.3%	5.5%	5.1%	4.6%

Note: weighting factor: production output; electricity costs in this graph are based on observations from 24 plants except for 2016 where observations from 23 plants were available and 2017 where observations from only 20 plants were available. Turnover is based on observations from 22 plants except for 2017 where observations from only 15 plants were available.
Source: Authors' elaboration

Figure 83 Electricity costs versus EBITDA (€/tonne, EU) – Simple averages



Note: electricity costs in this graph are based on observations from 24 plants except for 2016 where observations from 23 plants were available and 2017 where observations from only 20 plants were available. EBITDA is based on observations from 17 plants except for 2017 where observations from only 11 plants were available.
Source: Authors' elaboration

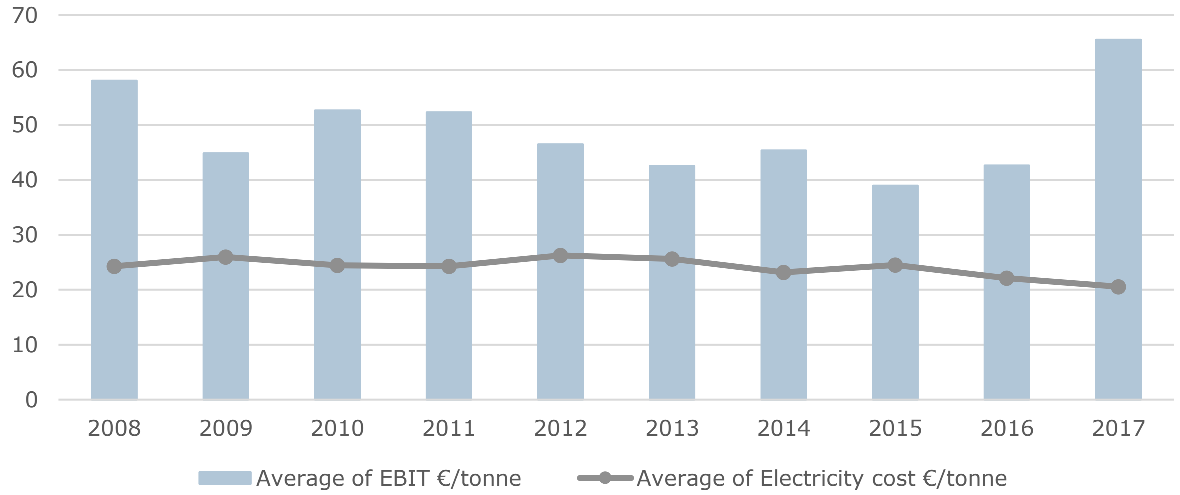
Table 109 Electricity costs versus EBITDA (EU) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity costs simple average (€/tonne)	24.3	26.0	24.5	24.2	26.2	25.6	23.2	24.5	22.1	20.6
Electricity costs weighted average (€/tonne)	23.5	25.2	23.9	23.2	24.6	23.5	21.2	22.3	20.3	19.9
EBITDA simple average (€/tonne)	77.9	70.1	74.7	69.2	68.4	65.1	63.9	62.5	70.9	66.0
EBITDA weighted average (€/tonne)	78.6	75.5	76.5	68.9	68.2	65.9	66.3	66.4	76.5	96.3

Note: weighting factor: production output; electricity costs in this graph are based on observations from 24 plants except for 2016 where observations from 23 plants were available and 2017 where observations from only 20 plants were available. EBITDA is based on observations from 17 plants except for 2017 where observations from only 11 plants were available.

Source: Authors' elaboration

Figure 84 Electricity costs versus EBIT (€/tonne, EU) – Simple averages



Note: electricity costs in this graph are based on observations from 24 plants except for 2016 where observations from 23 plants were available and 2017 where observations from only 20 plants were available. EBIT is based on observations from 22 plants except for 2008-2009 where observations from 21 plants were available and 2017 where observations from only 15 plants were available.

Source: Authors' elaboration

Table 110 Electricity costs versus EBIT (EU) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity costs simple average (€/tonne)	24.3	26.0	24.5	24.2	26.2	25.6	23.2	24.5	22.1	20.6
Electricity costs weighted average (€/tonne)	23.5	25.2	23.9	23.2	24.6	23.5	21.2	22.3	20.3	19.9
EBIT simple average (€/tonne)	58.0	44.9	52.6	52.3	46.5	42.5	45.4	39.0	42.6	65.5
EBIT weighted average (€/tonne)	55.0	50.6	53.9	50.3	43.6	39.2	43.9	41.0	46.2	69.2

Note: weighting factor: production output; electricity costs in this graph are based on observations from 24 plants except for 2016 where observations from 23 plants were available and 2017 where observations from only 20 plants were available. EBIT is based on observations from 22 plants except for 2008-2009 where observations from 21 plants were available and 2017 where observations from only 15 plants were available.
Source: Authors' elaboration

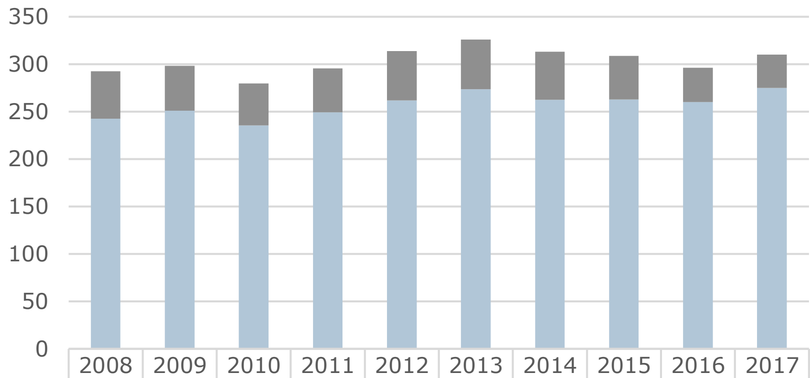
Natural gas

The next five graphs provide an overview of the cost competitiveness of the sector in relation to natural gas costs.

The share of natural gas costs out of total production costs in the EU packaging glass sector decreased from 17.1% in 2008 to 11.3% in 2017 (Figure 85). It fluctuated over the period under observation, as shown in Figure 87 and followed the trend of natural gas prices. Similarly, natural gas costs as a share of turnover declined from 12.2% in 2008 to under 7.8% in 2017. The share of natural gas costs out of total production costs net of depreciation and amortisation was higher than the share of natural gas costs out of total production costs; however, it showed a very similar trend, decreasing from 17.8% in 2008 to 12.2% in 2017.

Weighted production costs are mostly below simple production costs; therefore, there are some economies of scale in the production process. However, weighted averages for natural gas costs are not always below simple averages. This is not necessarily in contradiction with the conclusions above, as economies of scale may be related to production inputs other than electricity and gas (e.g. labour or capital).

Figure 85 Natural gas costs as a share of production costs (€/tonne, EU) – Simple averages



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Average of Natural gas cost €/tonne	50.0	47.4	44.1	46.2	52.2	52.5	50.7	45.9	36.1	35.2
Average of other Production costs €/tonne	243	251	236	249	262	273	262	263	260	275

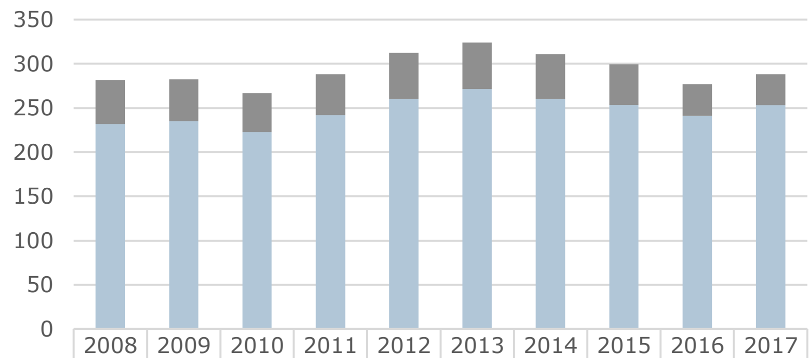
Note: natural gas costs in this graph are based on observations from 24 plants except for 2008-2011 where observations from 23 plants were available and 2017 where observations from only 20 plants were available. Production costs are based on observations from 22 plants except for 2017 where observations from only 15 plants were available.
Source: Authors' elaboration

Table 111 Natural gas costs as a share of productions costs (EU) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas costs simple average (€/tonne)	50.0	47.4	44.1	46.2	52.2	52.5	50.7	45.9	36.1	35.2
Natural gas costs weighted average (€/tonne)	47.9	46.6	43.2	44.8	50.5	50.9	49.2	44.0	34.8	34.0
Production costs simple average (€/tonne)	292.6	298.3	279.7	295.6	314.0	326.0	313.1	308.8	296.4	310.1
Production costs weighted average (€/tonne)	276.6	279.3	265.4	275.4	291.5	295.7	290.3	282.5	273.3	290.3
Natural gas costs as a share of production costs simple averages (%)	17.1%	15.9%	15.8%	15.6%	16.6%	16.1%	16.2%	14.9%	12.2%	11.3%
Natural gas costs as a share of production costs weighted averages (%)	17.3%	16.7%	16.3%	16.3%	17.3%	17.2%	16.9%	15.6%	12.7%	11.7%

Note: weighting factor: production output; natural gas costs in this graph are based on observations from 24 plants except for 2008-2011 where observations from 23 plants were available and 2017 where observations from only 20 plants were available. Production costs are based on observations from 22 plants except for 2017 where observations from only 15 plants were available.
Source: Authors' elaboration

Figure 86 Natural gas costs as a share of production costs net of depreciation and amortisation (€/tonne, EU) – Simple averages

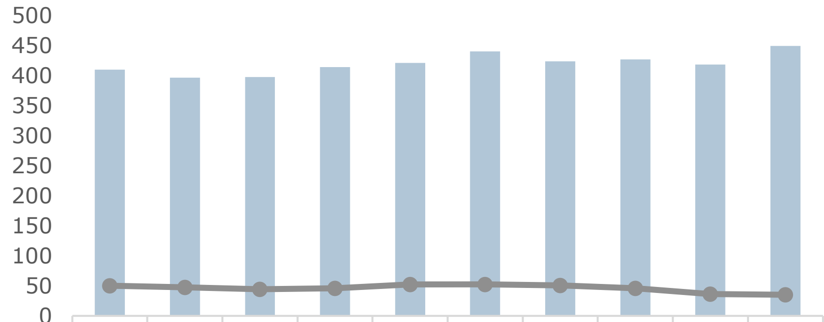


	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Average of Natural gas cost €/tonne	50.0	47.4	44.1	46.2	52.2	52.5	50.7	45.9	36.1	35.2
Average of other Production costs net dep/am €/tonne	232	235	223	242	260	271	260	253	241	253

Note: natural gas costs in this graph are based on observations from 24 plants except for 2008-2011 where observations from 23 plants were available and 2017 where observations from only 20 plants were available. Productions costs net of dep/am are based on observations from 15 plants except for 2017 where observations from only 12 plants were available.
Source: Authors' elaboration

Weighted averages for turnover are generally below simple averages for turnover. This may indicate that larger plants that incur lower production costs (economies of scale) sell their products on the market at a relatively lower price per tonne.

Figure 87 Natural gas costs versus turnover (€/tonne, EU) – Simple averages



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Average of Turnover €/tonne	409.7	396.7	397.8	414.0	421.2	440.0	423.5	426.9	418.5	449.6
Average of Natural gas cost €/tonne	50.0	47.4	44.1	46.2	52.2	52.5	50.7	45.9	36.1	35.2

Note: natural gas costs in this graph are based on observations from 24 plants except for 2008-2011 where observations from 23 plants were available and 2017 where observations from only 20 plants were available. Turnover is based on observations from 22 plants except for 2017 where observations from only 15 plants were available.
Source: Authors' elaboration

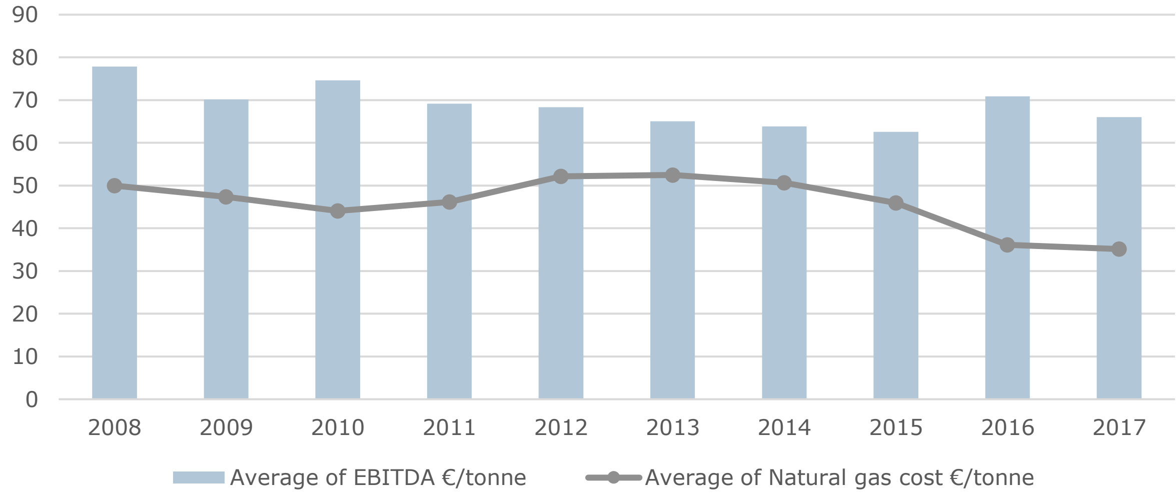
Table 112 Natural gas costs versus turnover (EU) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas costs simple average (€/tonne)	50.0	47.4	44.1	46.2	52.2	52.5	50.7	45.9	36.1	35.2
Natural gas costs weighted average (€/tonne)	47.9	46.6	43.2	44.8	50.5	50.9	49.2	44.0	34.8	34.0
Turnover simple average (€/tonne)	409.7	396.7	397.8	414.0	421.2	440.0	423.5	426.9	418.5	449.6
Turnover weighted average (€/tonne)	392.7	385.8	387.0	391.8	397.3	405.1	401.5	402.1	395.9	429.1
Natural gas costs as a share of turnover simple averages (%)	12.2%	11.9%	11.1%	11.1%	12.4%	11.9%	12.0%	10.8%	8.6%	7.8%
Natural gas costs as a share of turnover weighted averages (%)	12.2%	12.1%	11.2%	11.4%	12.7%	12.6%	12.2%	10.9%	8.8%	7.9%

Note: weighting factor: production output; natural gas costs in this graph are based on observations from 24 plants except for 2008-2011 where observations from 23 plants were available and 2017 where observations from only 20 plants were available. Turnover is based on observations from 22 plants except for 2017 where observations from only 15 plants were available.
Source: Authors' elaboration

On average, larger plants seem to be more profitable than smaller ones, for most years included in the study.

Figure 88 Natural gas costs versus EBITDA (€/tonne, EU) – Simple averages



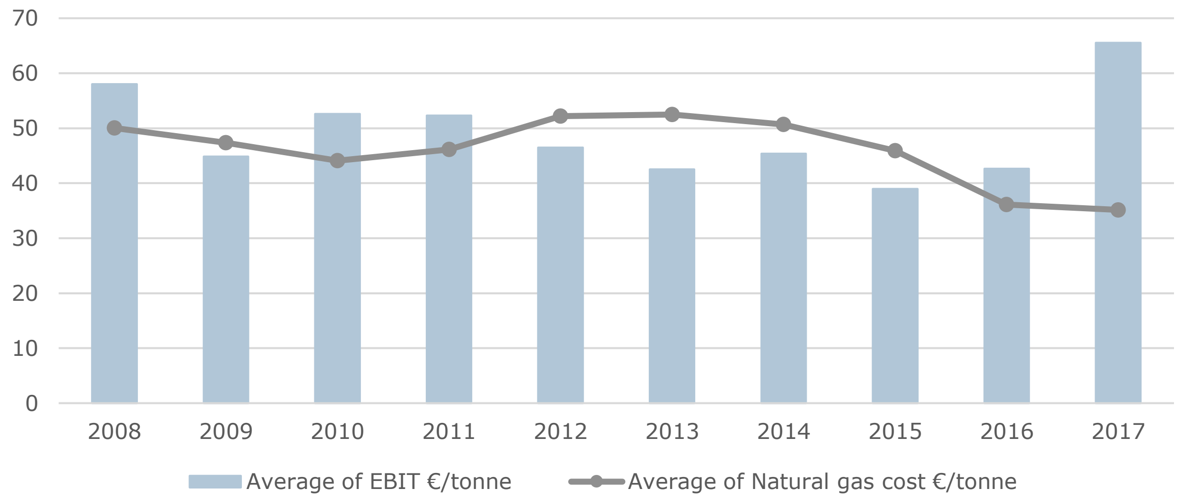
Note: natural gas costs in this graph are based on observations from 24 plants except for 2008-2011 where observations from 23 plants were available and 2017 where observations from only 20 plants were available. EBITDA is based on observations from 17 plants except for 2017 where observations from only 11 plants were available.
Source: Authors' elaboration

Table 113 Natural gas costs versus EBITDA (EU) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas costs simple average (€/tonne)	50.0	47.4	44.1	46.2	52.2	52.5	50.7	45.9	36.1	35.2
Natural gas costs weighted average (€/tonne)	47.9	46.6	43.2	44.8	50.5	50.9	49.2	44.0	34.8	34.0
EBITDA simple average (€/tonne)	77.9	70.1	74.7	69.2	68.4	65.1	63.9	62.5	70.9	66.0
EBITDA weighted average (€/tonne)	78.6	75.5	76.5	68.9	68.2	65.9	66.3	66.4	76.5	96.3

Note: weighting factor: production output; natural gas costs in this graph are based on observations from 24 plants except for 2008-2011 where observations from 23 plants were available and 2017 where observations from only 20 plants were available. EBITDA is based on observations from 17 plants except for 2017 where observations from only 11 plants were available.
Source: Authors' elaboration

Figure 89 Natural gas costs versus EBIT (€/tonne, EU) – Simple averages



Note: natural gas costs in this graph are based on observations from 24 plants except for 2008-2011 where observations from 23 plants were available and 2017 where observations from only 20 plants were available. EBIT is based on observations from 22 plants except for 2008-2009 where observations from 21 plants were available and 2017 where observations from only 15 plants were available.
Source: Authors' elaboration

Table 114 Natural gas costs versus EBIT (EU) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas costs simple average (€/tonne)	50.0	47.4	44.1	46.2	52.2	52.5	50.7	45.9	36.1	35.2
Natural gas costs weighted average (€/tonne)	47.9	46.6	43.2	44.8	50.5	50.9	49.2	44.0	34.8	34.0
EBIT simple average (€/tonne)	58.0	44.9	52.6	52.3	46.5	42.5	45.4	39.0	42.6	65.5
EBIT weighted average (€/tonne)	55.0	50.6	53.9	50.3	43.6	39.2	43.9	41.0	46.2	69.2

Note: weighting factor: production output; natural gas costs in this graph are based on observations from 24 plants except for 2008-2011 where observations from 23 plants were available and 2017 where observations from only 20 plants were available. EBIT is based on observations from 22 plants except for 2008-2009 where observations from 21 plants were available and 2017 where observations from only 15 plants were available.
Source: Authors' elaboration

6 Aluminium

Box 9 Highlights - Aluminium

Between 2008 and 2017, electricity costs represented 37% on average of total production costs of primary aluminium producers. For secondary aluminium and downstream plants, they represented respectively 6% and 1% on average of total production costs. Between 2008 and 2017, natural gas costs represented on average 1.1% of total production costs of primary aluminium producers. For secondary aluminium and downstream plants, natural gas costs were measured over 2016 and 2017, and represented respectively 7.1% and 1.5% on average of total production costs.

Electricity

- Electricity prices and costs in €/MWh for **primary aluminium** producers were on an increasing trend between 2008 and 2017. However, since 2015, prices and costs in €/MWh have been decreasing, in particular for **primary aluminium.** This trend results from: i) a lower absolute value of energy components; and ii) lower levels of RES levies, most likely resulting from changes in national legislation. In secondary aluminium, the trend started back in 2013.
- The majority of primary plants source electricity through the wholesale electricity market, while the secondary and downstream plants mostly buy through providers, with a limited number sourcing a share of their electricity from the wholesale market.
- Primary aluminium plants can associate on-site generation or self-generation from small hydro turbines or photovoltaic solar (PV). However, self-generation was not recorded in the survey for secondary aluminium (refiners and remelters) and for downstream aluminium (rolling mills and extruders).
- Almost all aluminium smelters take part in a flexibility scheme, while less than 25% of secondary and downstream aluminium plants take part in a flexibility scheme.
- **Electricity prices** (simple average) for **primary aluminium** plants fell from €43/MWh in 2015 to €39/MWh in 2017. Electricity prices (simple average) for **secondary aluminium** producers decreased from €126/MWh in 2013 to €90/MWh in 2017. Electricity prices (simple average) for **downstream aluminium** producers also decreased from €99/MWh in 2013 to €84/MWh in 2017. The magnitude of the decreasing trend for downstream producers was offset by an increase in electricity network and capacity costs.
- For primary and downstream plants, weighted average electricity prices are below simple average electricity prices. Larger primary and downstream aluminium plants benefit from the scale of their energy consumption compared to that of smaller plants.
- For secondary plants, weighted average electricity prices are above simple average electricity prices. Larger secondary aluminium plants do not benefit from the scale of their energy consumption, compared to smaller plants.
- **Electricity costs in €/MWh** (simple average) for **primary aluminium** plants rose from €34/MWh in 2008 to €36/MWh in 2017, with a peak in 2012 (€44/MWh). The trend observed follows the variations in the energy supply component, which accounts for an average of 80-90% of the total electricity price. Electricity costs (simple average) for **secondary aluminium** fell from €94/MWh in 2016 to €86/MWh in 2017. For **downstream aluminium producers**, electricity prices (simple average) increased from €80/MWh in 2016 to €82.5/MWh in 2017. The small difference between electricity prices and costs in €/MWh is due to *ex post* electricity price reimbursements granted to some producers.
- **Electricity costs in €/tonne** (simple average) for **primary aluminium** plants increased over the period under investigation, rising from €461/tonne in 2008 to €542/tonne in 2017; this is mainly due to an overall increase in electricity prices

and an increase in the average electricity intensity observed in the sample (see Sample and Limitations for further details). Electricity costs in €/tonne (simple average) for **secondary and downstream aluminium** plants decreased from 2016 to 2017. For secondary aluminium plants, electricity costs were €31/tonne in 2016 and fell to €27/tonne in 2017. For downstream plants, and similar to secondary plants, electricity average costs (€/MWh) in the SE region are higher than in NWE and CEE.

- The **electricity intensity** of the production process (simple average) for **primary aluminium** plants was 15.4 MWh/tonne in 2017. The electricity intensity of the production processes (simple average) for **secondary aluminium and downstream plants** was significantly lower, at 0.37 MWh/tonne and 0.93 MWh/tonne respectively in 2017.

Natural gas

- Natural gas prices for producers in all three aluminium sectors have decreased since 2012; this is mainly due to a decrease in the energy component, which is linked to the wholesale market price, where natural gas is traded. The energy component accounted for 86% and 91% of the total natural price for secondary aluminium and downstream aluminium, respectively.
- The **natural gas price** (simple average) for primary aluminium producers has decreased, going from €32.5/MWh in 2012 to around €19.5/MWh in 2017. Similarly, the natural gas price for secondary and downstream aluminium producers decreased respectively from €35/MWh and €42/MWh in 2012 to €22/MWh and €20/MWh in 2017.
- For secondary and downstream plants, weighted average natural gas prices are below simple average natural gas prices. Larger secondary and downstream aluminium plants benefit from the scale of their energy consumption, compared to that of smaller plants.
- For primary plants, weighted average natural gas prices are for the most part above simple average natural gas prices. Larger primary aluminium plants do not benefit from the scale of their energy consumption, compared to that of smaller plants.
- For primary aluminium producers, **natural gas costs in €/tonne** (simple average) fluctuated over the period under observation between €17/tonne and €26/tonne. There was a sharp decrease from 2014 due to a reduction in the natural gas wholesale price, and an increase in 2017 back to €21.7/tonne. The weighted average is in general marginally below the simple average, reflecting economies of scale. Natural gas costs in €/tonne for secondary and downstream aluminium plants declined from 2016 to 2017. These costs were €40/tonne in 2016 and €35/tonne in 2017 for secondary aluminium producers, while downstream aluminium producers reported natural gas costs of €32/tonne in 2016 and €28/tonne in 2017.
- The **natural gas intensity** (simple average) for **primary aluminium** producers was in the region of 1 MWh/tonne throughout the 10 years under observation. The natural gas intensity for **secondary aluminium** producers was in the range between 1.60 MWh/tonne and 1.89 MWh/tonne throughout the 10 years under observation. For **downstream aluminium** producers, the **natural gas intensity** gradually declined over the period from 1.48 MWh/tonne in 2013 to 1.30 MWh/tonne in 2017. This indicates that the natural gas production process for downstream aluminium plants has become more efficient over the period under observation.

Competitiveness

- Both electricity costs and production costs in €/tonne for **primary aluminium** plants decreased over the period under observation; however, the **share of electricity costs** relative to **total production costs** (simple average) increased from 28.7% to 38.3% between 2008 and 2017. Electricity costs as a share of production costs (simple average) were between 6.1% and 5.1% for **secondary aluminium** plants in 2016 and 2017 respectively, while for **downstream aluminium** plants this share was between 0.9% and 1.3% in the same time span.

- Between 2008 and 2017, natural gas costs in €/tonne for **primary aluminium** plants decreased. The share of **natural gas costs** relative to **total production costs** (simple average) remained relatively stable at between 1.3% and 1.9% throughout the period under observation. Natural gas costs as a share of production costs (simple average) were between 7.9% and 6.4% for **secondary aluminium plants** in 2016 and 2017, while for **downstream aluminium** plants this share was between 0.6% and 0.4% respectively for the same period.
- Weighted averages reveal that **larger secondary aluminium plants** incur both lower natural gas costs and lower production costs in €/tonne. Natural gas costs represent on average a smaller share of production costs in larger plants. For primary aluminium plants, the weighted average of the share of natural gas costs in production costs was very similar to the simple average; this is in line with the evidence showing that quantity discounts are less relevant when it comes to negotiating natural gas prices.
- The share of electricity costs relative to **turnover** for primary aluminium plants increased over the period under observation from 20.6% in 2008 to 29.6% in 2017. Natural gas costs were between 0.9% (2010) and 1.4% (2014) of the average sectoral turnover.
- Because of the high degree of electricity consumption per output (see electricity intensity), electricity costs for primary aluminium plants observed between 2008 and 2017 were much higher than profitability indicators such as **EBITDA** and **EBIT**. Natural gas costs, on the other hand, were much lower than EBITDA and EBIT; this is because primary aluminium plants are much less natural gas intensive.

Sample and limitations

- The **sample** includes 10 primary aluminium plants, nine secondary aluminium plants and eight downstream aluminium plants across the EU, representing about **60% of total primary aluminium production** and around **13% of downstream aluminium production**. The representativeness of the secondary aluminium sample cannot be assessed. In the observed sample for 2017, the majority of the primary plants (50%) and downstream plants (60%) operate in the NWE region. Two-thirds of the secondary aluminium plants are located in SE.
- Within the primary aluminium sample, there is a factor of 4.8 x between the lowest level and highest level of electricity consumption recorded for each plant. In the downstream and secondary sector, the deviation to the mean electricity consumption is higher than the primary sector, due to a lower energy intensity, the existence of less homogeneous processes and more diversified and fragmented streams of product outputs.
- 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.
- For some indicators, the number of available observations varies between years; trends may therefore be affected by **changes in the sample size**. More details are provided beneath each figure and table.

  A **regional analysis is not available** for this sector due to confidentiality reasons. Data provided by plants in all regions are included in the EU averages.

6.1 Composition of the sample

Sampling strategy

The population of EU aluminium plants can be divided into three subsectors: the primary aluminium subsector that includes smelters, the secondary aluminium subsector that includes refiners and remelters, and the downstream subsector that includes rolling mills and extruders. Products manufactured in the primary and secondary aluminium subsectors serve as inputs to the plants operating in the downstream subsector.

Keeping in mind international best practices in collecting plant-level data, a minimum number of five plants for each subsector per geographical region was considered necessary. There are, however, only 16 primary aluminium plants within the EU. Four primary aluminium plants are located in the SE region, with one company owning three of those plants. In the CEE region, there are three plants all with different ownership. In view of this and due to confidentiality concerns, a regional analysis is not possible for the primary aluminium subsector.

Table 115 Minimum number of plants to be surveyed

Geographical regions	Primary	Secondary		Downstream	
	Smelters	Refiners	Remelters	Rollers	Extruders
Southern Europe	<5	5		5	
Central Eastern Europe	<5	5		5	
North-Western Europe	9	5		5	
Total	**16**	**15**		**15**	

Source: Authors' elaboration based on data provided by European Aluminium (2018).

Box 10 Key features of the sector

- Key statistics pertaining to the aluminium sector (part of NACE 24.42) are presented below:
  - Production value (2015): €43.2 billion
  - Number of plants (2015, Eurostat data): 1,400
  - Turnover of plants (2015, Eurostat data): €47.2 billion
  - Turnover breakdown by subsectors (2017, EA; 2015, Eurostat): primary aluminium (9%), Downstream (49%), Secondary aluminium (42%)
  - The six largest aluminium-producing Member States (Germany, Spain, France, Romania, Greece and Slovakia) represented 76% of primary aluminium capacity (EA, 2018).
  - Production of primary aluminium in the EU-28 is estimated at 2.2 million tonnes in 2017 (EA, 2017).
  - With regard to international trade, the EU is a net importer of aluminium and net imports account for 54% of all aluminium processed in the EU.
  - The main importers of European aluminium (2016) are Switzerland, the USA, China, Turkey and India.
  - The main exporters to the EU of aluminium (2017) are Norway, Russia, Switzerland, Ireland and the United Arab Emirates.
- The aluminium sector consists of a few very large primary plants (16 plants), and a large number of regional SME operating in the secondary and downstream sectors. A total of 1,400 plants producing aluminium products operated in the EU in 2015.
- Most of the primary aluminium plants included in this study tend to fall in the following ranges (first quartile – third quartile range) for the indicators presented:

  - Electricity consumption: from 1,000,000 MWh to 3,690,000 MWh per year
  - Electricity intensity: 12.4 MWh/tonne and 16.2 MWh/tonne
  - Natural gas consumption: from 120,000 MWh to 294,000 MWh per year
  - Natural gas intensity: 0.7 MWh/tonne and 1.5 MWh/tonne
- Most of the secondary aluminium plants included in this study tend to fall in the following ranges (first quartile – third quartile range) for the indicators presented:
  - Electricity consumption: from 5,300 MWh to 73,000 MWh per year
  - Electricity intensity: 0.12 MWh/tonne and 0.95 MWh/tonne
  - Natural gas consumption: from 52,000 MWh to 265,000 MWh per year
  - Natural gas intensity: 1.1 MWh/tonne and 2.8 MWh/tonne
- Most of the downstream aluminium plants included in this study tend to fall in the following ranges (first quartile – third quartile range) for the indicators presented:
  - Electricity consumption: from 14,000 MWh to 250,000 MWh per year
  - Electricity intensity: 0.5 MWh/tonne and 1.3 MWh/tonne
  - Natural gas consumption: from 21,000 MWh to 475,000 MWh per year
  - Natural gas intensity: 0.9 MWh/tonne and 1.7 MWh/tonne

For additional details pertaining to the production process and sector information, please refer to Annex A.

Coverage and representativeness of the sample statistics

A total of 135 plants were contacted and 32 questionnaires collected, resulting in a collection rate equivalent to 24%. More details are provided in Table 116 and Table 117 overleaf. Six plants shared supporting evidence in the form of electricity and natural gas bills or financial statements. These supporting documents were used to verify whether data provided matched those reported in the questionnaire.

The coverage rate has been calculated using capacity or production values of the plants having responded to the questionnaire, compared to the capacity of all primary plants in the EU, provided by European Aluminium (EA).

In the primary sector, 13 primary smelters provided questionnaires, but only 10 plants were included in the study. From the 13 questionnaires received, 84.4% of the primary aluminium population is covered.

Three questionnaires were not included because purchased energy data provided was not sufficient to calculate electricity or gas prices. Two companies informed the Research Team that this data could not be supplied due to company policy, while the third company did not respond. Of the 10 primary plants included in the study, four did not provide purchased natural gas costs.

For the 10 questionnaires included in this study, coverage of the primary aluminium EU population is 65.2% based on installed capacity, and 59.8% based on production values.

Sector coverage of secondary aluminium plants has not been calculated. Data from European Aluminium could not be used to calculate the sector coverage for two reasons: i) only two-thirds of the plants within the database provided by EA show plant capacity values and ii) the database they provided does not cover all the refiners and remelters operating within the EU. The Research Team was unable to use data from Prodcom or Eurostat to calculate the representativeness of each of the three aluminium subsectors analysed within this report. This is because the NACE and HS codes often cover more than one subsector (primary, secondary and downstream), hence, total turnover or production values are unavailable at the sector level.

Based on production value data provided by European Aluminium, sector coverage for downstream aluminium plants was calculated as 13%.

Table 116 Plants contacted

Geographical regions	Primary	Secondary		Downstream	
	Smelters	**Refiners**	**Remelters**	**Rollers**	**Extruders**
Southern Europe	4	10	9	7	24
Central Eastern Europe	3	11	3	2	9
North-Western Europe	9	15	11	10	8
Total	**16**	**36**	**23**	**19**	**41**

Source: Authors' elaboration

Table 117 Questionnaire collected

Geographical regions	Primary	Secondary		Downstream	
	Smelters	**Refiners**	**Remelters**	**Rollers**	**Extruders**
Southern Europe	4	4	2	0	3
Central Eastern Europe	2	1	1	1	0
North-Western Europe	7	0	1	5	1
Total collected	**13**	**5**	**4**	**6**	**4**

Source: Authors' elaboration

All nine refiners and remelters that provided a completed questionnaire have been included in the Final Report due to the reliability of the data. As for rolling mills and extruders, questionnaires from 10 downstream plants were received; however, the data provided in two questionnaires was not sufficient and therefore were not included in the report for a similar reason that some primary questionnaires were not included in the study. In total, questionnaires from eight downstream plants have been included in the Final Report. All secondary and downstream plants included in the Report provided information on both electricity and natural gas. In order to give a comprehensive overview, the prices of natural gas and electricity as well as the components of these prices are discussed for the three subsectors.

Disclaimer: For the primary sector, the trends observed mostly result from the changes in the sample composition across each consecutive year reported in the Study, and therefore do not reflect the characteristics of the sector.

6.2 Electricity

Electricity is by far the main energy carrier for the primary aluminium sector, when compared to natural gas. Both natural gas and electricity are important for plants in the secondary and downstream sample. As highlighted in the three following tables, electricity prices and costs in the primary sector are much lower than in the secondary and downstream subsectors. This is due to the electricity intensity of the smelting process. When based on the sample of the 10 plants observed, electricity intensity was equivalent to 15.4 MWh/tonne (or 15.4 kWh/kg) in 2017. When comparing electricity intensity in the subsectors, the secondary sector appears to consume less than 2.4% of the electricity used in the primary sector. The electricity intensity in the downstream sector corresponds to no more than 6% of the primary sector.

Table 118 Electricity: summary table (EU, simple averages) for primary aluminium plants

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: Authors' elaboration

Table 119 Electricity: summary table (EU, simple averages) for secondary aluminium plants

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: Authors' elaboration

Table 120 Electricity: summary table (EU, simple averages) for downstream aluminium plants

Indicator	2008	2010	2012	2013	2014	2015	2016	2017
Electricity prices (€/MWh)	Conf.	69.3	91.4	99.1	98.5	89.2	80.0	84.1
Electricity costs (€/MWh)	Conf.	57.8	78.4	99.1	98.3	89.2	80.0	82.5
Electricity costs (€/tonne)	Conf.	54.2	64.8	97.1	87.3	67.5	68.2	58.6
Electricity intensity (MWh/tonne)	Conf.	1.21	1.08	1.11	1.05	0.93	1.04	0.93

Source: Authors' elaboration

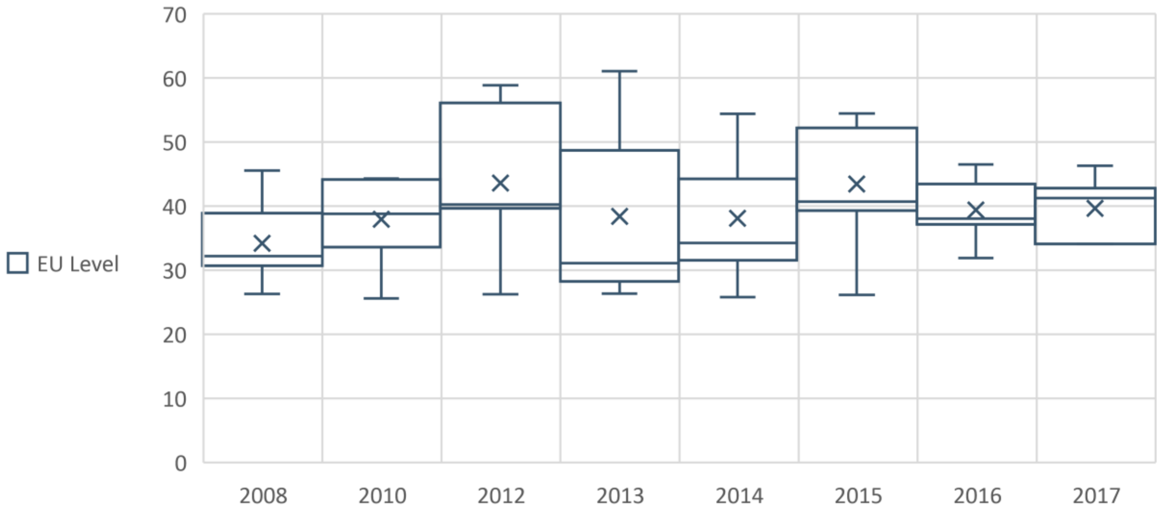
Electricity prices

The following three sets of figures and tables show the price of electricity paid by plants. This is the annual cost of purchasing electricity divided by the total annual electricity purchased. Total annual electricity purchased varies depending on the output of the plant and the intensity of the process. Electricity prices paid by primary aluminium plants are more homogenous than for the downstream and secondary sectors. Independently from their geographical location, the secondary and downstream producers sample contains plants that differ in terms of size, product and technology; therefore, price comparisons in this section show deviations in electricity prices paid by the different plants.

Figure 90 shows a small variance, indicating that in general, plants provided comparable electricity prices. Electricity prices increased between 2008 and 2012, where they peaked. After a decrease in 2013, the increase in prices resumed at a slower pace. Electricity prices declined in 2016 and 2017.

Table 121 shows the weighted average electricity prices, with a weighting factor of purchased electricity, and simple averages. Weighted averages are lower than the simple averages in 2008, 2010, 2012, 2015 and 2016. Over the observed sample of plants, electricity prices do not directly correlate to volumes of electricity purchased. This the relationship between simple averages and weighted averages of electricity prices is not consistent over the observed period. Sample heterogeneity and regional differences also play a role in the variations shown between the different years.

Figure 90 Primary aluminium electricity prices (€/MWh) – Box plots and simple averages



Note: observations from 6 plants in 2008 and 2010, 7 plants in 2012-2015, 9 plants in 2016 and 10 plants in 2017.
Source: Authors' elaboration

Table 121 EU average of primary aluminium electricity prices (€/MWh) – Simple and weighted averages

Average	2008	2010	2012	2013	2014	2015	2016	2017
Weighted	34.0	35.8	43.0	39.1	38.2	40.5	39.0	40.2
Simple	34.2	38.0	43.6	38.4	38.1	43.5	39.4	39.6

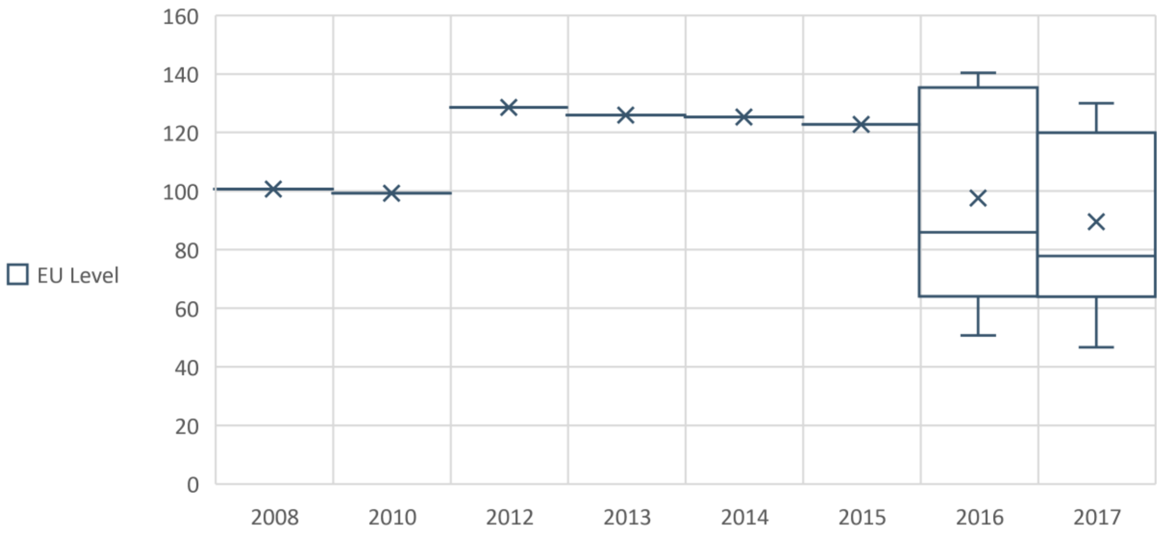
Note: Weighting factor: purchased electricity; *observations from 6 plants in 2008 and 2010, 7 plants in 2012-2015, 9 plants in 2016 and 10 plants in 2017.*
Source: Authors' elaboration

For secondary and downstream aluminium, box plots could not be shown for some years due to fewer than six observations from plants available.

Compared with primary aluminium plants, secondary plants reported less homogeneous electricity prices, as illustrated by Table 122 and the wide shape of the box in Figure 91. It is important to note that the data collected show deviations mostly due to the regional origin of the plants and the trend is not representative as data from only four plants were available in the years between 2008 and 2010, and only five plants between 2012 and 2015. It can be concluded that the increase in electricity prices between 2012 and 2015 is down to the number of observations included rather than a trend that is observed across all plants in this sector.

Table 122 shows the weighted averages using a weighting factor based on purchased electricity. Weighted averages are generally above simple averages (with the exception of 2010 and 2017); therefore, it appears that larger secondary aluminium plants do not benefit from the scale of their energy consumption compared to smaller plants; however, considering this is not the case for most other sectors, the Research Team concludes that this is the result of using a small sample for this sector.

Figure 91 Secondary aluminium electricity prices (€/MWh) – Box plots and simple averages



Note: based on 4 observations in 2008 & 2010, 5 in 2012-2015 and 9 observations in 2016 & 2017.
Source: Authors' elaboration

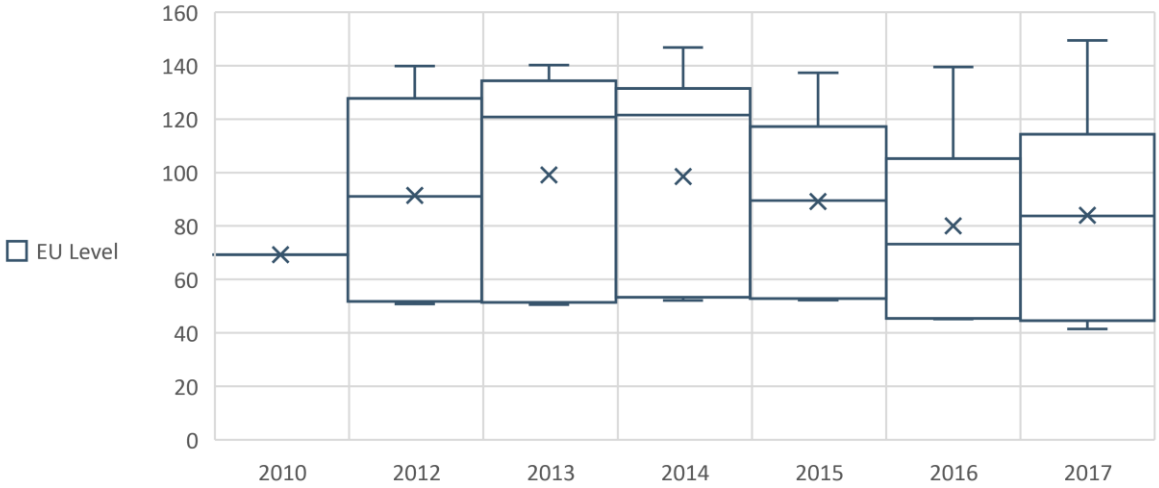
Table 122 EU average of secondary aluminium electricity prices (€/MWh) – Simple and weighted averages

Average	2008	2010	2012	2013	2014	2015	2016	2017
Weighted	105.7	98.5	130.2	130.3	127.4	126.1	98.0	89.5
Simple	100.7	99.3	128.5	125.9	125.3	122.8	97.6	89.5

Note: Weighting factor: purchased electricity; *observations from 4 plants in 2008-2010, 5 in 2012-2015 and 9 plants in 2016 and 2017.*
Source: Authors' elaboration

The prices reported by the downstream aluminium plants show in general lower electricity prices than those reported by secondary plants. This may be due to the fact that downstream plants are being reported as more electricity intensive than secondary plants, which may result in a greater amount of consumed electricity as compared to secondary plants. For downstream plants and similar to secondary plants, electricity average costs in the SE region are higher than in NWE and CEE.

Figure 92 Downstream aluminium electricity prices (€/MWh) – Box plots and simple averages



Note: based on observations from 5 plants in 2010, 6 plants in 2012, 7 plants in 2012-2016 and 8 plants in 2017.
Source: Authors' elaboration

Table 123 EU average of downstream aluminium electricity prices (€/MWh) – Simple and weighted averages

Average	2010	2012	2013	2014	2015	2016	2017
Weighted	55.3	59.9	62.0	62.9	61.6	54.5	53.2
Simple	69.3	91.4	99.1	98.5	89.2	80.0	84.1

Note: Weighting factor: purchased electricity; based on observations from 5 plants in 2010, 6 plants in 2012, 7 plants in 2012-2016 and 8 plants in 2017.
Source: Authors' elaboration

Components of the electricity price[43]

As in some of the aluminium subsectors fewer than three plants reported costs related to capacity payments, for confidentiality reasons, such costs are included with network costs in the following electricity component graphs. However, capacity components reported in the survey do not represent any significant contribution.

The majority of primary plants operate in the NWE region. The 2017 result shows a slight decline in electricity costs, mostly due to lower average RES levies in electricity prices. This results from changes in legislation in some Member States, leading in certain cases to an increase in renewable levy reimbursements. Overall, aluminium smelters that provided component data show much lower regulatory costs in electricity prices when compared with other sectors.

The graphs in Figure 93 show the absolute and relative values of primary aluminium components of the electricity price. The energy component of primary aluminium account for 85-90% of the total electricity price and the regulatory components make up 10-20% of the total electricity price. For primary plants, network and capacity levies have increased over time, while RES levies decreased from €2.7/MWh in 2013 to €0.7/MWh in 2017, as recorded

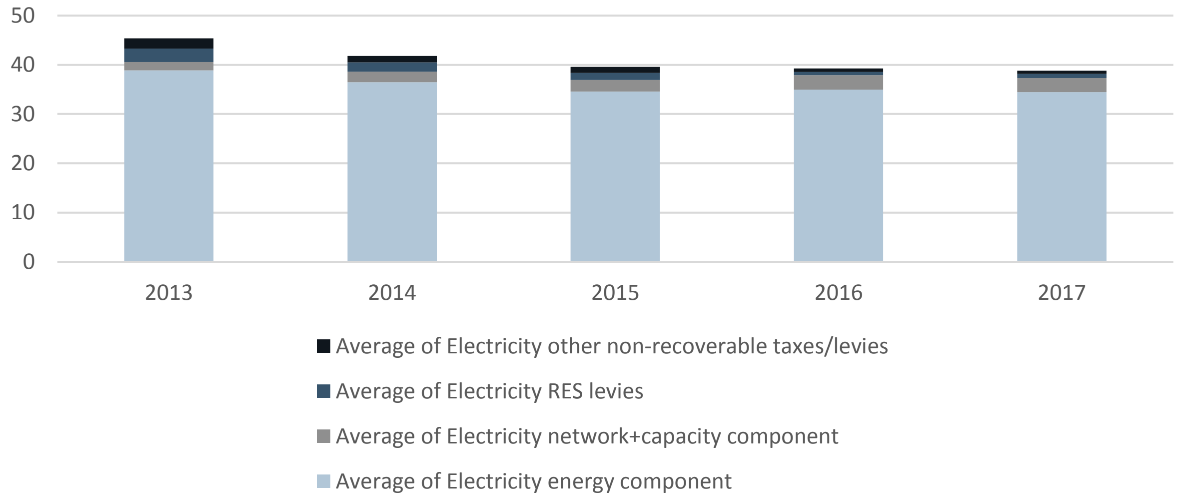
[43] The sum of the electricity bill components does not necessarily add up to the total electricity price mentioned before, as there might be plants that did not provide a breakdown of the electricity bill components while still providing the total electricity price.

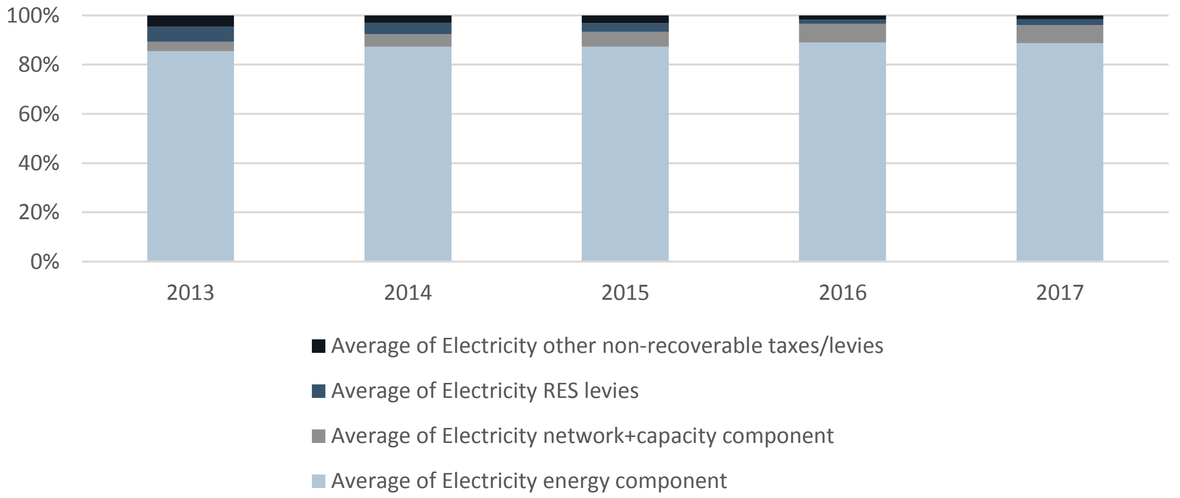
by the weighted average (Table 124). The largest regulatory component reported by primary aluminium plants is the network cost.

The trend in 2016 and 2017, particularly for regulatory components, does not necessarily match the trend in the previous years. This is for two reasons: i) the graph is based on six observations from plants in 2016 and 2017, while for the previous years it is based on observations from only three plants; ii) the Research Team was informed that plants used different methodologies to calculate regulatory costs for the previous study, hence for 2013-2015, shown in the graph.

Weighted averages of the energy component, shown in Table 124, are lower than simple averages in 2013-2015, showing that larger plants negotiate better energy supply contracts. In 2016 and 2017, this was not the case. It is not clear why this has changed in recent years.

Figure 93 Primary aluminium components of the electricity price (€/MWh and %, EU) – Simple averages





Note: observations from 3 plants in 2013-2015 and 6 plants in 2016 and 2017. Fewer than 3 observations were available for the years between 2008 and 2012.
Source: Authors' elaboration

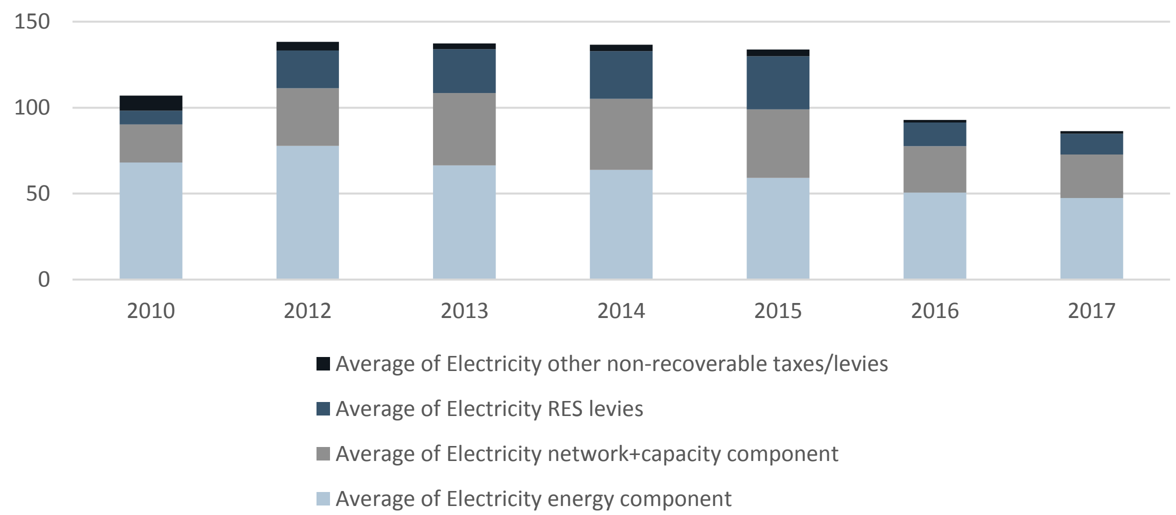
Table 124 EU average electricity components (€/MWh) for primary plants– Simple and weighted averages

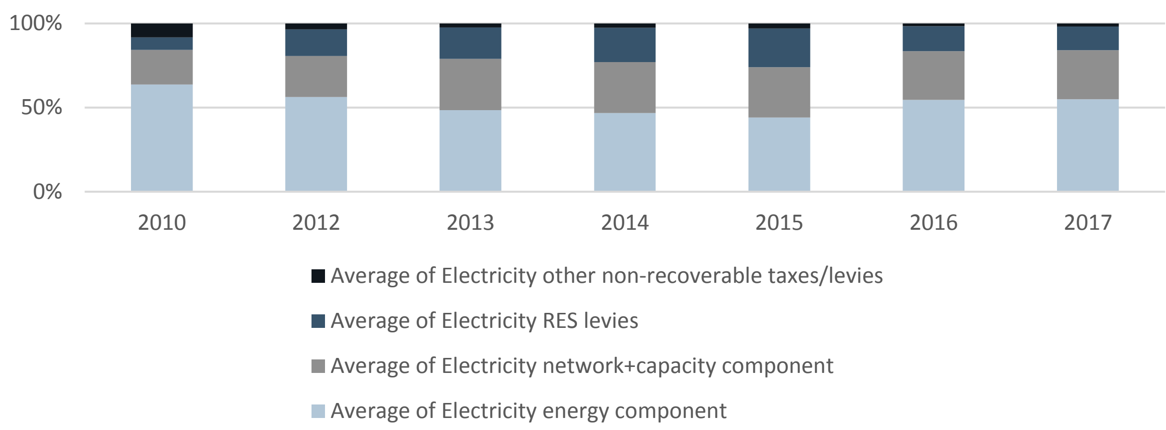
Average	2013	2014	2015	2016	2017
Energy component					
Weighted	37.5	35.4	33.7	35.2	35.0
Simple	38.8	36.5	34.5	35.0	34.5
Network + capacity component					
Weighted	1.7	2.1	2.3	3.2	3.4
Simple	1.7	2.2	2.4	3.0	2.8
RES levies					
Weighted	2.7	1.8	1.4	0.7	0.7
Simple	2.8	1.9	1.4	0.7	0.9
Other non-recoverable taxes/levies					
Weighted	2.0	1.2	1.2	0.8	0.7
Simple	2.1	1.3	1.2	0.7	0.6

Note: Weighting factor: purchased electricity; observations from 3 plants in 2013-2015 and 6 plants in 2016 and 2017. Fewer than 3 observations were available for the years between 2008 and 2012.
Source: Authors' elaboration

Electricity prices in the sample of secondary aluminium plants declined over the observed years from 2012. Figure 94 and Table 125 show that, for the sampled secondary aluminium producers, regulatory components (network, capacity, RES levies, and other non-recoverable taxes/levies) make a larger contribution to the total electricity price when compared with primary aluminium plants, and make up almost 50% of the electricity cost. The largest component is network costs, which include costs associated with both the transmission and distribution of electricity. For these plants, the share of electricity component costs in the electricity price barely changes from 2016 to 2017. Weighted averages shown in Table 125 are in general similar to simple averages for all components except for the RES levies where weighted averages are well below simple averages for the years before 2016 and above simple averages in the last two years. As explained before, this could be a result of the number of observations in the previous years being different from the last two years.

Figure 94 Secondary aluminium components of the electricity price (€/MWh and %, EU) – Simple averages





Note: observations from 4 plants for 2010-2015 and 6 plants for 2016-2017.
Source: Authors' elaboration

Table 125 EU average electricity components (€/MWh) for secondary plants– Simple and weighted averages

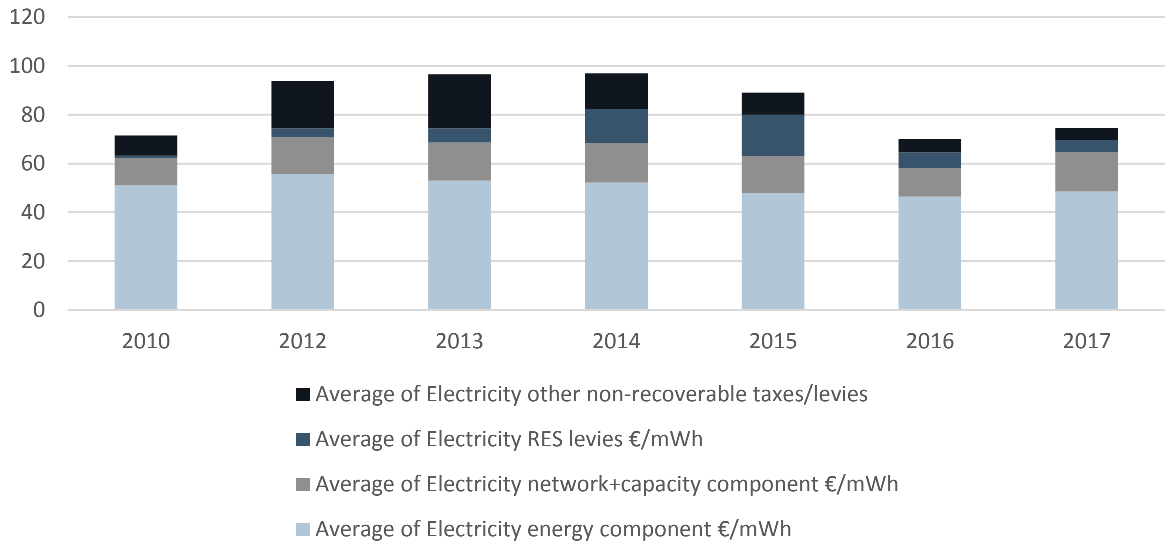
Average	2010	2012	2013	2014	2015	2016	2017
Energy component							
Weighted	68.3	78.5	66.1	62.2	59.6	43.5	41.8
Simple	68.2	77.7	66.4	63.8	59.1	50.7	47.5
Network + capacity component							
Weighted	21.3	34.4	43.4	42.8	40.3	32.7	28.9
Simple	22.1	33.6	42.1	41.3	39.9	27.0	25.2
RES levies							
Weighted	3.0	19.5	23.4	24.4	27.4	18.3	16.1
Simple	7.9	21.8	25.4	27.8	30.9	13.6	12.2
Other non-recoverable taxes/levies							
Weighted	10.5	2.6	3.4	3.8	4.2	1.2	1.2
Simple	8.8	5.0	3.4	3.6	3.9	1.6	1.5

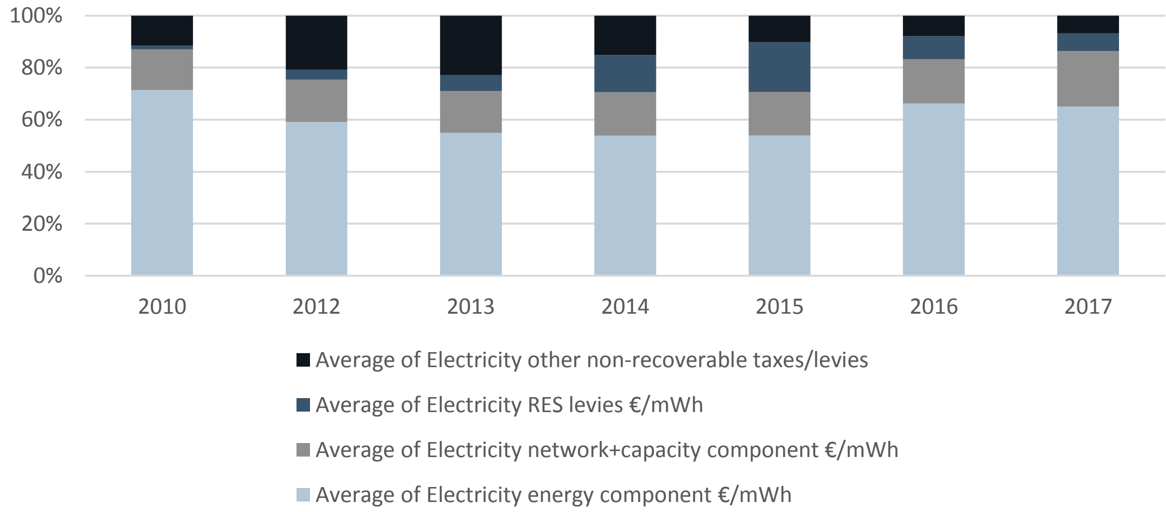
Note: Weighting factor: purchased electricity; observations from 4 plants for 2010-2015 and 6 plants for 2016-2017.
Source: Authors' elaboration

Figure 95 and Table 126 show that, similar to secondary aluminium plants, the regulatory components in electricity prices of downstream aluminium plants make up a large share of the electricity price. Of those plants, the majority are in the NWE region. As opposed to primary and secondary plants, data reported by downstream aluminium plants show that the share of the energy component remained steady between 2013 and 2015, and increased from 2016 to 2017 due to a reduction in the regulatory component in absolute terms.

Regulatory electricity components make up almost 50% of electricity prices in the years 2013 to 2015 and just under 40% in 2016 and 2017. The difference is probably a result of the composition of the sample between those two periods. In general, the largest regulatory component is network costs, followed by renewables' levy costs. It is not possible to draw any robust conclusions from the variation in the non-recoverable-taxes/levies component, as this component varies between small and large plans and over years. The declining trend can be partially due to changes in the number of observations across years.

Figure 95 Downstream aluminium - Components of the electricity prices (€/MWh and %, EU) – Simple averages





Note: observations from 3 plants in 2010, 4 plants in 2012, 5 plants in 2013-2016 and 6 plants in 2017.
Source: Authors' elaboration

Table 126 EU average electricity components (€/MWh) for downstream plants– Simple and weighted averages

Average	2010	2012	2013	2014	2015	2016	2017
Energy component							
Weighted	44.5	44.3	41.8	42.9	41.0	39.2	36.5
Simple	51.1	55.6	53.1	52.2	48.1	46.5	48.6
Network + capacity component							
Weighted	7.2	8.4	9.8	10.1	10.9	7.8	9.1
Simple	11.1	15.2	15.6	16.2	15.0	11.8	15.9
RES levies							
Weighted	1.8	2.5	3.0	5.3	6.7	1.1	1.1

Average	2010	2012	2013	2014	2015	2016	2017
Simple	**1.1**	**3.6**	**5.8**	**13.8**	**17.0**	**6.3**	**5.1**
Other non-recoverable taxes/levies							
Weighted	**2.1**	**5.0**	**6.0**	**3.6**	**2.3**	**1.0**	**1.0**
Simple	**8.2**	**19.6**	**22.1**	**14.7**	**9.0**	**5.5**	**5.1**

Note: Weighting factor: purchased electricity; observations from 3 plants in 2010, 4 plants in 2012, 5 plants in 2013-2016 and 6 plants in 2017.
Source: Authors' elaboration

Electricity costs

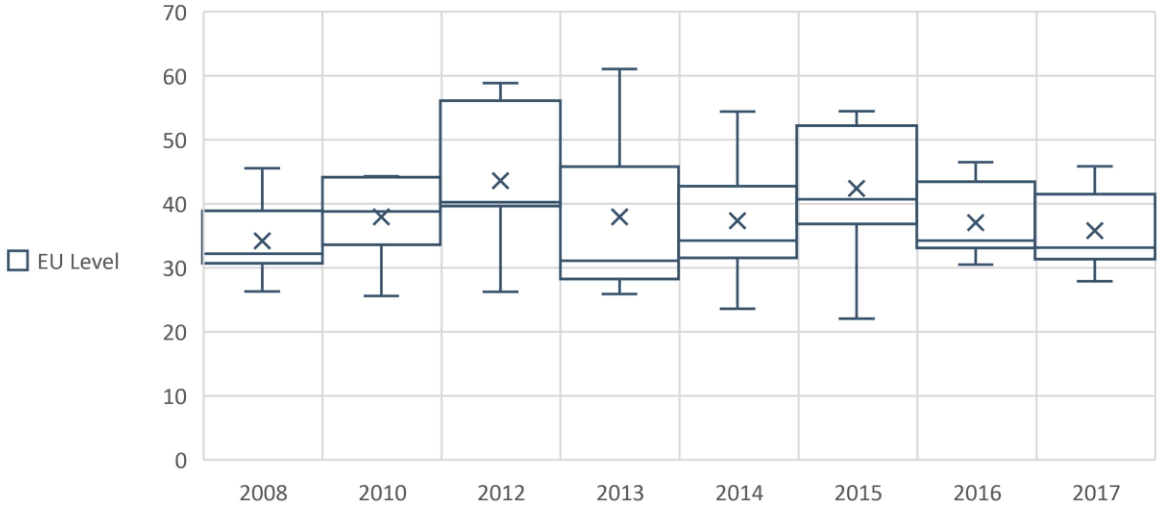
The average electricity costs of sampled EU aluminium producers is computed by factoring in any reimbursements, payments for flexibility schemes, costs for self-generating electricity and revenues from selling self-generated electricity to the grid. [44]

Figure 96 and Table 127 show that the average electricity cost in €/MWh paid by primary aluminium producers is equal to, or slightly below the electricity price, which is a result of reimbursements and payments for flexibility schemes. The trend of electricity costs for primary aluminium producers is very similar to electricity prices. The difference in electricity prices and electricity costs in €/MWh increases over the period. This is most likely because more plants report having recourse to self-generation or on-site generation, in order to optimise their energy consumption and/or improve their energy efficiency, for instance when using combined heat and power.

In the earlier years, i.e. between 2008 and 2015, data was extracted from a previous study, hence the information that plants provided and the methodologies to calculate certain figures were different. From 2008 to 2012, no data on *ex post* reimbursements and interruptibility schemes were available; as a consequence, the average electricity price (€/MWh) and electricity cost (€/MWh) for these years are the same, although we cannot conclude that no plant received reimbursements or interruptibility payments during this time. The data show that, from 2013, a number of plants reported that they were either taking part in an interruptibility scheme, receiving *ex post* reimbursements or self-generating electricity, or a combination of the three, which resulted in electricity costs in €/MWh being lower than prices.

[44] Electricity prices in €/MWh are defined as follows: Total price paid to purchase electricity/Total electricity purchased. Electricity costs in €/MWh are defined 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).

Figure 96 Primary aluminium electricity costs (€/MWh) – Box plots and simple averages



Note: based on 6 observations in 2008-2016 and 9 observations in 2017.
Source: Authors' elaboration

Table 127 EU average of primary aluminium electricity costs (€/MWh) – Simple and weighted averages

Average	2008	2010	2012	2013	2014	2015	2016	2017
Weighted	29.2	30.2	43.2	39.0	37.4	38.2	37.2	34.3
Simple	34.2	38.0	43.6	37.9	37.3	42.4	37.0	35.8

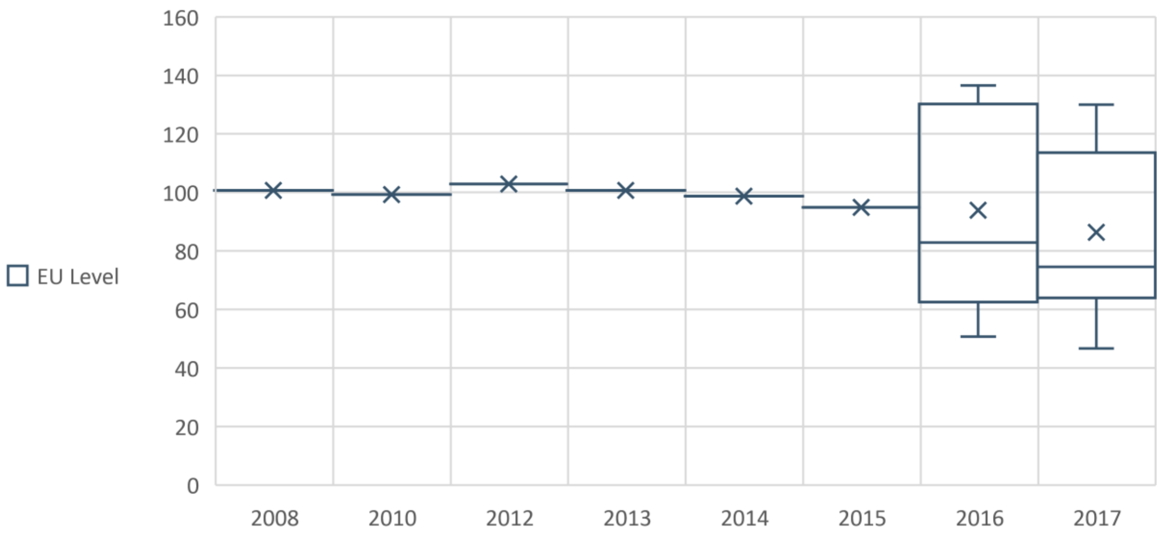
Note: Weighting factor: total electricity consumption; based on 6 observations in 2008-2016 and 9 observations in 2017.
Source: Authors' elaboration

Figure 97 and Table 128 show that simple averages of electricity costs in €/MWh of sampled secondary aluminium producers declined slightly by about 15% between 2008 and 2017.

In the earlier years, i.e. between 2008 and 2015, data were extracted from a previous study, hence the information that plants provided and the methodologies to calculate certain figures were different. In 2008 and 2010, no data on *ex post* reimbursements and interruptibility schemes were available; as a consequence, the average electricity price (€/MWh) and electricity cost (€/MWh) for these years are the same, although we cannot conclude that no plant received reimbursements or interruptibility payments during this time. The data shows that from 2012, a number of plants received interruptibility payments and/or *ex post* reimbursements, which resulted in electricity costs in €/MWh being lower than prices for secondary aluminium producers.

Box plots could not be shown for years previous to 2016 due to fewer than six observations from plants being available.

Figure 97 Secondary aluminium electricity costs (€/MWh) – Box plots and simple averages



Note: based on 4 observations in 2008 and 2010, 5 in 2012-2015 and 9 observations in 2016 & 2017.
Source: Authors' elaboration

Table 128 EU average of secondary aluminium electricity costs (€/MWh) – Simple and weighted averages

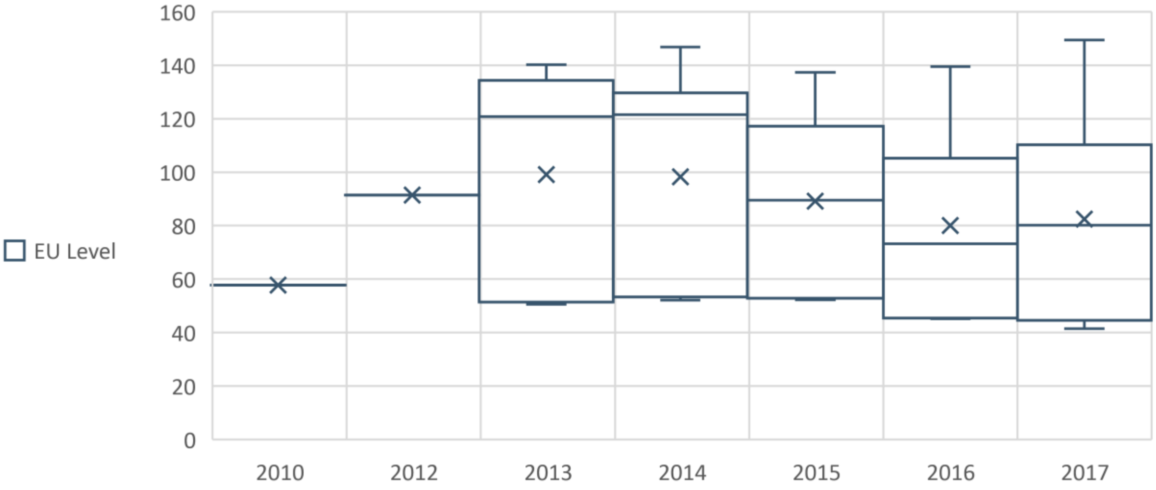
Average	2008	2010	2012	2013	2014	2015	2016	2017
Weighted	105.7	98.5	92.1	130.3	127.1	121.6	94.5	86.1
Simple	100.7	99.3	102.8	100.7	98.7	94.9	93.9	86.4

Note: Weighting factor: total electricity consumption; based on 4 observations in 2008 and 2010, 5 in 2012-2015 and 9 observations in 2016 and 2017.
Source: Authors' elaboration

Figure 98 and Table 129 show that, similar to downstream aluminium producers, electricity costs in €/MWh from sampled downstream aluminium producers show varying results due to differences in size, products and technologies. Weighted averages are well below simple averages, revealing that larger downstream aluminium plants have much lower electricity costs than smaller plants. This is down to larger plants taking part in flexibility schemes, since no downstream aluminium plant self-generates electricity.

Box plots could not be shown for years previous to 2013 due to fewer than six observations from plants being available.

Figure 98 Downstream aluminium electricity costs (€/MWh) – Box plots and simple averages



Note: based on observations from 5 plants in 2010, 6 plants in 2012, 7 plants in 2012-2016 and 8 plants in 2017.
Source: Authors' elaboration

Table 129 EU average of downstream aluminium electricity costs (€/MWh) – Simple and weighted averages

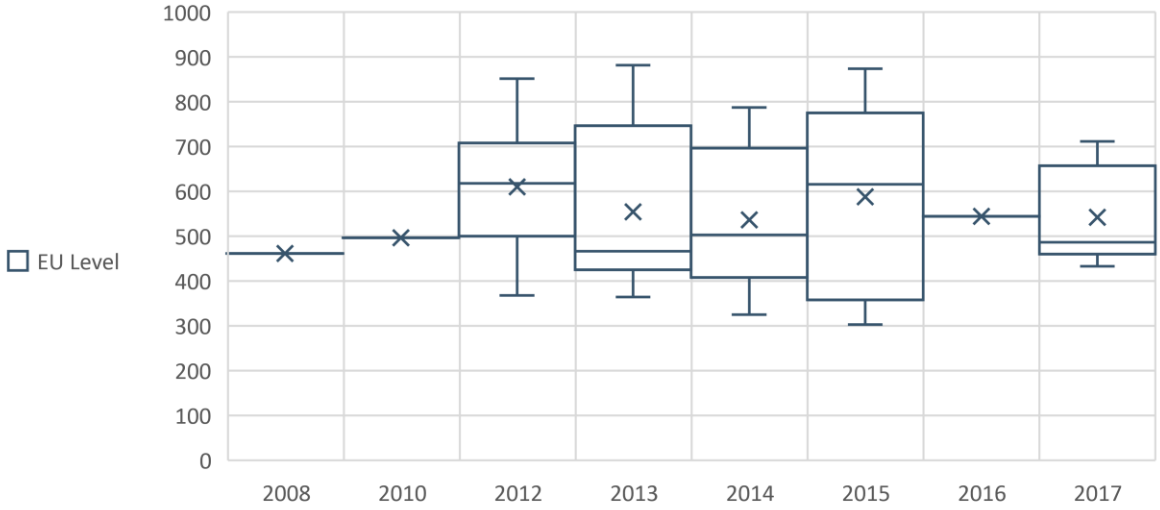
Average	2010	2012	2013	2014	2015	2016	2017
Weighted	48.7	52.5	64.2	64.3	56.7	49.1	47.4
Simple	57.8	78.4	99.1	98.3	89.2	80.0	82.5

Note: based on observations from 5 plants in 2010, 6 plants in 2012, 7 plants in 2012-2016 and 8 plants in 2017. Weighting factor: total electricity consumption.
Source: Authors' elaboration

Figure 99 and Table 130 show primary aluminium electricity costs in €/tonne. The trend of electricity costs for primary aluminium producers is very similar to electricity prices. Electricity costs are much higher for primary plants than they are for secondary and downstream aluminium plants by a factor of 10 and 5 respectively. This is because primary aluminium plants are by far the most electricity intensive industry included in this report.

Weighted averages shown in Table 130 are lower than simple averages meaning that larger plants experience lower electricity costs per tonne of production than smaller plants. This is likely a result of a number reasons: i) larger plants consuming large amounts of electricity may negotiate better electricity supply contracts; ii) larger plants tend to self-produce electricity, reducing electricity costs; iii) larger plants tend to take part in flexibility schemes, further reducing electricity costs. Box plots could not be shown for years 2008, 2010 and 2016 due to fewer than six observations from plants being available.

Figure 99 Primary aluminium electricity costs (€/tonne) – Box plots and simple averages



Note: Fewer than 6 primary aluminium plants provided reliable data for 2016, thus only the simple average is shown for this year. Similarly, 5 observations were available for 2008 and 2010, hence for these years only simple averages are shown. Six observations from plants were available for 2012-2015 and 9 observations in 2017.
Source: Authors' elaboration

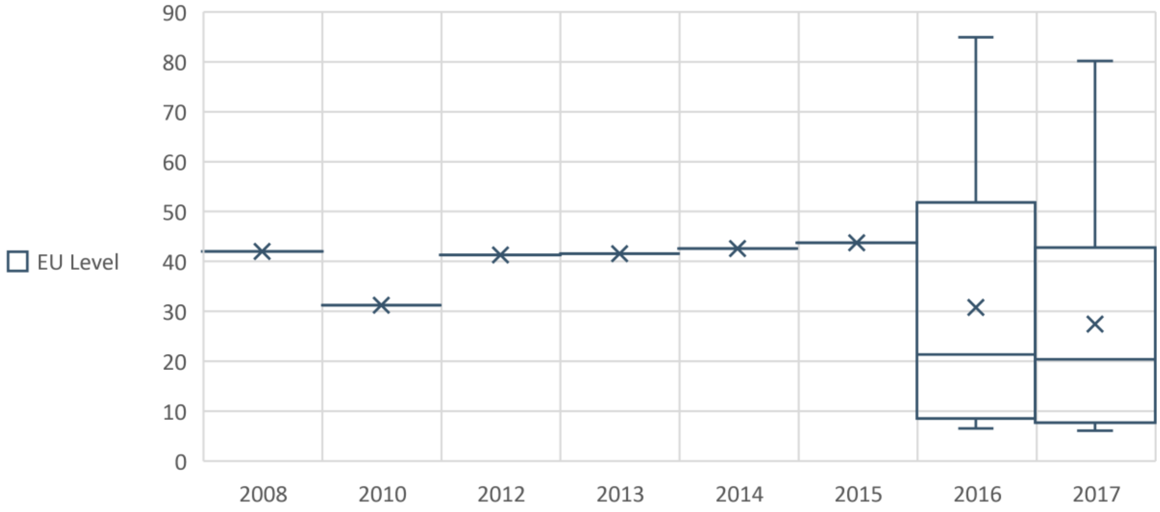
Table 130 EU average of primary aluminium electricity costs (€/tonne) – Simple and weighted averages

Average	2008	2010	2012	2013	2014	2015	2016	2017
Weighted	406.3	417.2	589.8	542.3	518.6	529.8	511.3	517.6
Simple	461.3	496.6	609.6	554.1	536.4	587.6	544.1	541.9

Note: Weighting factor: production output; 5 observations for 2008 and 2010, 6 observations for 2012-2015, 5 observations for 2016 and 9 observations for 2017.
Source: Authors' elaboration

Figure 100 and Table 131 shows the trend of electricity costs in €/tonne of sampled secondary aluminium plants. For 2016 and 2017 electricity costs are much lower than previous years, which is a result of the number of observations available for each year. Before 2016, the results are based on observations from only three plants, while for 2016 and 2017 the results are based on observations from eight plants. Therefore, box plots could not be shown for years before 2016 due to fewer than six observations from plants being available.

Figure 100 Secondary aluminium electricity costs (€/tonne) – Box plots and simple averages



Note: based on 3 observations from 2008-2015 and 8 observations for 2016 and 2017.
Source: Authors' elaboration

Table 131 EU average of secondary aluminium electricity costs (€/tonne) – Simple and weighted averages

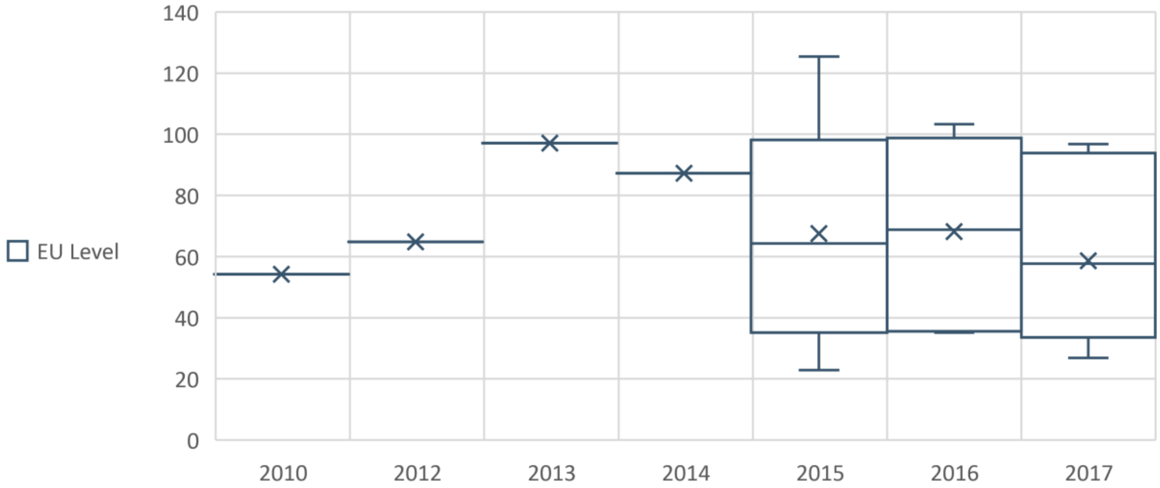
Average	2008	2010	2012	2013	2014	2015	2016	2017
Weighted	39.0	35.4	46.6	47.1	46.7	46.3	35.3	32.4
Simple	42.0	31.2	41.3	41.5	42.6	43.7	30.8	27.4

Note: Weighting factor: production output; based on 3 observations from 2008-2015 and 8 observations for 2016 and 2017.
Source: Authors' elaboration

Figure 101 and Table 132 show that electricity costs of sampled downstream aluminium plants have been fluctuating and this is a result of the number of observations for each year shown below the graph. Box plots are not shown for years previous to 2015 due to fewer than six observations from plants being available.

Table 132 shows the simple and weighted averages for downstream aluminium producers. The weighted average electricity costs, weighted on production output, are below the simple average for the years after 2014. This is probably because larger producers benefit from economies of scale. In addition, some downstream plants take part in flexibility schemes that allow them to pay lower electricity prices; for instance, when shifting away from peak times when electricity prices are higher.

Figure 101 Downstream aluminium electricity costs (€/tonne) – Box plots and simple averages



Note: based on 3 observations in 2010, 4 plants in 2012, 5 plants in 2013 and 2014, 6 in 2015 and 2016, and 7 observations in 2017.
Source: Authors' elaboration

Table 132 EU average of downstream aluminium electricity costs (€/tonne) – Simple and weighted averages

Average	2010	2012	2013	2014	2015	2016	2017
Weighted	74.1	72.6	85.0	81.9	53.1	49.8	45.3
Simple	54.2	64.8	97.1	87.3	67.5	68.2	58.6

Note: Weighting factor: production output; based on 3 observations in 2010, 4 plants in 2012, 5 plants in 2013 and 2014, 6 in 2015 and 2016, and 7 observations in 2017.
Source: Authors' elaboration

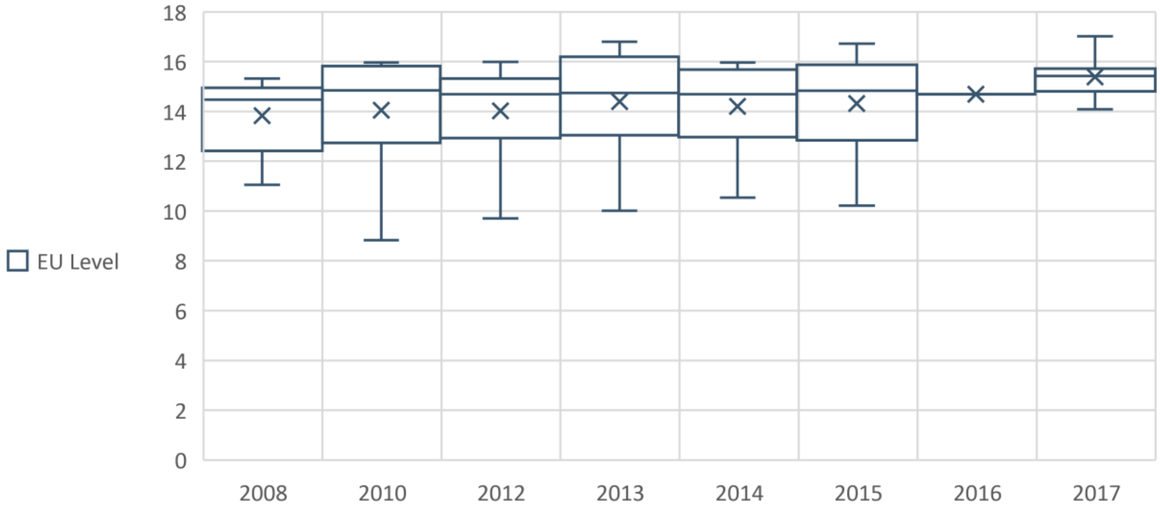
Electricity intensity

Figure 102 and Table 133 show the electricity intensity in MWh per tonne of primary smelter production output. Note that not all primary smelters provided the same coverage for the period. Electricity intensity for primary aluminium increased over the 10-year period. Electricity intensity increased from 13.8 MWh/tonne of weighted output in 2008 to 15.4 MWh/tonne in 2017. It is concluded that this is a result of the different number of observations for the two most recent years.

A box plot for 2016 is not presented in the graph due to the number of observations available. Instead, a simple average is presented for that year.

Table 133 shows the simple and weighted averages for electricity intensity. For all years except 2008, weighted averages are below simple averages. This is because larger plants in general are more electricity efficient than smaller primary aluminium plants.

Figure 102 Primary aluminium electricity intensity (MWh/tonne) – Box plots and simple averages



Note: Fewer than 5 plants provided reliable data to calculate electricity intensity per tonne of production for 2016; 6 observations in 2008-2015 and 9 observations in 2017.
Source: Authors' elaboration

Table 133 EU average of primary aluminium electricity intensity (MWh/tonne) – Simple and weighted averages

Average	2008	2010	2012	2013	2014	2015	2016	2017
Weighted	13.9	13.8	13.6	13.9	13.9	13.9	13.7	15.1
Simple	13.8	14.1	14.0	14.4	14.2	14.3	14.7	15.4

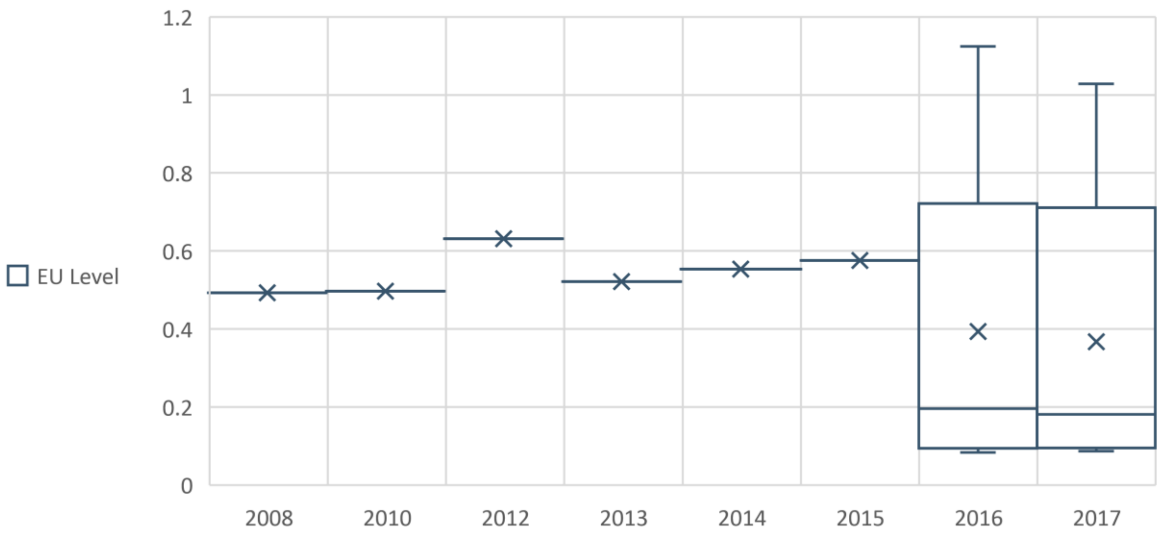
Note: Weighting factor: production output; fewer than 5 plants provided reliable data to calculate electricity intensity per tonne of production for 2016; 6 observations in 2008-2015 and 9 observations in 2017.
Source: Authors' elaboration

Figure 103 and Table 134 show that secondary aluminium producers are much less electricity intensive than primary aluminium producers, and marginally less than downstream aluminium producers. Secondary aluminium plants reported a wide-range of electricity intensity values, with a number of plants reporting very low intensities lowering the overall average, while downstream aluminium plants reported more homogenous electricity intensity values. The survey results did not provide any explanatory information, such as, for instance, the presence of on-site recycling downstream processes (remelting), using electricity as an energy carrier.

Box plots could not be shown for years previous to 2016 due to fewer than six observations from plants being available.

Table 134 shows the weighted averages of electricity intensity for secondary aluminium plants. For all years except 2017, weighted averages are below simple averages. This is because larger plants in general are more electricity efficient than smaller secondary aluminium plants.

Figure 103 Secondary aluminium electricity intensity (MWh/tonne) – Box plots and simple averages



Note: Observations from 4 plants in the years 2008-2015 and 9 plants in 2016 and 2017.
Source: Authors' elaboration

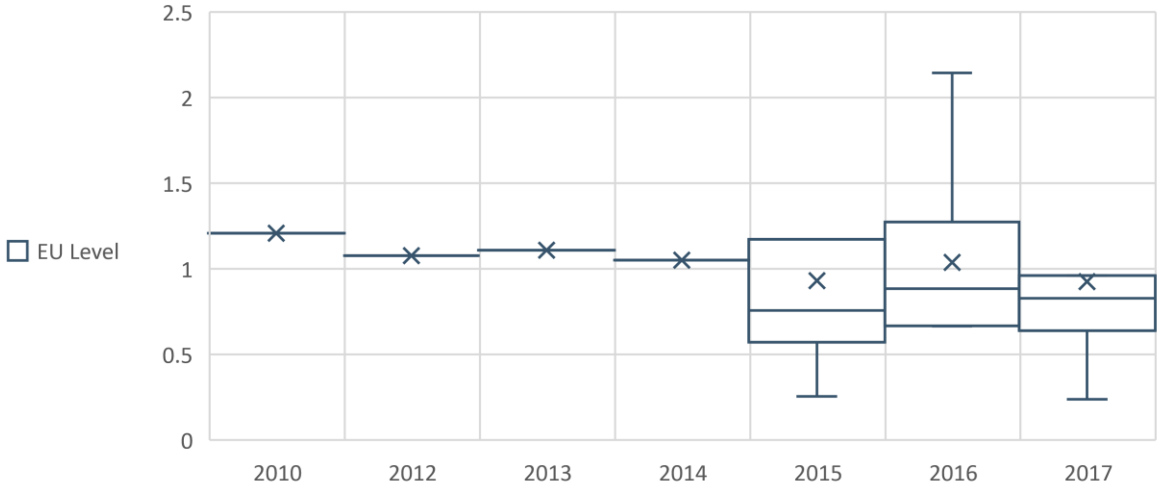
Table 134 EU average of secondary aluminium electricity intensity (MWh/tonne) – Simple and weighted averages

Average	2008	2010	2012	2013	2014	2015	2016	2017
Weighted	0.37	0.36	0.45	0.36	0.37	0.38	0.38	0.38
Simple	0.49	0.50	0.63	0.52	0.55	0.58	0.39	0.37

Note: Weighting factor: production output; observations from 4 plants in 2008-2015 and 9 plants in 2016 and 2017.
Source: Authors' elaboration

Figure 104 and Table 135 show that downstream plants included in the Study are more homogenous in terms of electricity intensity as compared to secondary aluminium plants, despite the wide variety of specialised products made in the downstream sector. Box plots could not be shown for years previous to 2015 due to fewer than six observations from plants being available. The observed change between 2010 and 2017 in Table 135 may be partially explained by the change in sample composition over the observed period.

Figure 104 Downstream aluminium electricity intensity (MWh/tonne) – Box plots and simple averages



Note: Observations from 3 plants for 2010, 4 plants for 2012, 5 for 2013 and 2014, 6 plants for 2015 and 2016 and observations from 7 plants for 2017.
Source: Authors' elaboration

Table 135 EU average of downstream aluminium electricity intensity (MWh/tonne) – Simple and weighted averages

Average	2010	2012	2013	2014	2015	2016	2017
Weighted	1.52	1.38	1.32	1.27	0.94	1.01	0.96
Simple	1.21	1.08	1.11	1.05	0.93	1.04	0.93

Note: Observations from 3 plants for 2010, 4 plants for 2012, 5 for 2013 and 2014, 6 plants for 2015 and 2016 and observations from 7 plants for 2017.Weighting factor: production output.
Source: Authors' elaboration

Additional information

The majority of primary plants source electricity through the wholesale electricity market, while the secondary and downstream plants mostly buy through providers, with a limited number sourcing a share of their electricity from the wholesale market.

The majority of plants in the aluminium sector have electricity contracts in place that last up to five years.

Almost all aluminium smelters take part in a flexibility scheme, while only 22% and 25% of secondary and downstream aluminium plants included in the Study take part in a flexibility scheme.

Table 136, Table 137 and Table 138 show that primary aluminium plants experienced the most outages of all the aluminium subsectors. Based on our definition, planned outages are mostly notified outages for the provision of flexibility schemes to the transmission system operator (interruptibility, primary and tertiary reserves). Primary smelters reported experiencing high unplanned outages in 2016. The reason behind these non-notified unplanned outages was not provided.

Five plants equivalent to 50% of the responding primary plants reported that they were self-generating electricity through either solar or hydro renewable energy technologies. None of the 10 plants included in the study reported self-generation based upon combined heat and power. All five plants sell a share of their self-generated electricity back to the grid. Survey responses improved when compared to the last EPC study, where only one primary aluminium plant provided information on self-generation capacity.

No secondary or downstream aluminium plants reported self-generating electricity.

Table 136 Primary aluminium electricity outages

EU	Planned outages		Other planned outages		Unplanned outages	
Year	Total number	Average duration in minutes	Total number	Average duration in minutes	Total number	Average duration in minutes
2016	5	75	7	280	75	761
2017	7	73	5	300	13	143

Note: Planned outages are linked to flexibility schemes; other planned outages are not linked to flexibility schemes, but notified in advance by the energy supplier; unplanned outages are not notified.
Source: Authors' elaboration

Table 137 Secondary aluminium electricity outages

EU	Planned outages		Other planned outages		Unplanned outages	
Year	Total number	Average duration in minutes	Total number	Average duration in minutes	Total number	Average duration in minutes
2016	0	NR	0	NR	1	NR
2017	0	NR	0	NR	2	10

Note: Planned outages are linked to flexibility schemes; other planned outages are not linked to flexibility schemes, but notified in advance by the energy supplier; unplanned outages are not notified.
Source: Authors' elaboration

Table 138 Downstream aluminium electricity outages

EU	Planned outages		Other planned outages		Unplanned outages	
Year	Total number	Average duration in minutes	Total number	Average duration in minutes	Total number	Average duration in minutes
2016	0	NR	0	NR	1	0
2017	0	NR	1	60	2	10

Note: Planned outages are linked to flexibility schemes; other planned outages are not linked to flexibility schemes, but notified in advance by the energy supplier; unplanned outages are not notified.
Source: Authors' elaboration

6.3 Natural gas

Table 139, Table 140 and Table 141 summarise the main indicators related to gas prices and costs that are further detailed in this Section of the Chapter. Gas prices and costs fluctuated across the period under observation and all aluminium subsectors experienced a sharp decrease in 2016 and 2017; this was mainly due to a decrease in the energy component of the gas price. Natural gas costs €/tonne for each subsector also decreased, following the trend of decreasing prices.

Table 139 Natural gas: summary table (EU, simple averages) for primary aluminium plants

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: Authors' elaboration

Table 140 Natural gas: summary table (EU, simple averages) for secondary aluminium plants

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: Authors' elaboration

Table 141 Natural gas: summary table (EU, simple averages) for downstream aluminium plants

Indicator	2008	2010	2012	2013	2014	2015	2016	2017
Natural gas prices (€/MWh)	Conf.	Conf.	41.8	38.9	37.0	28.7	24.7	20.2
Natural gas costs (€/tonne)	Conf.	Conf.	58.6	68.8	58.3	42.0	32.2	28.0
Natural gas intensity (MWh/tonne)	Conf.	Conf.	1.33	1.48	1.32	1.21	1.32	1.30

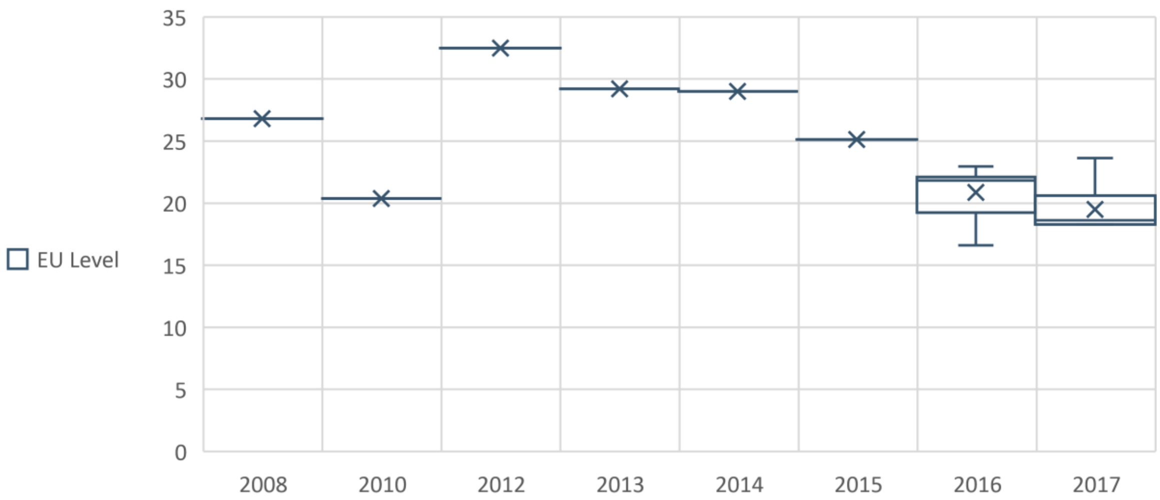
Source: Authors' elaboration

Natural gas prices

The following three graphs show the price of natural gas paid by aluminium producers. As illustrated by the figures and tables, the price of natural gas paid by all aluminium plants in the primary, secondary and downstream sectors did not vary significantly. The weighted average of the price of natural gas observed in 2017 ranges between €19.1/MWh for primary aluminium plants to €21.2/MWh for secondary plants, and downstream producers paid on average €20.0/MWh for natural gas. Wider standard deviations were observed over the years 2008 to 2014. These deviations were based on a small sample size.

Box plots could not be shown for years previous to 2016 due to fewer than six observations from plants being available. Table 142, Table 143 and Table 144 show the weighted averages of primary, secondary and downstream aluminium plants respectively. In 2016 and 2017, when more reliable data points were available, the weighted averages (weighted on purchased natural gas) of natural gas prices are lower than the simple averages. This is evidence that larger natural gas consumers are able to negotiate better natural gas supply contracts.

Figure 105 Primary aluminium natural gas prices (€/MWh) – Box plots and simple averages



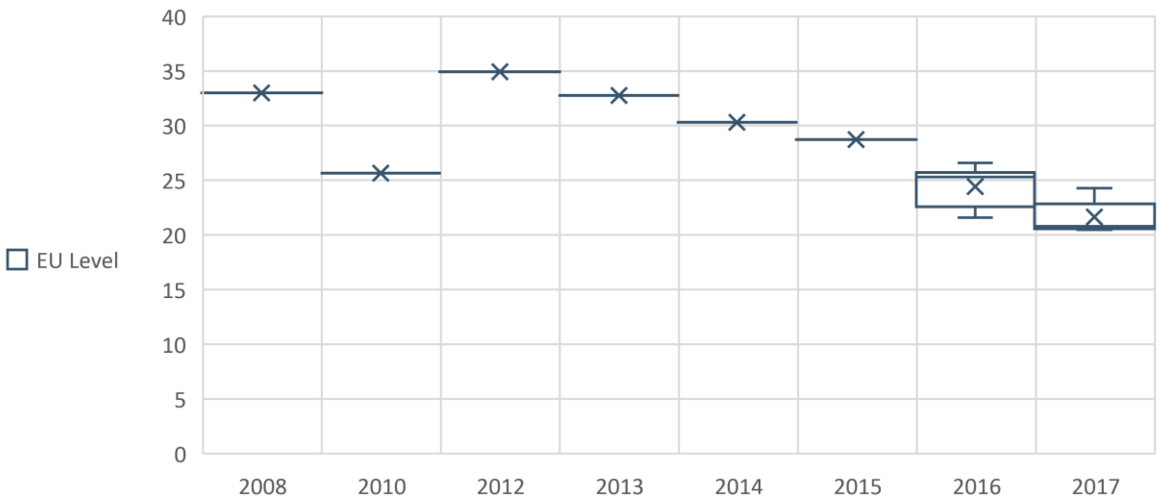
Note: Observations from 3 plants in 2008 and 2010, 4 plants in 2012-2015 and 6 plants in 2016 and 2017.
Source: Authors' elaboration

Table 142 EU average primary aluminium natural gas price (€/MWh) – Simple and weighted averages

Average	2008	2010	2012	2013	2014	2015	2016	2017
Weighted	25.3	19.7	42.2	35.8	34.3	27.5	20.4	19.1
Simple	26.8	20.4	32.5	29.2	29.0	25.1	20.9	19.5

Note: Weighting factor: purchased natural gas; observations from 3 plants in 2008 and 2010, 4 plants in 2012-2015 and 6 plants in 2016 and 2017.
Source: Authors' elaboration

Figure 106 Secondary aluminium natural gas prices (€/MWh) – Box plots and simple averages



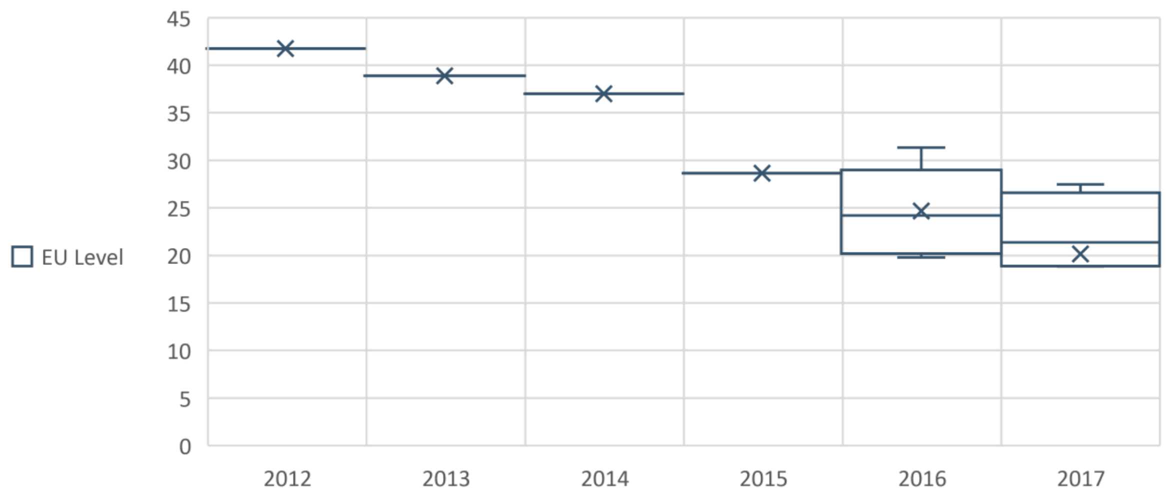
Note: Observations from 4 plants were available for 2008-2014, 5 plants for 2015 and 9 secondary aluminium plants for 2016 and 2017.
Source: Authors' elaboration

Table 143 EU average secondary aluminium natural gas prices (€/MWh) – Simple and weighted averages

Average	2008	2010	2012	2013	2014	2015	2016	2017
Weighted	33.2	25.8	34.9	31.8	28.7	27.1	23.6	21.2
Simple	33.0	25.7	34.9	32.8	30.3	28.7	24.4	21.6

Note: Weighting factor: purchased natural gas; observations from 4 plants were available for 2008-2014, 5 plants for 2015 and 9 secondary aluminium plants for 2016 and 2017.
Source: Authors' elaboration

Figure 107 Downstream aluminium natural gas prices (€/MWh) – Box plots and simple averages



Note: Observations from 4 downstream aluminium plants in 2012-2014, 5 in 2015, 7 in 2016 and 8 plants in 2017.
Source: Authors' elaboration

Table 144 EU average downstream aluminium natural gas prices (€/MWh) – Simple and weighted averages

Average	2012	2013	2014	2015	2016	2017
Weighted	31.3	29.8	29.6	24.3	23.0	20.0
Simple	41.8	38.9	37.0	28.7	24.7	20.2

Note: Weighting factor: purchased natural gas; observations from 4 downstream aluminium plants in 2012-2014, 5 in 2015, 7 in 2016 and 8 plants in 2017.
Source: Authors' elaboration

Components of the natural gas price[45]

The energy component is the most important part of the natural gas price paid by the sampled aluminium plants in the three subsectors, with the regulatory component making up a much lower share of the price when compared to electricity. In the prices, network costs are generally higher than other non-recoverable taxes and levies. Natural gas prices reported by plants in the aluminium sector have in general declined since 2012. The main component in

[45] The sum of the natural gas bill components does not necessarily add up to the total natural gas price mentioned before, as there might be plants that did not provide a breakdown of the natural gas bill components while still providing the total natural gas price.

the natural gas price responsible for this decline in the subsectors surveyed is the energy component.

As fewer than three primary plants provided reliable natural gas component data throughout the Study period the components of the natural gas prices paid by sampled primary aluminium producers cannot be graphically represented.

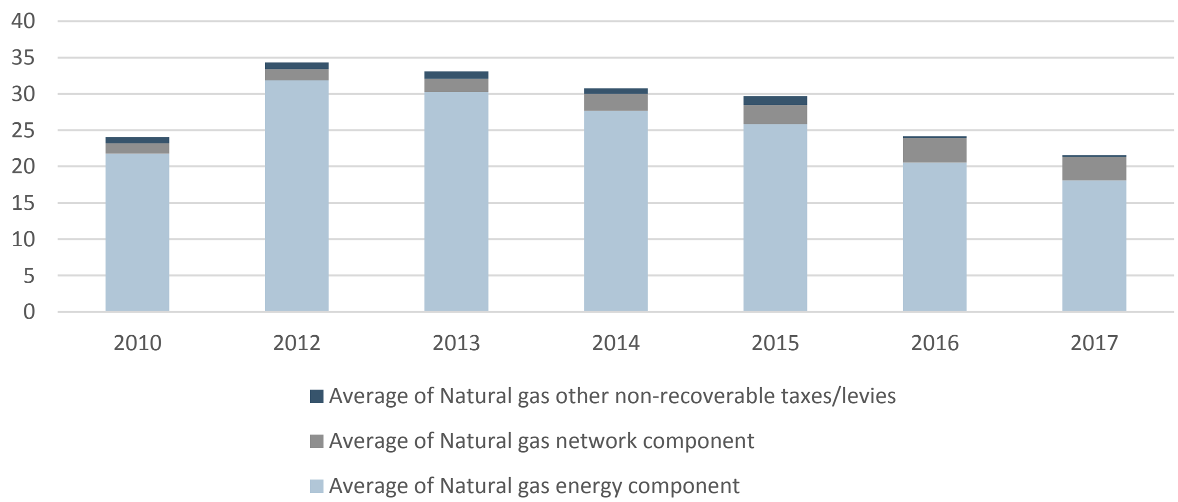
Figure 108 and Table 145 show that, compared to 2016, natural gas costs in sampled secondary aluminium sites declined in 2017 because of lower energy component costs. Network component costs increased slightly; however, this increase is marginal when compared to the magnitude of the decline of energy component costs.

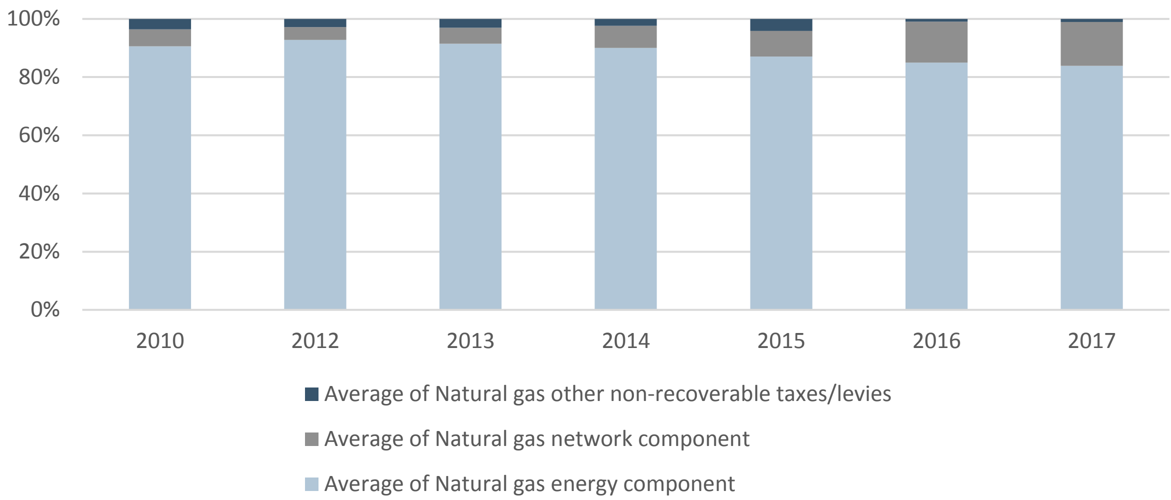
Note that not enough observations were available to show 2008 secondary aluminium components of the natural gas price.

Figure 109 and Table 146 show that downstream aluminium plants reported declining costs from 2015 as a result of the gas energy component. For secondary and downstream plants, the energy component of natural gas prices accounted for 80-90% of the total price.

Table 145 and Table 146 show simple and weighted averages for components of the natural gas price for secondary and downstream aluminium plants. The weighted averages (weighted on purchased natural gas) show very similar values to simple averages for secondary aluminium producers, except for the network component where weighted averages are significantly lower than the simple averages in the period analysed. Therefore, it appears that larger natural gas consumers pay less for network costs than smaller consumers.

Figure 108 Secondary aluminium - Components of the natural gas price (€/MWh and %, EU) – Simple averages





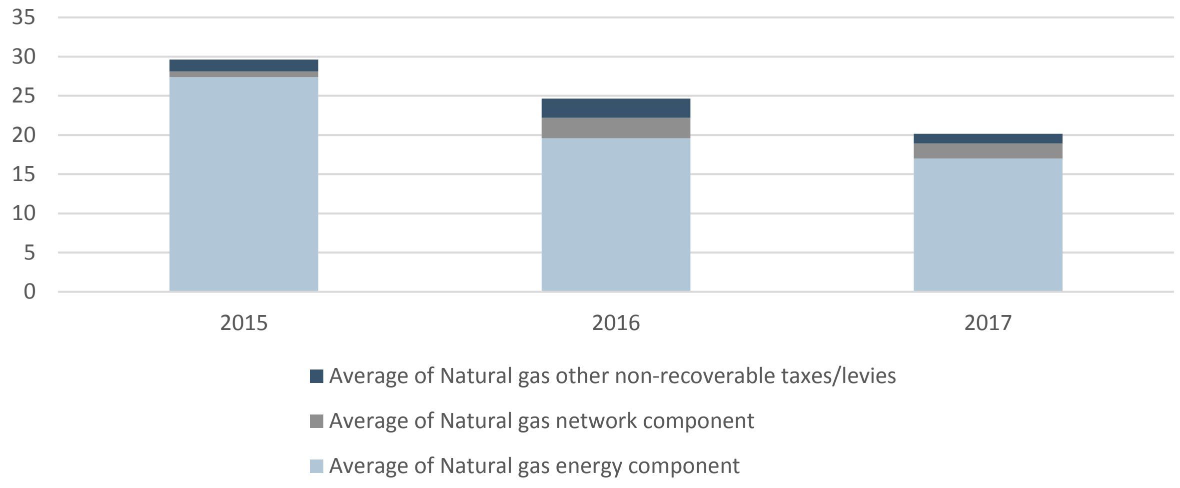
Note: Observations from3 plants were used for 2010-2015 and 6 secondary aluminium plants in 2016 and 2017.
Source: Authors' elaboration

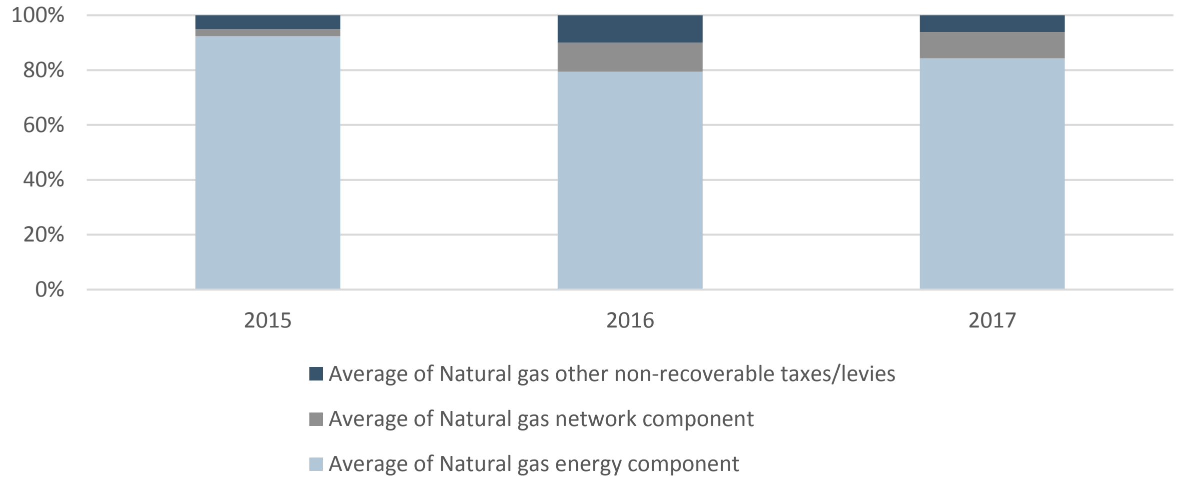
Table 145 EU average of secondary aluminium - Components of the natural gas price (€/MWh) – Simple and weighted averages

Average	2010	2012	2013	2014	2015	2016	2017
Energy component							
Weighted	21.9	32.2	29.9	26.8	24.6	20.0	17.9
Simple	21.8	31.9	30.3	27.7	25.8	20.5	18.1
Network component							
Weighted	0.6	1.0	1.4	1.5	1.9	3.1	3.0
Simple	1.4	1.5	1.8	2.4	2.6	3.4	3.3
Other non-recoverable taxes/levies							
Weighted	0.7	0.8	0.9	0.7	0.9	0.2	0.1
Simple	0.8	0.9	1.0	0.7	1.2	0.2	0.2

Note: Weighting factor: purchased natural gas; observations from 3 plants were used for 2010-2015 and 6 secondary aluminium plants in 2016 and 2017.
Source: Authors' elaboration

Figure 109 Downstream aluminium - Components of the natural gas price (€/MWh and %, EU) – Simple averages





Note: Observations from 3 downstream aluminium plants in 2015, 6 in 2016 and 7 in 2017.
Source: Authors' elaboration

Table 146 EU average of downstream aluminium - Components of the natural gas price (€/MWh) – Simple and weighted averages

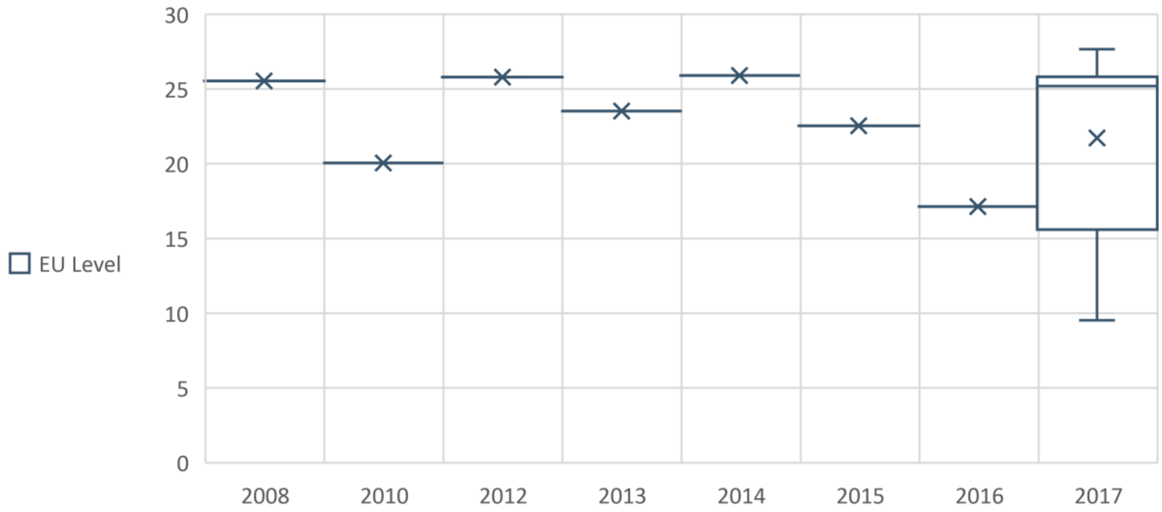
Average	2015	2016	2017
Energy component			
Weighted	23.7	20.6	17.8
Simple	27.4	19.6	17.0
Network component			
Weighted	1.0	1.5	1.1
Simple	0.7	2.6	1.9
Other non-recoverable taxes/levies			
Weighted	1.1	3.2	0.7
Simple	1.5	2.5	1.2

Note: Weighting factor: purchased natural gas; observations from 3 downstream aluminium plants in 2015, 6 in 2016 and 7 in 2017.
Source: Authors' elaboration

Natural gas costs

Figure 110 and Table 147 show natural gas costs in €/tonne for primary aluminium plants. These costs in general follow natural gas price trends reported by plants, shown in Figure 105. Box plots could not be shown for all years except for 2017 due to fewer than six observations from plants being available. Weighted averages of natural gas costs, shown in Table 147, are very similar to simple averages revealing that, in general, large and small natural gas consumers are subject to very similar natural gas costs overall.

Figure 110 Primary aluminium natural gas costs (€/tonne) – Box plots and simple averages



Note: Observations from 4 plants were available for 2008-2015 and 8 secondary aluminium plants for 2016 and 2017.
Source: Authors' elaboration

Table 147 EU average of primary aluminium natural gas cost (€/tonne) – Simple and weighted averages

Average	2008	2010	2012	2013	2014	2015	2016	2017
Weighted	25.8	19.6	25.6	23.1	25.2	22.0	17.1	21.0
Simple	25.5	20.1	25.8	23.5	25.9	22.5	17.1	21.7

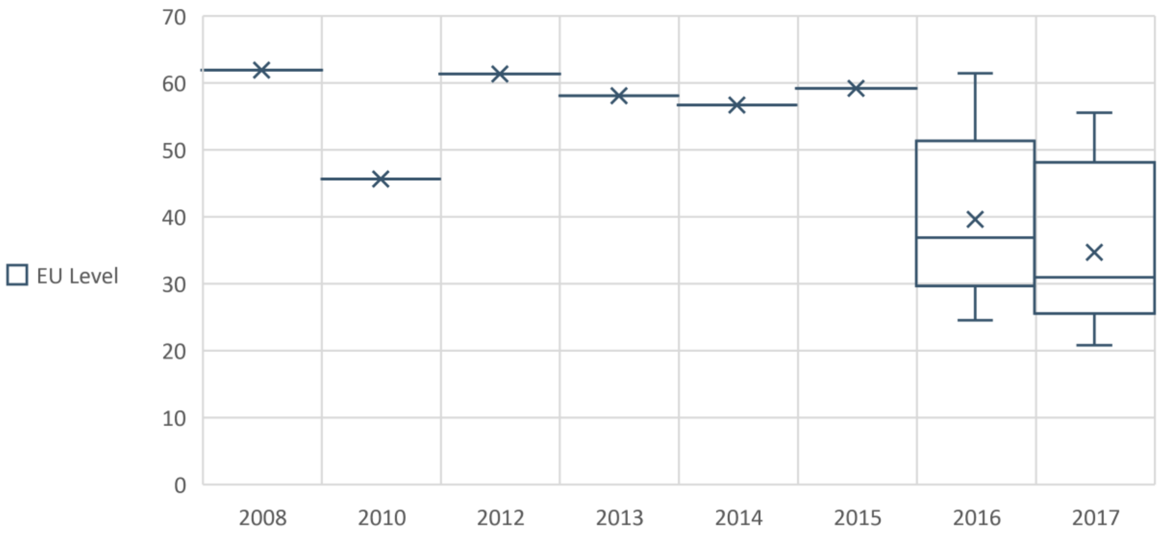
Note: Weighting factor: production output; observations from 4 plants were available for 2008-2015 and 8 secondary aluminium plants for 2016 and 2017.
Source: Authors' elaboration

Figure 111 and Table 148 show that secondary aluminium plants report having higher natural gas costs as compared to primary aluminium plants. The large difference observed over 2008 to 2015 relates to differences in sampling composition with the number of observed plants doubling from four to eight between 2008-2015 and 2016-2017. It shall not be considered as having any relevance to the analysis.

Box plots could not be shown for years previous to 2016 due to fewer than six observations from plants being available. The difference in natural gas costs from the years before 2016 are due to the number of observations for those years.

The weighted averages shown in Table 148 are constantly below simple averages. Interestingly, there are fewer observations available for the years before 2016; in this period, one large secondary aluminium producer reported lower natural gas costs and this plant had a significantly larger influence over the weighted average natural gas cost.

Figure 111 Secondary aluminium natural gas costs (€/tonne) – Box plots and simple averages



Note: Observations from 4 secondary aluminium plants in the years from 2008 to 2015 and 8 secondary aluminium plants in 2016 and 2017.
Source: Authors' elaboration

Table 148 EU average of secondary aluminium natural gas cost (€/tonne) – Simple and weighted averages

Average	2008	2010	2012	2013	2014	2015	2016	2017
Weighted	52.2	39.5	51.0	46.4	43.5	44.2	35.4	31.6
Simple	61.9	45.6	61.3	58.1	56.7	59.2	39.6	34.7

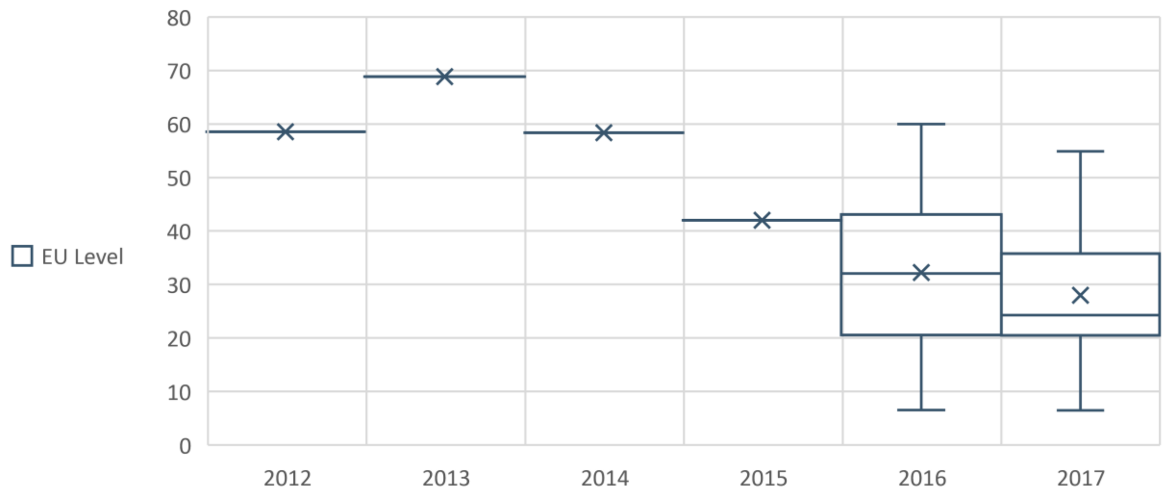
Note: Weighting factor: production output; observations from 8 secondary aluminium plants in 2016 and 2017.
Source: Authors' elaboration

Figure 112 and Table 149 show that downstream aluminium plants experience slightly lower natural gas costs in €/tonne as compared to secondary aluminium plants from 2015 onwards.

In the graph, box plots could not be shown for years previous to 2016 due to fewer than six observations from plants being available.

Weighted averages of natural gas costs for downstream aluminium producers, shown in Table 149, are comparable to the simple averages, particularly for 2016 and 2017 when more observations were available.

Figure 112 Downstream aluminium natural gas cost (€/tonne) – Box plots and simple averages



Note: Observations from 3 downstream aluminium plants in 2012-2014, 4 in 2015, 7 in 2016 and 8 in 2017.
Source: Authors' elaboration

Table 149 EU average of downstream aluminium natural gas cost (€/tonne) – Simple and weighted averages

Average	2012	2013	2014	2015	2016	2017
Weighted	60.1	65.3	57.9	37.4	32.5	28.5
Simple	58.6	68.8	58.3	42.0	32.2	28.0

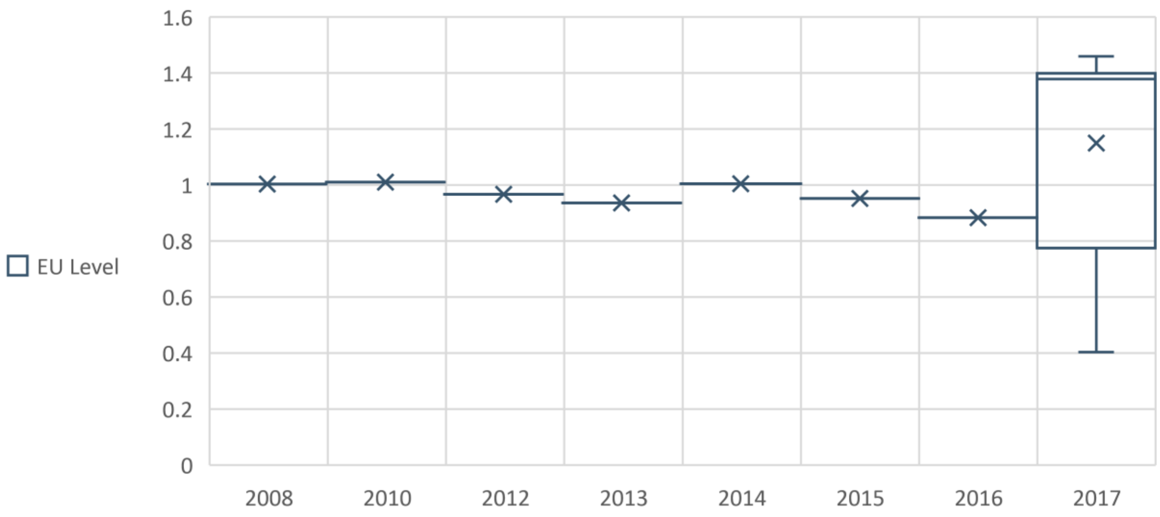
Note: Weighting factor: production output; observations from 4 downstream aluminium plants in 2012, 5 plants in 2013-2014, 6 in 2015 and 2016 and 7 plants in 2017.
Source: Authors' elaboration

Natural gas intensity

Due to the limited number of observations, a box plot of natural gas intensity can only be presented for primary aluminium plants in 2017 (Figure 113); simple averages are shown for all other years.

The natural gas intensity of primary aluminium production is significantly lower than the electricity intensity presented earlier. However, per tonne of aluminium, a 2017 weighted average of 1.1 MWh of natural gas is reported by the respondents. There is, however, a very large disparity between different plants, which is shown by the high standard deviation illustrated by the wide box plot in 2017.

Figure 113 Primary aluminium natural gas intensity (MWh/tonne) – Box plots and simple averages



Note: Observations from 3 primary aluminium plants in 2008-2016 and observations from 6 primary aluminium plants in 2017.
Source: Authors' elaboration

Table 150 EU average of primary aluminium natural gas intensity (MWh/tonne) – Simple and weighted averages

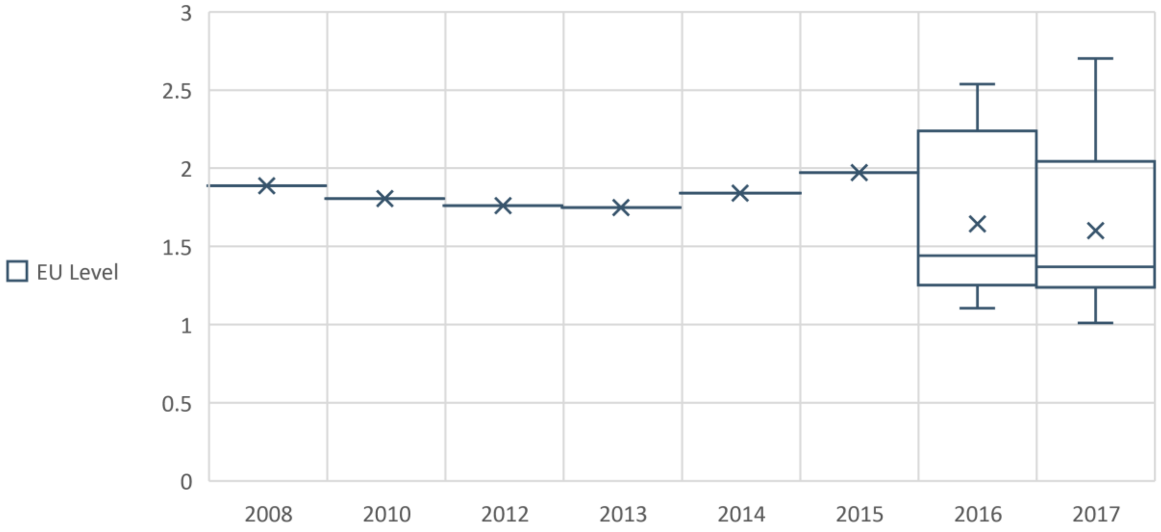
Average	2008	2010	2012	2013	2014	2015	2016	2017
Weighted	1.02	1.00	0.94	0.90	0.96	0.92	0.90	1.10
Simple	1.00	1.01	0.97	0.94	1.00	0.95	0.88	1.15

Note: Weighting factor: production output; observations from 3 primary aluminium plants in 2008-2016 and observations from 6 primary aluminium plants in 2017.
Source: Authors' elaboration

Figure 114 shows that secondary aluminium plants included in the Study generally have slightly higher natural gas intensities than downstream aluminium plants. It is likely that the lower weighted averages shown in Table 151 is a result of larger natural gas consumers in the secondary aluminium sector having a slightly more efficient process in regard to natural gas, as compared to smaller consumers.

Box plots could not be shown for years previous to 2016 due to fewer than six observations from plants being available.

Figure 114 Secondary aluminium natural gas intensity (MWh/tonne) – Box plots and simple averages



Note: Observations from 4 secondary aluminium plants in the years from 2008 to 2015 and 8 secondary aluminium plants in 2016 and 2017.
Source: Authors' elaboration

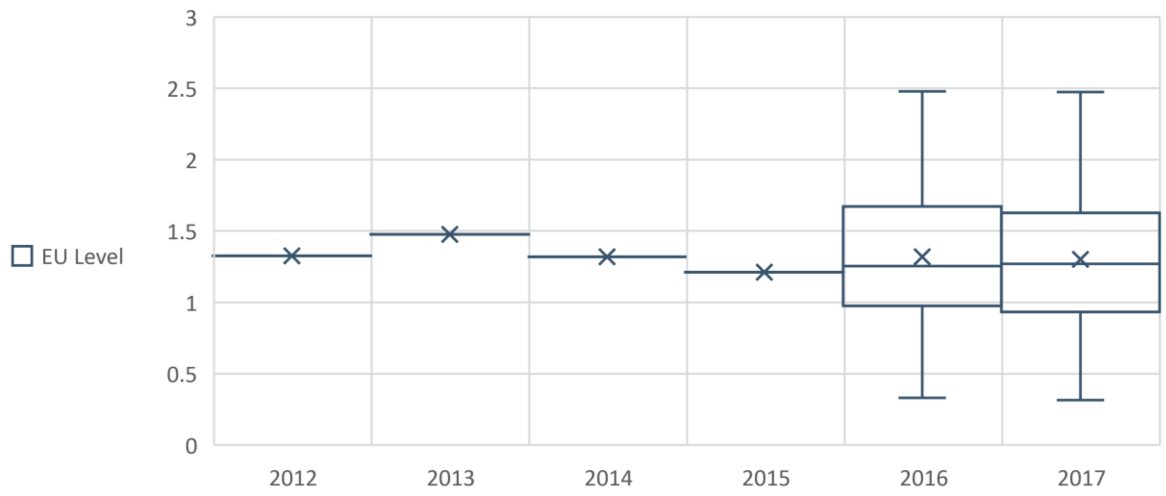
Table 151 EU average of secondary aluminium natural gas intensity (MWh/tonne) – Simple and weighted averages

Average	2008	2010	2012	2013	2014	2015	2016	2017
Weighted	1.57	1.53	1.46	1.46	1.52	1.63	1.52	1.50
Simple	1.89	1.81	1.76	1.75	1.84	1.97	1.64	1.60

Note: Weighting factor: production output; observations from 4 secondary aluminium plants in the years from 2008 to 2015 and 8 secondary aluminium plants in 2016 and 2017.
Source: Authors' elaboration

Figure 115 and Table 152 show that natural gas intensities reported by downstream aluminium plants are more homogenous as compared to secondary plants, illustrated by the interquartile range shown for 2016 and 2017. Weighted averages of natural gas intensity for downstream aluminium plants are marginally higher than the simple averages for 2015, 2016 and 2017. As the weighting factor is on production output, it means that for these years, larger consumers in the downstream aluminium industry appear to be less efficient in regard to natural gas than smaller consumers. Box plots could not be shown for years previous to 2016 due to fewer than six observations from plants being available.

Figure 115 Downstream aluminium natural gas intensity (MWh/tonne) – Box plots and simple averages



Note: Observations from 3 downstream aluminium plants in 2013, 4 plants in 2013 and 2014, 5 in 2015 and 6 in 2016-2017.
Source: Authors' elaboration

Table 152 EU average of downstream aluminium natural gas intensity (MWh/tonne) – Simple and weighted averages

Average	2012	2013	2014	2015	2016	2017
Weighted	1.41	1.36	1.29	1.26	1.45	1.45
Simple	1.33	1.48	1.32	1.21	1.32	1.30

Note: Weighting factor: production output; observations from 3 downstream aluminium plants in 2013, 4 plants in 2013 and 2014, 5 in 2015 and 6 in 2016-2017.
Source: Authors' elaboration

Additional information

Out of all plants included in the study from the aluminium subsectors, 22% reported that they purchase their natural gas on the wholesale market. No plant reported a natural gas contract duration of longer than five years.

Similarly, no aluminium plant reported being part of a natural gas flexibility scheme or self-generating natural gas.

Only one secondary aluminium plant reported a natural gas planned outage[46]; this outage was not associated with a flexibility scheme and took place in 2017, lasting for 480 minutes. The reason for this outage was not reported by the plant.

6.4 Competitiveness

Cost competitiveness

Electricity

Primary aluminium

[46] Planned outages are linked to flexibility schemes; other planned outages are not linked to flexibility schemes, but notified in advance by the energy supplier; unplanned outages are not notified.

This Section provides an overview of the competitiveness of the primary aluminium sector in relation to electricity costs, production costs and profitability indicators (EBITDA and EBIT), and their evolution over time.

The overview presented below takes into account the fact that the average electricity costs shown are based on the following observations: nine plants were observed from 2008 to 2017, except for 2016 when observations from only three plants were available.

The primary aluminium sector experienced the highest average electricity costs per tonne of production, as compared to all other energy intensive sectors included in this study. In absolute terms, the simple average of electricity costs for primary aluminium plants stood at €542/tonne in 2017. This is due to the level of electricity intensity of the smelting process, as opposed to the lower level of process intensities in the downstream and secondary sectors, and in other sectors (see Chapter 10 – Cross-sectoral analysis).

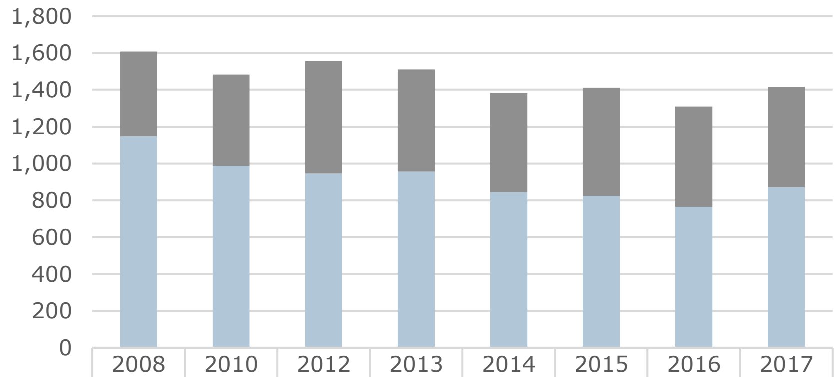
When looking at the weighted averages shown in Table 153, it appears that larger plants face both lower electricity costs and lower production costs in €/tonne. This is most likely due to two main factors: i) economies of scale; ii) direct access to wholesale markets and better supply conditions of larger consumers; iii) load consumption profile of smelters.

The data presented in Table 153 shows a reduction in the average production costs for primary aluminium plants by a factor of 11-12% between 2008 and 2017.

Over the same period the share of average electricity costs in production costs increased from 29% to 37-38%. Except in 2008 and 2016, the electricity costs for primary aluminium plants expressed as weighted averages of production output are lower than their simple averages. Hence, cost advantages for large plants tend to compensate for the relatively higher costs supported by small plants. When expressed as a share of production costs, the weighted average and simple average of electricity costs for primary aluminium is relatively similar, and stands between 37.3% and 38.3%.

It was not possible to show the impact of electricity costs over production costs net of depreciation and amortisation, as only a limited number of plants disclosed this indicator.

Figure 116 Electricity costs as a share of total production costs for primary aluminium plants (€/tonne, EU) – Simple averages



	2008	2010	2012	2013	2014	2015	2016	2017
Average of Electricity cost €/tonne2	461.3	496.6	609.6	554.1	536.4	587.6	544.1	541.9
Average of other Production costs €/tonne	1,147	987	945	957	845	824	764	872

Note: electricity costs are based on 5 observations for 2008 and 2010, 6 observations from plants in 2011-2015, 3 observations in 2016 and 9 in 2017. Production costs are based on observations from 3 plants in all years except for 2016 and 2017 where they are based on 4 observations.
Source: Authors' elaboration

Table 153 Electricity costs as a share of production costs for primary aluminium plants (EU) – Simple and weighted averages

Indicator	2008	2010	2012	2013	2014	2015	2016	2017
Electricity costs simple average (€/tonne)	461.3	496.6	609.6	554.1	536.4	587.6	544.1	541.9
Electricity costs weighted average (€/tonne)	467.0	476.1	589.8	542.3	518.6	529.8	540.6	517.6
Production costs simple average (€/tonne)	1608.2	1483.3	1554.9	1510.7	1381.6	1411.8	1308.5	1414.4
Production costs weighted average (€/tonne)	1564.2	1423.4	1551.1	1507.5	1375.4	1401.3	1311.8	1386.0
Electricity costs as a share of production costs simple averages (%)	28.7%	33.5%	39.2%	36.7%	38.8%	41.6%	41.6%	38.3%
Electricity costs as a share of production costs weighted averages (%)	29.9%	33.4%	38.0%	36.0%	37.7%	37.8%	41.2%	37.3%

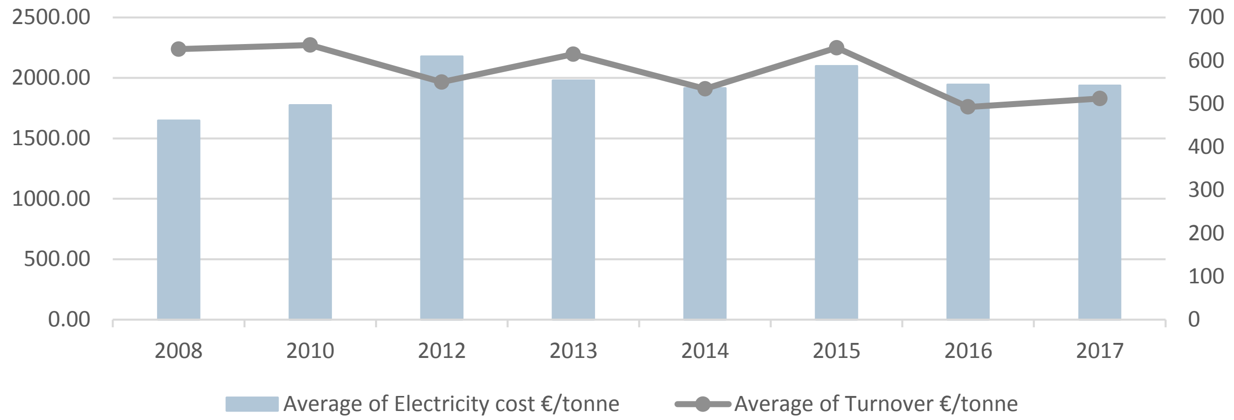
Note: Weighting factor: production output; electricity costs are based on 5 observations for 2008 and 2010, 6 observations from plants in 2011-2015, 3 observations in 2016 and 9 in 2017. Production costs are based on observations from 3 plants in all years except for 2016 and 2017 when they are based on 4 observations.
Source: Authors' elaboration

Electricity unit costs peaked in 2012 and 2015 but declined in 2017 again to roughly the same levels as 2013-2014. Electricity costs represented a 38.3% share of production costs in 2017, when measured as a simple average, and 37.3% share of production costs when measured as a weighted average.

Electricity unit costs fluctuated over the observed period, as a result of the variations in the number of observed variations, combined with differences in the level of electricity costs in the different regions: NWE, SE; CEE.

Between 2015 and 2016, there were diverging trends between the simple average and the weighted average electricity costs, resulting from the lower number of observations in 2016. The fact that three primary aluminium plants were included in 2016 led to an increase in the weighted average electricity cost, as opposed to the simple average.

Figure 117 Electricity costs versus turnover for primary aluminium plants (€/tonne, EU) – Simple averages



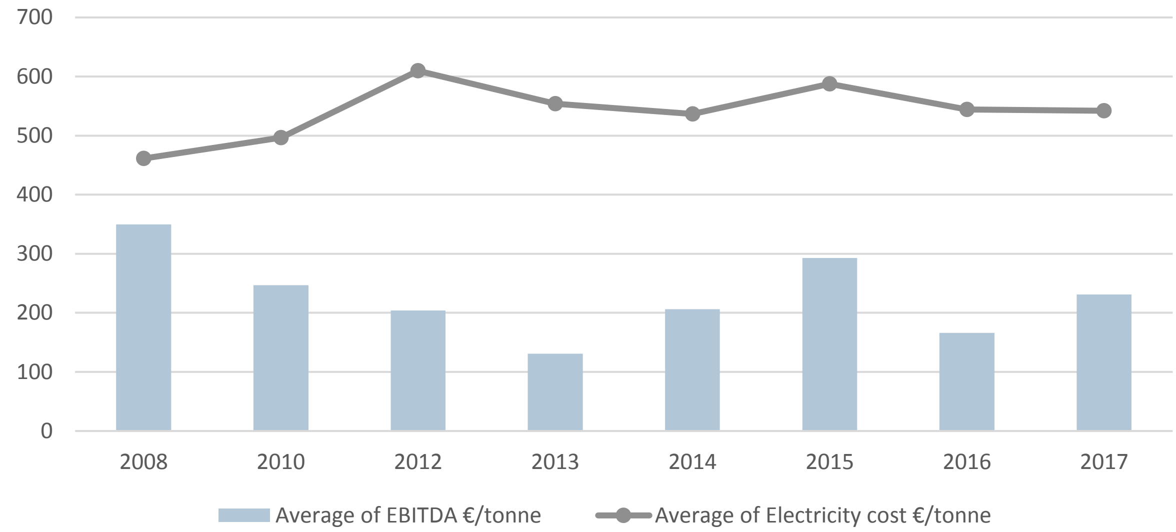
Note: electricity costs are based on 5 observations for 2008 and 2010, 6 observations from plants in 2011-2015, 3 observations in 2016 and 9 in 2017. Turnover is based on 3 observations for all years except 2016 and 2017 where it is based on 7 observations.
Source: Authors' elaboration

Table 154 Electricity costs versus turnover for primary aluminium plants (EU) – Simple and weighted averages

Indicator	2008	2010	2012	2013	2014	2015	2016	2017
Electricity costs simple average (€/tonne)	461.3	496.6	609.6	554.1	536.4	587.6	544.1	541.9
Electricity costs weighted average (€/tonne)	467.0	476.1	589.8	542.3	518.6	529.8	540.6	517.6
Turnover simple average (€/tonne)	2238.1	2271.8	1965.4	2195.7	1908.6	2249.9	1759.2	1829.0
Turnover weighted average (€/tonne)	2149.1	2085.8	1931.0	2084.3	1865.2	2178.2	1582.6	1848.6
Electricity costs as a share of turnover simple averages (%)	20.6%	21.9%	31.0%	25.2%	28.1%	26.1%	30.9%	29.6%
Electricity costs as a share of turnover weighted averages (%)	21.7%	22.8%	30.5%	26.0%	27.8%	24.3%	34.2%	28.0%

Note: Weighting factor: production output; electricity costs are based on 5 observations for 2008 and 2010, 6 observations from plants in 2011-2015, 3 observations in 2016 and 9 in 2017. Turnover is based on 3 observations for all years except 2016 and 2017 when it is based on 7 observations.
Source: Authors' elaboration

Figure 118 Electricity costs versus EBITDA for primary aluminium plants (€/tonne, EU) – Simple averages



Note: electricity costs are based on 5 observations for 2008 and 2010, 6 observations from plants in 2011-2015, 3 observations in 2016 and 9 in 2017. Observations for EBITDA are based on average data provided in the previous study (CEPS et al. 2016) for 2008-2015 and observations from 7 plants for 2016 and 2017.
Source: Authors' elaboration

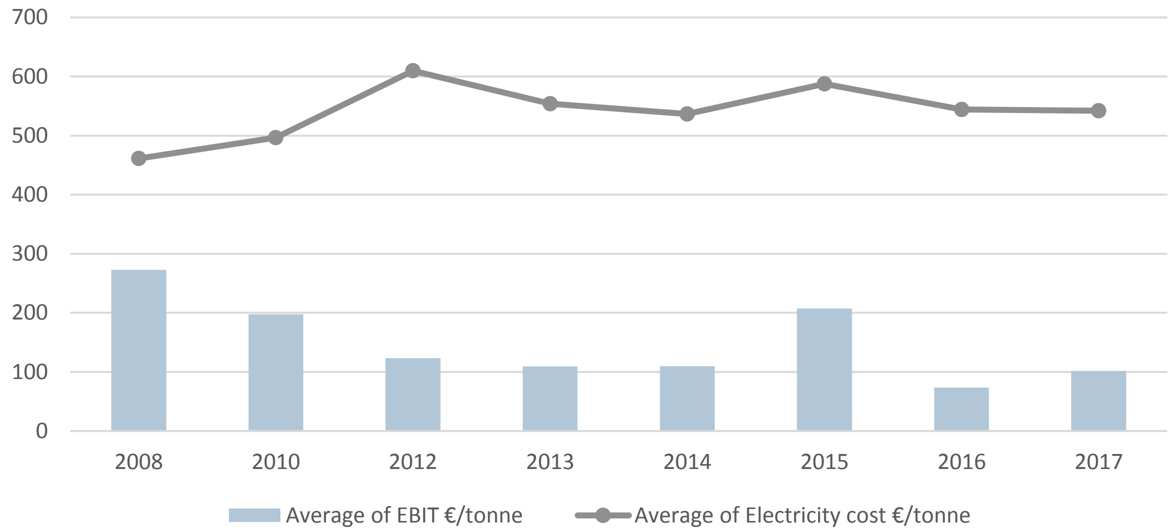
Table 155 Electricity costs versus EBITDA for primary aluminium plants (€/tonne, EU) – Simple and weighted averages

Indicator	2008	2010	2012	2013	2014	2015	2016	2017
Electricity costs simple average (€/tonne)	461.3	496.6	609.6	554.1	536.4	587.6	544.1	541.9
Electricity costs weighted average (€/tonne)	467.0	476.1	589.8	542.3	518.6	529.8	540.6	517.6
EBITDA simple average (€/tonne)	350.0	247.0	204.2	130.8	206.5	293.1	166.0	231.1
EBITDA weighted average (€/tonne)	n/a	n/a	n/a	n/a	n/a	n/a	131.9	180.3

Note: Weighting factor: production output; electricity costs are based on 5 observations for 2008 and 2010, 6 observations from plants in 2011-2015, 3 observations in 2016 and 9 in 2017. Observations for EBITDA are based on average data provided in the previous study (CEPS et al. 2016) for 2008-2015 and observations from 7 plants for 2016 and 2017.
Source: Authors' elaboration

The average production cost values are based on four plants, turnover on seven plants, EBIT on four plants and EBITDA on seven plants. Both EBITDA and EBIT increased again in 2017, after 2016 values which were amongst the lowest values in the 10-year period observed.

Figure 119 Electricity costs versus EBIT for primary aluminium plants (€/tonne, EU) – Simple averages



Note: electricity costs are based on 5 observations for 2008 and 2010, 6 observations from plants in 2011-2015, 3 observations in 2016 and 9 in 2017. Observations for EBIT are based on average data provided in the previous study (CEPS et al. 2016) for 2008-2015 and observations from 4 plants for 2016 and 2017.
Source: Authors' elaboration

Table 156 Electricity costs versus EBIT for primary aluminium plants (€/tonne, EU) – Simple and weighted averages

Indicator	2008	2010	2012	2013	2014	2015	2016	2017
Electricity costs simple average (€/tonne)	461.3	496.6	609.6	554.1	536.4	587.6	544.1	541.9
Electricity costs weighted average (€/tonne)	467.0	476.1	589.8	542.3	518.6	529.8	540.6	517.6
EBIT simple average (€/tonne)	272.7	197.5	123.2	109.5	109.8	207.4	73.4	101.6
EBIT weighted average (€/tonne)	n/a	n/a	n/a	n/a	n/a	n/a	64.1	107.0

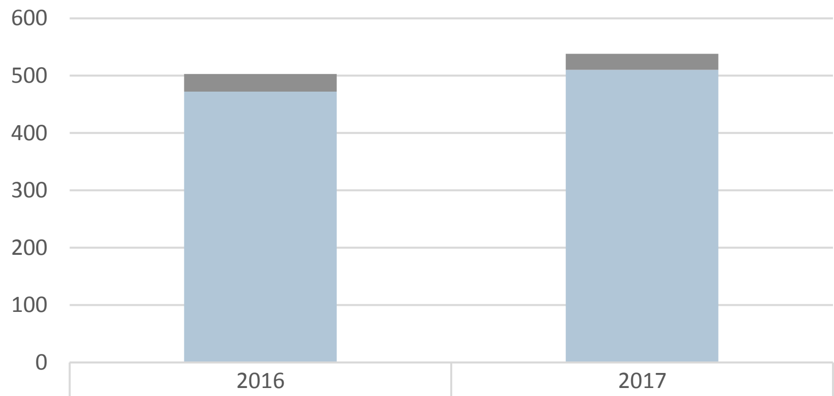
Note: Weighting factor: production output; electricity costs are based on 5 observations for 2008 and 2010, 6 observations from plants in 2011-2015, 3 observations in 2016 and 9 in 2017. Observations for EBIT are based on average data provided in the previous study (CEPS et al. 2016) for 2008-2015 and observations from 4 plants for 2016 and 2017.
Source: Authors' elaboration

Secondary aluminium

Figure 120 provides an overview of the cost competitiveness of the secondary aluminium sector in relation to electricity costs. In the graph, the average electricity cost shown is based on observations from all nine plants. The average production cost values are based on observations from six plants.

Compared to downstream plants, electricity costs form a larger share of total production costs. The weighted averages of electricity costs as a share of production costs are between 7.3% and 6.0%. These values are in general higher than simple averages.

Figure 120 Electricity costs as a share of production costs for secondary aluminium plants (EU)



	2016	2017
Average of Electricity cost €/tonne	30.79	27.43
Average of other Production costs €/tonne	472	511

Note: 6 observations in 2016 and 2017 for production costs, and 9 observations in 2016 and 2017 for electricity costs.
Source: Authors' elaboration

Table 157 Electricity costs as a share of production costs for secondary aluminium plants (EU) – Simple and weighted averages

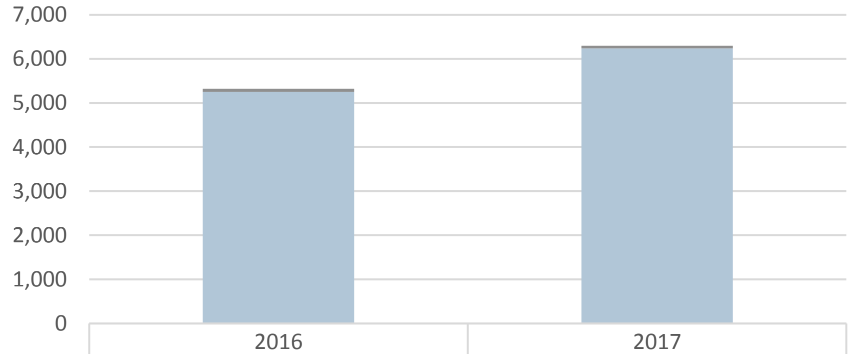
Indicator	2016	2017
Electricity costs simple average (€/tonne)	30.8	27.4
Electricity costs weighted average (€/tonne)	35.3	32.4
Production costs simple average (€/tonne)	503.0	538.0
Production costs weighted average (€/tonne)	482.9	537.6
Electricity costs as a share of production costs simple averages (%)	6.1%	5.1%
Electricity costs as a share of production costs weighted averages (%)	7.3%	6.0%

Note: Weighting factor: production output; 6 observations in 2016 and 2017 for production costs, and 9 observations in 2016 and 2017 for electricity costs.
Source: Authors' elaboration

Downstream aluminium

In Figure 121, the average electricity cost shown is based on observations from seven plants in 2017 and six in 2016. The average production costs are based on four plants.

Figure 121 Electricity costs as a share of total production costs for downstream aluminium plants (€/tonne, EU) – Simple averages



	2016	2017
Average of Electricity cost €/tonne	68.2	58.6
Average of other Production costs €/tonne	5,254	6,237

Note: 4 observations in 2016 and 2017 for production costs, and 6 observations in 2016 and 7 in 2017 for electricity costs.
Source: Authors' elaboration

Table 158 Electricity costs as a share of production costs for downstream aluminium plants (EU) – Simple and weighted averages

Indicator	2016	2017
Electricity costs simple average (€/tonne)	68.2	58.6
Electricity costs weighted average (€/tonne)	49.8	45.3
Production costs simple average (€/tonne)	5322.7	6295.9
Production costs weighted average (€/tonne)	7062.9	6123.2
Electricity costs as a share of production costs simple averages (%)	1.3%	0.9%
Electricity costs as a share of production costs weighted averages (%)	0.7%	0.7%

Note: Weighting factor: production output; 4 observations in 2016 and 2017 for production costs, and 6 observations in 2016 and 7 in 2017 for electricity costs.
Source: Authors' elaboration

Natural gas

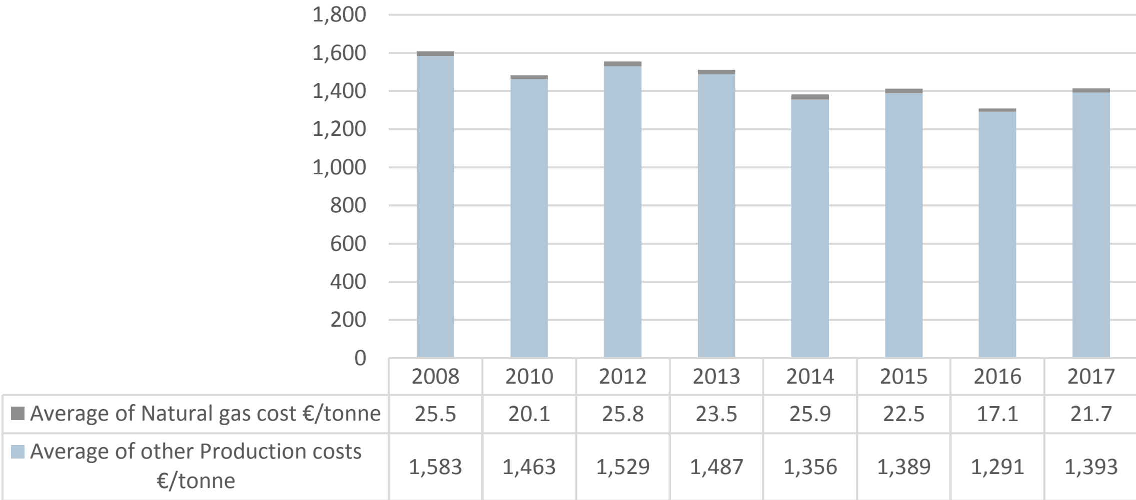
Primary aluminium

The next four graphs provide an overview of the cost competitiveness of the primary aluminium sector in relation to natural gas costs.

As reflected in Figure 122, natural gas costs represent a small share of total production costs and turnover, of 1.5% and 1.2% respectively in 2017. This is minor when compared to the share of electricity costs in total production costs (of 37-38%). The simple averages of natural gas costs for primary plants have gone down from €25.9/tonne in 2014 to €21.7/tonne in 2017. As a result, their share in total production costs has gone down from 1.9% in 2014 to 1.5% in 2017. Due to their small contribution to total production costs and turnover, variations in natural gas costs have less impact on EBITA and EBIT indicators than electricity cost variations.

It is not possible to show the impact of electricity costs over production costs net of depreciation and amortisation, as only a limited number of plants disclosed this indicator.

Figure 122 Natural gas costs as a share of total production costs for primary aluminium plants (€/tonne, EU) – Simple averages



Note: natural gas costs are based on 3 observations except for 2017 when 7 observations from plants were available. Production costs are based on observations from 3 plants in all years except 2016 and 2017 when observations from 4 plants were available.
Source: Authors' elaboration

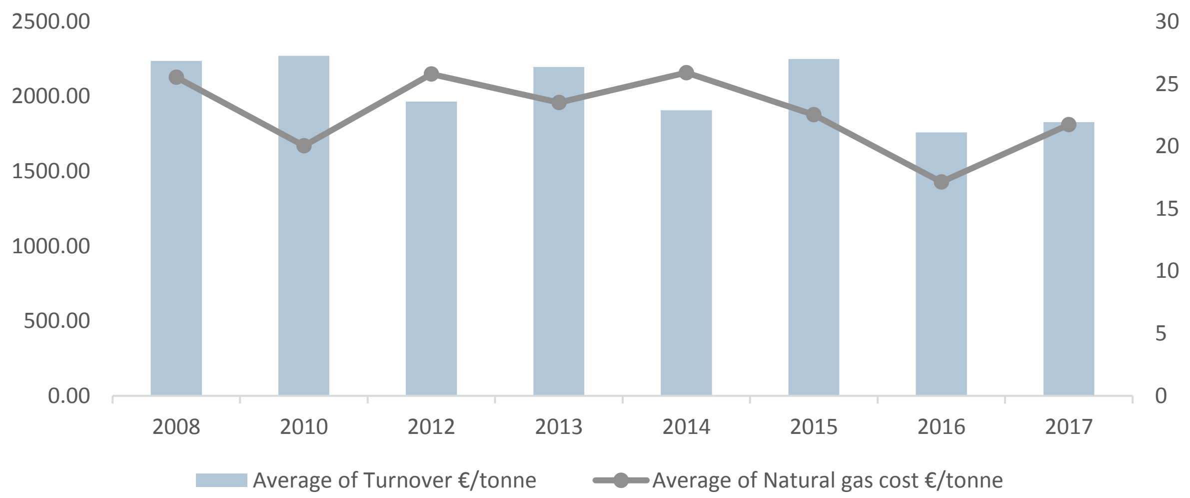
Table 159 Natural gas costs as a share of production costs for primary aluminium plants (EU) – Simple and weighted averages

Indicator	2008	2010	2012	2013	2014	2015	2016	2017
Natural gas costs simple average (€/tonne)	25.5	20.1	25.8	23.5	25.9	22.5	17.1	21.7
Natural gas costs weighted average (€/tonne)	25.8	19.6	25.6	23.1	25.2	22.0	17.1	21.0
Production costs simple average (€/tonne)	1608.2	1483.3	1554.9	1510.7	1381.6	1411.8	1308.5	1414.4

Indicator	2008	2010	2012	2013	2014	2015	2016	2017
Production costs weighted average (€/tonne)	1564.2	1423.4	1551.1	1507.5	1375.4	1401.3	1311.8	1386.0
Natural gas costs as a share of production costs simple averages (%)	1.6%	1.4%	1.7%	1.6%	1.9%	1.6%	1.3%	1.5%
Natural gas costs as a share of production costs weighted averages (%)	1.7%	1.4%	1.7%	1.5%	1.8%	1.6%	1.3%	1.5%

Note: Weighting factor: production output; natural gas costs are based on 3 observations except for 2017 when 7 observations from plants were available. Production costs are based on observations from 3 plants in all years except 2016 and 2017 when observations from 4 plants were available.
Source: Authors' elaboration

Figure 123 Natural gas costs versus turnover for primary aluminium plants (€/tonne, EU) – Simple averages



Note: natural gas costs are based on 3 observations except for 2017 when 7 observations from plants were available. Turnover is based on observations from 3 plants in all years except for 2016 and 2017 when observations from 7 plants were available.
Source: Authors' elaboration

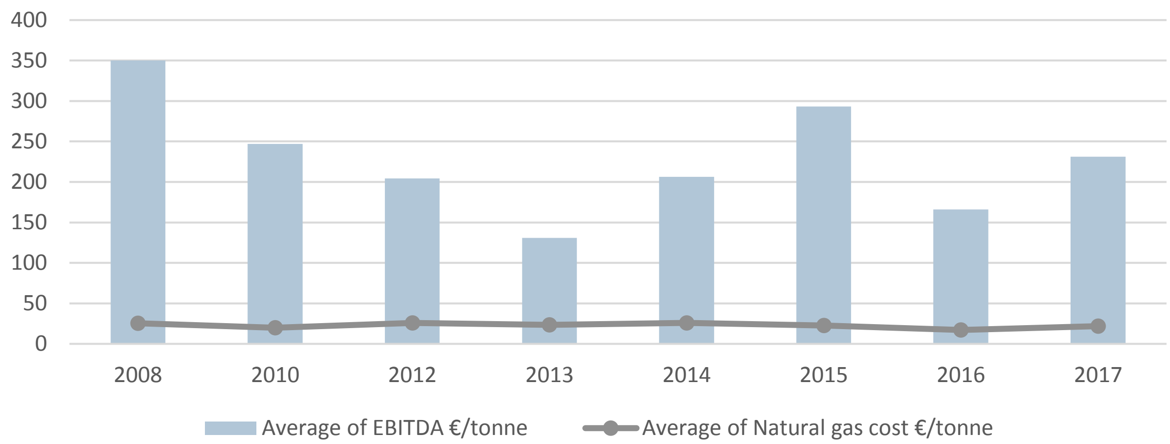
Table 160 Natural gas costs versus turnover for primary aluminium plants (€/tonne, EU) – Simple and weighted averages

Indicator	2008	2010	2012	2013	2014	2015	2016	2017
Natural gas costs simple average (€/tonne)	25.5	20.1	25.8	23.5	25.9	22.5	17.1	21.7
Natural gas costs weighted average (€/tonne)	25.8	19.6	25.6	23.1	25.2	22.0	17.1	21.0
Turnover simple average (€/tonne)	2238.1	2271.8	1965.4	2195.7	1908.6	2249.9	1759.2	1829.0

Indicator	2008	2010	2012	2013	2014	2015	2016	2017
Turnover weighted average (€/tonne)	2149.1	2085.8	1931.0	2084.3	1865.2	2178.2	1582.6	1848.6
Natural gas costs as a share of turnover simple averages (%)	1.1%	0.9%	1.3%	1.1%	1.4%	1.0%	1.0%	1.2%
Natural gas costs as a share of turnover weighted averages (%)	1.2%	0.9%	1.3%	1.1%	1.4%	1.0%	1.1%	1.1%

Note: Weighting factor: production output; natural gas costs are based on 3 observations except for 2017 when 7 observations from plants were available. Turnover is based on observations from 3 plants in all years except 2016 and 2017 when observations from 7 plants were available.
Source: Authors' elaboration

Figure 124 Natural gas costs versus EBITDA for primary aluminium plants (€/tonne, EU) – Simple averages



Note: natural gas costs are based on 3 observations except for 2017 when 7 observations from plants were available. Observations for EBITDA are based on average data provided in the previous study (CEPS et al. 2016) for 2008-2015 and observations from 7 plants for 2016 and 2017.
Source: Authors' elaboration

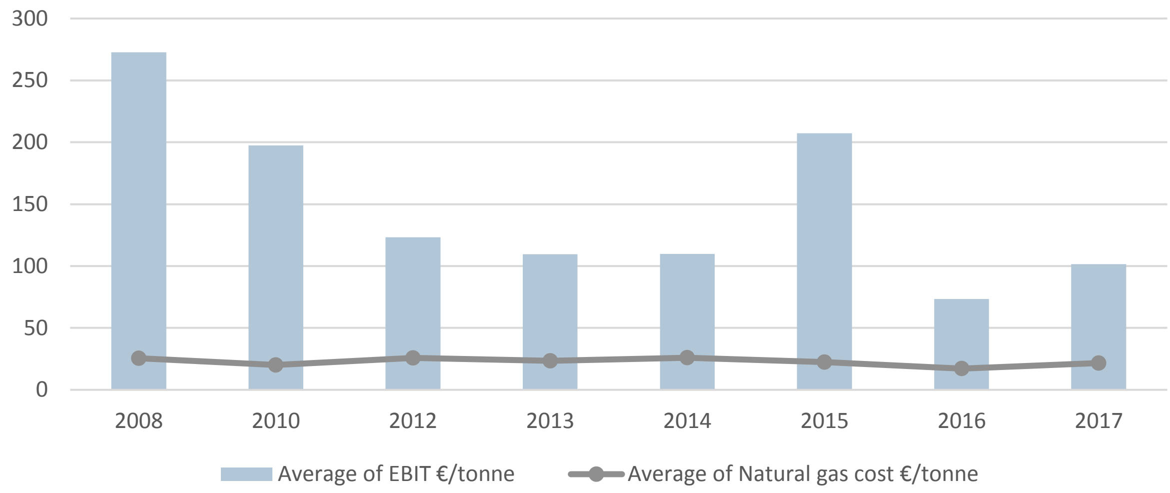
Table 161 Natural gas costs versus EBITDA for primary aluminium plants (€/tonne, EU) – Simple and weighted averages

Indicator	2008	2010	2012	2013	2014	2015	2016	2017
Natural gas costs simple average (€/tonne)	25.5	20.1	25.8	23.5	25.9	22.5	17.1	21.7
Natural gas costs weighted average (€/tonne)	25.8	19.6	25.6	23.1	25.2	22.0	17.1	21.0
EBITDA simple average (€/tonne)	350.0	247.0	204.2	130.8	206.5	293.1	166.0	231.1

Indicator	2008	2010	2012	2013	2014	2015	2016	2017
EBITDA weighted average (€/tonne)	n/a	n/a	n/a	n/a	n/a	n/a	131.9	180.3

Note: Weighting factor: production output; natural gas costs are based on 3 observations except for 2017 where 7 observations from plants were available. Observations for EBITDA are based on average data provided in the previous study (CEPS et al. 2016) for 2008-2015 and observations from 7 plants for 2016 and 2017.
Source: Authors' elaboration

Figure 125 Natural gas costs versus EBIT for primary aluminium plants (€/tonne, EU) – Simple averages



Note: natural gas costs are based on 3 observations except for 2017 when 7 observations from plants were available. Observations for EBIT are based on average data provided in the previous study (CEPS et al. 2016) for 2008-2015 and observations from 4 plants for 2016 and 2017.
Source: Authors' elaboration

Table 162 Natural gas costs versus EBIT for primary aluminium plants (€/tonne, EU) – Simple and weighted averages

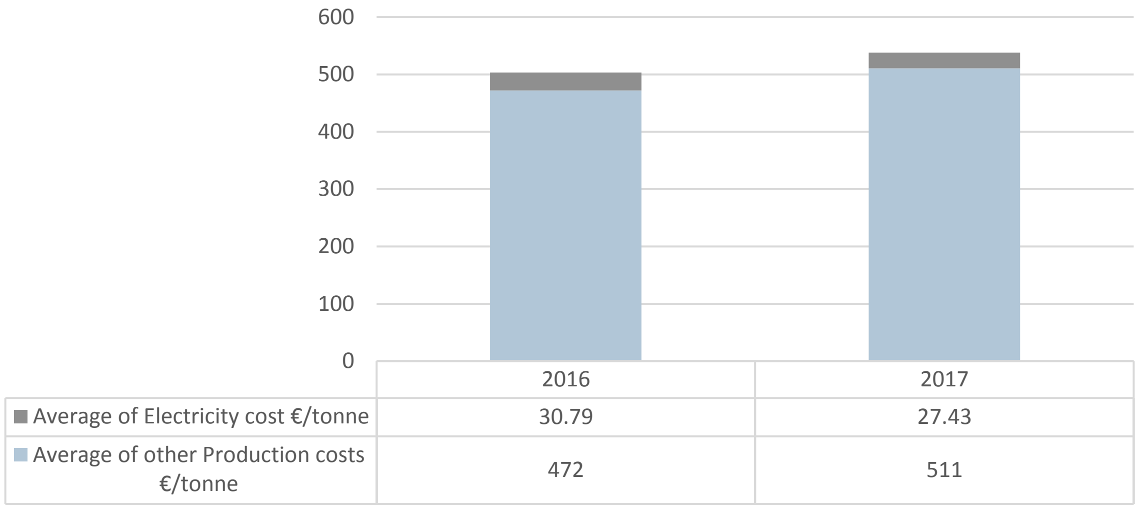
Indicator	2008	2010	2012	2013	2014	2015	2016	2017
Natural gas costs simple average (€/tonne)	25.5	20.1	25.8	23.5	25.9	22.5	17.1	21.7
Natural gas costs weighted average (€/tonne)	25.8	19.6	25.6	23.1	25.2	22.0	17.1	21.0
EBIT simple average (€/tonne)	272.7	197.5	123.2	109.5	109.8	207.4	73.4	101.6
EBIT weighted average (€/tonne)	n/a	n/a	n/a	n/a	n/a	n/a	64.1	107.0

Note: natural gas costs are based on 3 observations except for 2017 when 7 observations from plants were available. Observations for EBIT are based on average data provided in the previous study (CEPS et al. 2016) for 2008-2015 and observations from 4 plants for 2016 and 2017.
Source: Authors' elaboration

Secondary aluminium

Figure 126 provides an overview of the cost competitiveness of the secondary aluminium sector in relation to natural gas costs.

Figure 126 Natural gas costs as a share of total production costs for secondary aluminium plants (€/tonne) – Simple averages



Note: 6 observations in 2016 and 2017 for production costs, and 3 observations in 2016 and 6 in 2017 for natural gas costs.
Source: Authors' elaboration

Table 163 Natural gas costs as a share of production costs for secondary aluminium plants (€/tonne, EU) – Simple and weighted averages

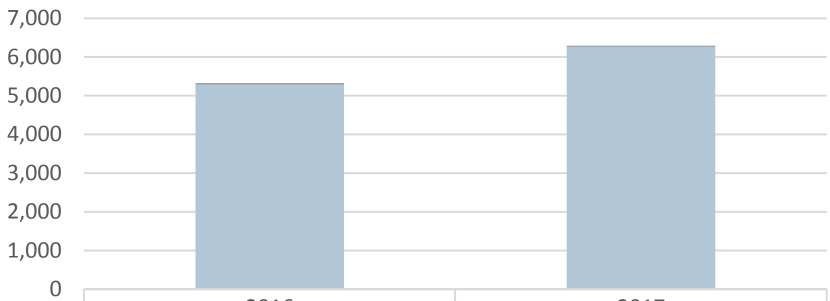
Indicator	2016	2017
Natural gas costs simple average (€/tonne)	39.6	34.7
Natural gas costs weighted average (€/tonne)	35.4	31.6
Production costs simple average (€/tonne)	503.0	538.0
Production costs weighted average (€/tonne)	482.9	537.6
Natural gas costs as a share of production costs simple averages (%)	7.9%	6.4%
Natural gas costs as a share of production costs weighted averages (%)	7.3%	5.9%

Note: Weighting factor: production output; 6 observations in 2016 and 2017 for production costs, and 3 observations in 2016 and 6 in 2017 for natural gas costs.
Source: Authors' elaboration

Downstream aluminium

Figure 127 and Table 164 provide an overview of the cost competitiveness of the downstream aluminium sector in relation to natural gas costs. The average natural gas cost shown is based on observations from seven plants except for 2016 when observations from only six plants were available.

Figure 127 Natural gas costs as a share of total production costs for downstream aluminium plants (€/tonne) – Simple averages



	2016	2017
Average of Natural gas cost €/tonne	32.2	28.0
Average of other Production costs €/tonne	5,290	6,268

Note: 3 observations in 2016 and 4 in 2017 for turnover, and 6 observations in 2016 and 7 in 2017 for natural gas costs.
Source: Authors' elaboration

Table 164 Natural gas costs as a share of production costs for downstream aluminium plants (€/tonne, EU) – Simple and weighted averages

Indicator	2016	2017
Natural gas costs simple average (€/tonne)	32.2	28.0
Natural gas costs weighted average (€/tonne)	32.5	28.5
Production costs simple average (€/tonne)	5322.7	6295.9
Production costs weighted average (€/tonne)	7062.9	6123.2
Natural gas costs as a share of production costs simple averages (%)	0.6%	0.4%
Natural gas costs as a share of production costs weighted averages (%)	0.5%	0.5%

Note: Weighting factor: production output; 3 observations in 2016 and 4 in 2017 for turnover, and 6 observations in 2016 and 7 in 2017 for natural gas costs.
Source: Authors' elaboration

International competitiveness

This Section compares energy prices and costs borne by EU aluminium producers with those borne by producers based in third countries. Given the large differences in terms of production costs and margins between the three aluminium subsectors, averaging energy costs in €/tonne, production costs and margins of primary, secondary and downstream aluminium producers would distort the analysis; for this reason, the competitiveness analysis is limited to the primary aluminium subsector. Primary international data on energy prices and costs were not disclosed by any company. Therefore, the non-EU data on electricity prices and plant production used for this international comparison between the EU and major aluminium trading partners have been acquired from CRU. The EU data used in this comparison are data gathered during the study (through questionnaires to EU primary smelters) and are the same data used throughout the aluminium section.

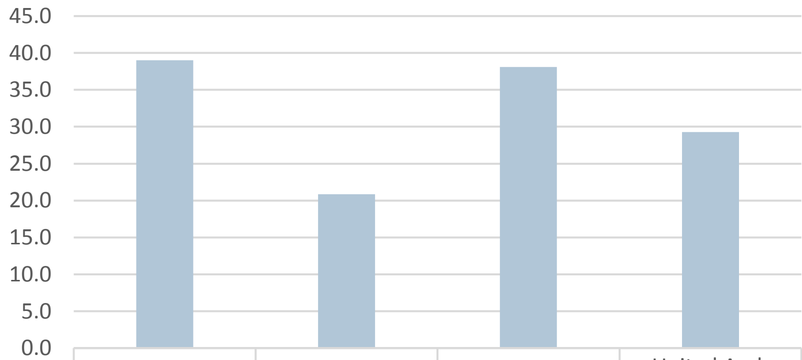
The comparison of three countries – Russia, China and United Arab Emirates – is included in this analysis. The choice of countries for this comparison is based on major aluminium producing regions and the EU's main import and export markets for primary aluminium.

Against this background, the subsection on 'Energy prices' presents average electricity prices borne by primary aluminium producers in the EU, Russia, China and United Arab Emirates for 2016. As the international data from CRU is based on weighted averages, we also use weighted average values for the EU to allow for a meaningful and consistent comparison between EU and international data. The subsection on 'International Competitiveness' compares key performance indicators of EU primary aluminium producers with those recorded by international competitors. In line with the methodology used by CRU, this Section also presents weighted averages in the figures.

Energy prices: primary aluminium

Figure 128 compares electricity prices borne by aluminium producers based in the EU, Russia, China and the United Arab Emirates. On average, EU producers, as well as Chinese producers, face higher prices than Russia and United Arab Emirates counterparts. Russian primary aluminium smelters experience the lowest electricity prices out of all four regions at €20.9/MWh.

Figure 128 Electricity prices (€/MWh) – 2016– Weighted averages



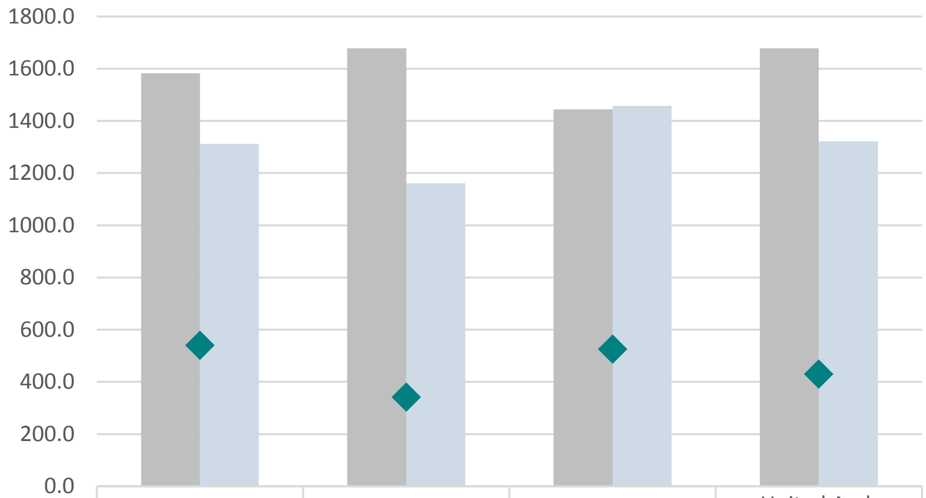
	Europe	Russia	China	United Arab Emirates
Electricity price (€/MWh)	39.0	20.9	38.1	29.3

Note: Russia, United Arab Emirates and China are weighted averages for 2016 from data provided by CRU. EU averages are weighted averages from data gathered as part of the Study through questionnaires at the plant level.
Source: Authors' elaboration

International competitiveness: primary aluminium

Figure 129 compares electricity costs with production costs and turnover in €/tonne in the aluminium sector. Electricity costs represent around 29.4% of total production costs in Russia, 32.5% in the United Arab Emirates and 36% in China, while in the EU they represent 41.2%. In the same vein, electricity costs represent around 20.3% of turnover in Russia, 25.6% in the United Arab Emirates, 34.2% in the EU and 36.3% in China. In regard to production costs, although the EU has the highest cost of energy, its production costs are over 10% less than Chinese plants' production costs and 13% higher than Russian plants' production costs, which experience turnover almost 5% above that of EU primary aluminium producers.

Figure 129 Electricity vs production costs and turnover (€/tonne, 2016) – Weighted averages



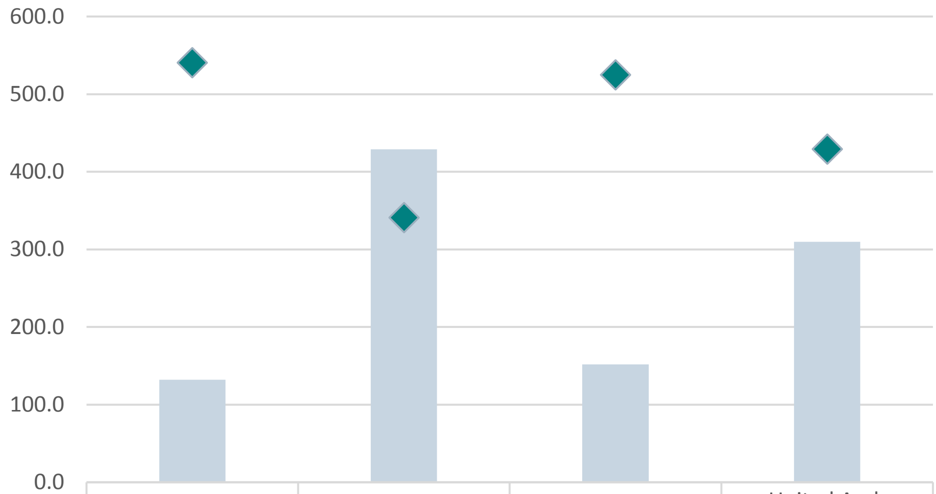
	Europe	Russia	China	United Arab Emirates
Turnover (€/tonne)	1582.6	1677.6	1444.5	1677.6
Production costs (€/tonne)	1311.8	1160.6	1458.0	1322.3
Electricity cost (€/tonne)	540.6	341.1	525.0	429.5

Turnover (€/tonne) Production costs (€/tonne) Electricity cost (€/tonne)

Note: Russia, United Arab Emirates and China are weighted averages for 2016 from data provided by CRU. EU averages are weighted averages from data gathered as part of the Study through questionnaires at the plant level.
Source: Authors' elaboration

In Figure 130, the results look different when it comes to profitability. In fact, in the primary aluminium sector, EBITDA values for China and the EU are similar, while data from CRU show that plants in Russia and United Arab Emirates experience higher EBITDA values. It is worth emphasising, however, that energy costs appear to be lower than EBITDA only in Russia.

Figure 130 Electricity costs vs EBITDA (€/tonne, 2016) – Weighted averages



	Europe	Russia	China	United Arab Emirates
EBITDA (€/tonne)	131.9	429.0	152.1	309.7
Electricity cost (€/tonne)	540.6	341.1	525.0	429.5

EBITDA (€/tonne) ◆ Electricity cost (€/tonne)

Note: Russia, United Arab Emirates and China are weighted averages for 2016 from data provided by CRU. EU averages are weighted averages from data gathered as part of the Study through questionnaires at the plant level.
Source: Authors' elaboration

7 Steel (EAF and BOF)

Box 11 Highlights - Steel

EAF

In the EAF steel sector, while electricity costs represented on average around 10% of total production costs (simple average) between 2008 and 2017, natural gas costs represented on average 3% of total production costs (simple average).

Electricity

- Average **electricity prices** (simple average) at the EU level remained fairly stable during the period 2008 to 2013, but dropped 20% from 2013 to 2017. The electricity price at EU level was €61/MWh in 2008 and €53/MWh in 2017. Throughout the 2008-2017 period, the average electricity energy component represented the largest share of the electricity price (€40/MWh in 2017), followed by the network and capacity component (€8/MWh in 2017). The relative share of the energy component declined from around 86% in 2008 to 76% in 2017. The other non-recoverable taxes/levies (€2/MWh in 2017) and the electricity RES levies (€3/MWh in 2017) more than doubled during the same period. Large consumers seem to not only pay less for the energy component, but also less for the network component and other regulatory components such as RES levies and other non-recoverable taxes/levies.
- Average **electricity costs in €/MWh** (simple average) at the EU level remained rather stable from 2008 to 2013, followed by a 21% decrease from 2013 to 2017. In 2017, the electricity costs were at €50/MWh while in 2008 they were €61/MWh. The difference between electricity price and electricity costs in €/MWh is caused by plants that received some form of *ex post* reimbursement and compensation from an interruptibility scheme. The weighted average (by electricity consumption) for this indicator was lower than the simple average, confirming better negotiating and bargaining power for larger consumers.
- The average **electricity costs in €/tonne** (simple average) at EU level remained fairly stable from 2008 to 2013 but dropped 24% from 2013 to 2017. In 2017, electricity costs were at €26/tonne. Weighted average (by production output) for electricity costs in €/tonne is below simple average, confirming better price conditions for larger consumers as well as economies of scale.
- The average **electricity intensity** (simple average) at the EU level ranged from 0.5 to 0.6 MWh/tonne, decreasing slightly from 2008 (0.56 MWh/tonne) to 2017 (0.53 MWh/tonne). The weighted average (by production output) for this indicator was constantly below the simple average; this may indicate that larger plants were more efficient than smaller ones.

Gas

- The average **natural gas prices** (simple average) dropped from 2008 to 2010, increased from 2010 to 2012 and then significantly decreased from 2012 to 2017. This is in line with international gas market price developments. The trend in natural gas prices for the EU and NWE are very similar. The prices were at €26/MWh in 2008 and €20/MWh in 2017. The average of the natural gas energy component represents the largest share of the natural gas price in every year. In 2008, the energy component accounted for around 91% of the natural gas price (€25/MWh), while in 2017 it accounted for around 86% of the natural gas price (€17/MWh in 2017). It was observed that large consumers do not necessarily pay less for the energy component, but do pay less for the network component and other regulatory components.
- The average **natural gas costs in €/tonne** (simple average) in the EU and NWE were volatile throughout the 2008-2017 period. In 2008 they were at €9/tonne and in 2017 at €8/tonne. Overall, during this timeframe, the cost decreased by around 15% in the EU. Weighted average (by production output)

for natural gas costs in €/tonne is below simple average; this seems to be due to the lower natural gas prices for large consumers and economies of scale.

- Average **natural gas intensity** (simple average) at EU level remained fairly stable throughout the period under investigation, with a 2–3% overall decrease between 2008 and 2017. In 2017, the average natural gas intensity was 0.38 MWh/tonne for both the EU and NWE region. Weighted average (by production output) for natural gas intensity is below simple average; this may indicate that larger plants are more efficient than smaller ones.

Competitiveness

- **Electricity costs** per tonne made up around 10% of **total production costs** per tonne (simple average). This share increased slightly from 9.0% in 2008 to 9.6% to 2017. While the average electricity costs (simple average) decreased by 24% from €34/tonne in 2008 to €26/tonne in 2017, the average of other production costs (simple average) decreased by 29% from €343/tonne in 2008 to €245/tonne in 2017.
- **Natural gas costs** (simple average) accounted for around 3% of **total production costs**. They increased slightly from 2.4% in 2008 to 2.8% in 2017.
- The share of electricity costs in **turnover** (simple average) went up from about 8% in 2008 to 9% in 2017. Natural gas costs in relation to turnover (simple average) ranged between 2% (2008) and 3% (2015). The average turnover per unit of production (simple average) decreased by 37% from €456/tonne in 2008 to €286/tonne in 2017.
- **EBITDA** per tonne (simple average) underwent a 63% decrease from 2008 to 2010 but then remained fairly stable at around €13 to €17/tonne. **EBIT** per tonne (simple average) also decreased substantially from 2008 (€28/tonne) to 2010 (-€5/tonne). In 2017, EBIT was -€2/tonne. In the case of EBITDA and EBIT, the weighted average (by production output) is generally higher than the simple average. This indicates that larger plants might benefit from economies of scale resulting in higher margins. 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 (more details on the point are provided in Annex B to this Study).

Sample and limitations

- The **sample for EAF** includes 18 plants across the EU, representing about **14% of the total crude steel capacity of EAFs** in the EU. About 72% of the sample is composed of plants based in the NWE region, while 17% of the sample is composed of plants in CEE. With 11% of plants in the SE region, the SE region is under-represented in the sample.
- The sample includes only plants operating in the entire period under observation; therefore, results may **overestimate profitability indicators and underestimate production costs and energy costs**, if one considers that between 2008 and 2017 a number of relatively less efficient plants and companies left the market.
- For some indicators, the number of available observations varies across years; the trend may therefore be affected by **changes in the sample size**. More details about the number of observations are provided underneath each figure and table.
- Averages for the **SE and CEE region cannot be shown for confidentiality reasons**. However, data provided by SE and CEE plants are included in the EU average.

BOF

In the BOF steel sector, while electricity costs represented on average around 3% of total production costs (simple average) between 2008 and 2017, natural gas costs represented on average 1–2% of total production costs (simple average).

Electricity

- Average **electricity prices** (simple average) at the EU level fluctuated slightly between €58 and €71/MWh during the period 2010 to 2017. The price in 2017 of €62/MWh is slightly lower than in 2010 with €64/MWh. From 2010 to 2017, the average electricity energy component represented the highest share of the electricity price (€45/MWh in 2017). In 2010, the electricity component, at €55/MWh, accounted for around 85% of the electricity price, while in 2017 it made up 72%. Large consumers seem to not only pay less for the energy component, but also less for the network component and other regulatory components such as RES levies and other non-recoverable taxes/levies.
- Average **electricity costs in €/MWh** at the EU level began a downward trend from 2010 (€67/MWh) to 2017 (€54/MWh) with a decrease of 13%. The difference between electricity price and electricity costs in €/MWh is mostly caused by plants producing self-generated electricity on site.
- The average **electricity costs in €/tonne** (simple average) at EU level saw a downward trend of 25% from 2012 (€22/tonne) to 2017 (€16/tonne). The weighted average (by production output) for electricity costs in €/tonne is below the simple average confirming the better price conditions for larger consumers as well as economies of scale.
- The average **electricity intensity** (simple average) at the EU level remained fairly stable throughout the period under observation, with a slight increase of 6% between 2012 and 2017. This increase is mainly driven by a changing sample. The weighted average (by production output) for this indicator was constantly below the simple average, thus indicating that larger plants were more efficient than smaller ones when it comes to electricity.

Gas

- In the EU, the average **natural gas prices** (simple average) show a clearly descending trend, which is quite visible from 2013 to 2016, when prices dropped from €30/MWh to €17/MWh, equivalent to a 37% reduction. In 2017, prices were at €19/MWh. The share of the natural gas energy component was the largest in every year. It accounted for around 86% in 2010 (€25/MWh) and 93% of the natural gas price in 2017 (€18/MWh in 2017). Large consumers seem to pay less for the network component, while this does not hold for the energy component and other regulatory components.
- The average **natural gas costs in €/tonne** (simple average) in the EU decreased by 27% from 2010 to 2017. In 2017, the costs were at €6/tonne. The weighted average for natural gas costs in €/tonne is generally below the simple average; this may be due to the lower natural gas prices for large consumers and economies of scale.
- The average **natural gas intensity** (simple average) at the EU level dropped 39% from 2008 to 2012 but increased by 41% from 2012 to 2017. In 2017, the average natural gas intensity was 0.31 MWh/tonne while it was 0.36 MWh/tonne in 2008. The **total gas intensity** (including natural gas and waste gas consumption) (simple average) at the EU level dropped from 2008 to 2015 by 36%, and then increased by 40%, reaching 1.5 MWh/tonne in 2017. Weighted average for natural gas and total gas intensity is not always below simple average; therefore, larger plants do not necessarily seem to be more efficient than smaller ones.

Competitiveness

- **Electricity costs** made up around 3% of **total production costs** (simple average), being substantially smaller when compared to EAF. This share decreased slightly from 4.3% in 2012 to 3.1% in 2017. While the average **costs for electricity** per tonne of product decreased by 25%, the average of **other production costs** per tonne of product increased from €490/tonne in 2012 to €512/tonne in 2017 (i.e. +5%).
- **Natural gas costs** made up around 1–2% of **total production costs** (simple average). This share increased from 2012 to 2014 but since then has been on a decreasing trend.

- The **share of electricity costs in relation to turnover** (simple average) decreased from about 4% in 2008 to 2% in 2017. **Natural gas costs in relation to turnover** (simple average) ranged between 2% (2010) and 1% (2017). The average **turnover** per unit of production (simple average) increased 44% from €478/tonne in 2008 to €688/tonne in 2017.
- **EBITDA** per tonne (simple average) increased substantially from €1/tonne in 2012 to €34/tonne in 2017. In the same period, **EBIT** per tonne increased from -€25/tonne in 2012 to €14/tonne in 2017. In the case of EBITDA and EBIT, the weighted average is generally higher than the simple average. This indicates that larger plants might benefit from economies of scale resulting in higher margins. By looking at trends in costs and margins, it is not possible to draw conclusions on the impact of electricity and natural gas costs on profitability (more details on the point are provided in Annex B to this Study).

Sample and limitations

- The **sample for BOF** includes seven plants across the EU, representing about **26% of the total crude steel capacity from BOFs** in the EU. About 57% of the sample is composed of plants based in the NWE region, while the remaining 43% of the sample is composed of plants in CEE. Therefore, the CEE region is over-represented in the sample, while the SE region is under-represented.
- The sample includes only plants operating in the entire period under observation; therefore, results may **overestimate profitability indicators and underestimate production costs and energy costs**, if one considers that between 2008 and 2017 a number of relatively less efficient plants and companies left the market.
- For some indicators, the number of available observations varies across years; the trend may therefore be affected by **changes in the sample size**. More details about the number of observations are provided underneath each figure and table.

Regional averages cannot be shown for confidentiality reasons. For some of the calculated parameters, certain years are also excluded when there is an insufficient number of observations.

7.1 Composition of the sample

<u>Sampling strategy</u>

For the present study, the sampling for the steel sector will take into account the following criteria:

- Production technology (subsectors)
- Geographical distribution
- Company ownership/size.

For subsectors (i.e. production technology), the following plant types are included and distinguished:

- Primary steel-making plants (BOF route)
- Secondary steel-making plants (EAF route).

The sampling accounts for the differentiation between production technologies, as BOF and EAF steel-making plants differ greatly in terms of regional distribution, capacities and energy consumption profiles, and can therefore not be compared in a meaningful way. Rolling and finishing plants are not considered in this assignment, as these are too heterogeneous, smaller in size, relatively less energy intensive and challenging to reach out to.

For the geographical distribution, we aimed for a sample of typical plants accounting for the steel sector's geographical distribution in terms of capacity over the three selected regions

(Southern, Central-Eastern and North-Western Europe). In this respect, capacity data collected by the German Steel Institute VDEh provides an overview of the spread of the nominal capacities over countries and companies.

When it comes to company ownership/size, the sample aimed to include global as well as regional players. This is relevant as many companies in the EU have a regional production focus (operating fewer than three plant sites), which might give these companies relatively less bargaining power and therefore expose them to higher energy prices. It is important to note that company size is not a relevant sampling criterion as SME are quasi non-existent among BOF and EAF crude steel-making facilities. For this reason, different company sizes are not directly taken into consideration in the sampling strategy.

Against this background and keeping in mind international best practices for collecting data on regulatory costs, the Research Team aimed to have a minimum of 15 steel plant sites for each subsector (BOF & EAF) (see Table 165).

Table 165 Minimum number of plants to be surveyed

Geographical regions	Steel	
	BOF	EAF
Southern Europe	5	5
Central Eastern Europe	5	5
North-Western Europe	5	5
Total	**15**	**15**

Source: Authors' elaboration

Box 12 Key features of the steel sector

Since the 1980s, the EU steel industry has developed from a process- and product-oriented industry to a market-oriented industry. This evolution is the result of a restructuring effort characterised by consolidation and closure of inefficient and obsolete plants as well as by selective investment in new technologies. Today, the EU steel sector is a modern customer-oriented industry with its main customer base found within the EU home markets. It focuses on high quality products, product innovation and value creation supported by technological development, efficiency and skilled manpower. The EU steel industry is dominated by large, multinational companies.

The steel sector overall is confronted with major challenges, notably in terms of costs and access to raw materials and energy, which are having a serious impact on the industry's performance. Furthermore, the EU steel industry is affected by the new and expected tightening of European environmental and climate legislation.

A 'typical plant':

- The average annual BOF capacity in the EU is around 3.75 million tonnes with a standard deviation of 1.8 million tonnes. The average annual EAF capacity in the EU is 0.54 million tonnes with a standard deviation of 0.38 million tonnes.
- Most of the steel making plants are located in Germany, Italy, France, Spain, Poland and Belgium.
- Steel making plants are either Minimills or Integrated plants.
- Sampled BOFs reported a weighted average electricity intensity of around 0.27 to 0.32 MWh/t of crude steel; whereas EAFs showed a value of between 0.39 and 0.43 MWh/t.

Snapshot in figures:

- The EU is the world's second largest producer of crude steel, after Asia, accounting for around 10% of world output.

- Total crude steel production in the EU-28 amounted to 162 million tonnes in 2016.
- In 2016, six countries – Germany, Italy, France, Spain, Poland and Belgium – accounted for more than two-thirds of total EU crude steel production.
- BOFs, which transform iron ore and coke into steel, account for 60.3% of EU crude steel production, whereas EAFs account for 39.7%.
- The largest BOF plant operated by Tata Steel has an annual production capacity of 7.5 million tonnes, whereas the smallest has an annual capacity of roughly 0.27 million tonnes.
- The largest EAF plant operated by the Arvedi Group has an annual production capacity of 2.5 million tonnes, whereas the smallest has an annual capacity of only 0.02 million tonnes.
- There are more than 500 steel production sites across 24 EU Member States.
- Italy, Spain and France have a high concentration of EAF, the share being above 90%. Germany, in contrast, has a much lower share of EAF (73%), highlighting its concentration in BOF steel production.
- The European steel industry directly employs 330,000 people.
- While steel production in the EU decreased by roughly 23% between 2007 and 2016, Asian countries, especially China, increased their production by more than 76% over the same period.
- In 2016, 25 million tonnes of basic iron, steel and ferro-alloys were exported while 43 million tonnes were imported.
- In 2015, the sector was responsible for approximately 3.1% of total European gross energy consumption and 18.1% of European industrial gross energy consumption.
- Coking coal represents the largest energy source, making up 48% of energy consumption. It is mainly used as a raw material feedstock in coke ovens.

Sample statistics

This Section provides details on the:

- Number of plants contacted
- Number of questionnaires received
- Sample coverage of the EU population
- Mitigation measures adopted to increase the response rate.

The Research Team together with Eurofer asked all member companies of Eurofer to participate in the Study and respond to the questionnaire via email and during a face-to-face meeting[47]. The email was circulated by Eurofer using an internal Eurofer emailing list. To improve the participation rate further, national associations were also approached to increase participation. This was needed for SE, where the participation rate was very low.

The Research Team does not know exactly how many plant sites were contacted through the Eurofer emailing list. As most EU EAF and BOF plants are members of Eurofer, we can expect that most EAF and BOF plant sites received the questionnaire. The number of EAF and BOF plants provided in Table 166 and Table 167 were directly contacted by the Research Team. Consequently, this number is a minimum number as the Research Team does not know exactly how many additional plants were contacted through the Eurofer mailing list. It can thus be expected that the number of contacted plants is higher for all regions.

Overall, according to data obtained by the German Steel Institute VDEh, there are 170 EAF plants and 32 BOF plants in the European Union. Eighteen EAF plants corresponding to nearly

[47] Note that the face-to-face meeting was done between Eurofer and its members.

14% of all EU EAF plants, and seven BOF plants corresponding to around 22% of all EU BOF plants responded to the questionnaire (see Table 166 and Table 167).

Table 166 EAF Plants participating in the survey

Geographical regions	Plants contacted	Questionnaires collected	Number of plants sharing supporting evidence
CEE	4	3	0
NWE	14	13	2
SE	2	2	0
Total	**20**	**18**	**2**

Source: Authors' elaboration

Table 167 BOF Plants participating in the survey[48]

Geographical regions	Plants contacted	Questionnaires collected	Number of plants sharing supporting evidence
CEE	3	3	0
NWE	7	4	0
SE	1	0	0
Total	**11**	**7**	**0**

Source: Authors' elaboration

The coverage of the EU population shows the share of the capacity of surveyed plants in total EU capacity (i.e. total production capacity of the sample divided by the total EU production capacity) in each year.

According to the VDEh steel database, total EAF crude steel capacity in the EU lies at around 92,000 kt/year. As the EAF respondents accounted for a capacity of around 13,000 kt/year in 2016 and 2017, we covered around 14.2% of total EU EAF crude steel capacity in 2016 and 2017.

According to the VDEh steel database, total BOF crude steel capacity in the EU lies at around 119,500 kt/year. As the BOF respondents accounted for a capacity of around 30,600 kt/year in 2016 and 2017, we covered around 25.6% of total EU BOF crude steel capacity in 2016 and 2017 (see Table 168).

Table 168 Crude steel capacity of sampled plants out of total crude steel capacity in the EU (%)

Sector	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EAF	7.2	0.0	10.2	0.0	10.2	10.2	10.2	9.3	14.2	14.2
BOF	11.2	0.0	21.8	0.0	21.8	21.8	21.8	15.5	25.6	25.6

Source: Authors' elaboration based on VDEh steel database.

[48] It is important to note that one of the BOF plants in fact covers more than one BOF plant as data were reported on the country level instead of the plant level. Therefore, the actual number of BOF plants covered in this study is higher than the figure above.

About 72% of the EAF sample is composed of plants based in the NWE region, while 17% of the sample is composed of plants in CEE. With 11% of plants in SE, this region is under-represented in the sample.

About 57% of the BOF sample is composed of plants based in the NWE region, while the remaining 43% of the sample is composed of plants in CEE. As a consequence, the CEE region is over-represented in the sample, while the SE region is under-represented.

As for mitigation measures, we did the following to increase the response rate:

- We asked for additional support from the EU association Eurofer, who helped convince companies to participate.
- We contacted national associations to improve the representativeness of the sample.
- We sent out reminders via email to all companies that we had contact details for.
- We called companies whenever we had a phone number.
- We specifically approached again those companies that participated in the previous study two years ago, either via email or phone.

7.2 Electricity

The following tables summarise the electricity data, including electricity prices and electricity costs in €/MWh, electricity costs in €/tonne and electricity intensity in MWh/tonne. For EAF, it shows that, after an initial increase, electricity prices as well as costs decreased in 2017 compared to 2010. In electricity intensity it shows some fluctuations, finally resulting in a value in 2017 slightly below the value of 2010. For BOF the trends on electricity prices are similar, while the fluctuations on costs are a lot stronger. On electricity intensity an increase can be noted since 2011.

Table 169 EAF - Electricity: summary table (EU) - Simple averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity prices (€/MWh)	61.4	n.a.	58.7	n.a.	61.5	63.8	58.7	57.9	53.7	53.2
Electricity costs (€/MWh)	61.3	n.a.	58.4	n.a.	61.1	63.5	58.4	56.1	50.6	50.1
Electricity costs (€/tonne)	34.1	n.a.	32.4	n.a.	33.8	34.3	29.8	30.9	25.8	25.9
Electricity intensity (MWh/tonne)	0.56	n.a.	0.55	n.a.	0.57	0.55	0.53	0.56	0.51	0.53

Source: Authors' elaboration

Table 170 BOF - Electricity: summary table (EU) - Simple averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity prices (€/MWh)	Conf.	n.a.	64.0	57.5	70.6	62.7	59.5	n.a.	57.6	62.4
Electricity costs (€/MWh)	Conf.	n.a.	62.6	92.2	73.7	64.8	64.0	n.a.	52.1	54.3
Electricity costs (€/tonne)	Conf.	n.a.	n.a.	20.9	22.0	20.6	18.9	n.a.	15.2	16.4
Electricity intensity (MWh/tonne)	Conf.	n.a.	n.a.	0.29	0.35	0.36	0.35	n.a.	0.34	0.37

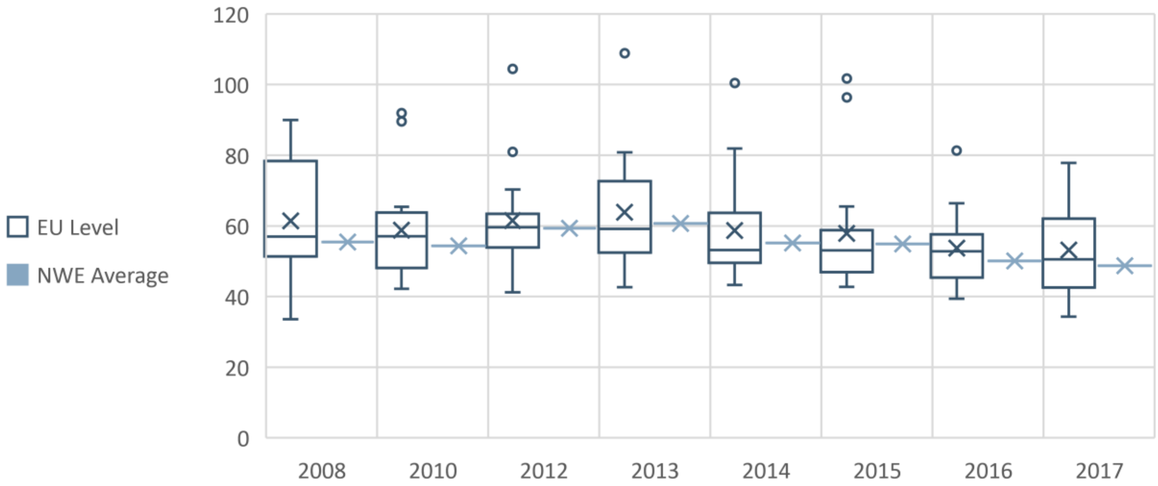
Source: Authors' elaboration

Electricity prices

EAF

Figure 131 shows that average electricity prices at the EU level remained fairly stable during the period 2008 to 2013 but dropped 20% from 2013 to 2017. In the NWE region, which observes lower prices than the EU average, the average electricity price increased 10% from 2008 to 2013 followed by a 20% decrease from 2013 to 2017. In 2017 alone, the electricity price at EU level was on average €53.2/MWh, while at the NWE level it was €48.7/MWh. The EU prices in 2017 were a minimum of €34.3/MWh and a maximum of €77.8/MWh. However, there are outliers; these are plants either in countries with high electricity prices or plants that have low electricity intensity while still experiencing high electricity prices.

Figure 131 EAF - Electricity prices (€/MWh) – Box plots and simple averages



Note: At the EU level the number of observations were 12 in 2008, 16 in 2010 and 2012-2015 and 18 in 2016 and 2017. Data for the CEE and SE regions are not displayed due to confidentiality reasons.
Source: Authors' elaboration

The electricity prices at the EU level and sub-regional level are weighted against the purchased electricity consumption in MWh. Table 171 shows that the EU and NWE weighted averages are lower than the simple averages. This probably indicates that large plants can negotiate more favourable contracts in this sector.

Table 171 EAF - Electricity prices (€/MWh) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EU simple average	61.4	n.a.	58.7	n.a.	61.5	63.8	58.7	57.9	53.7	53.2
EU weighted average	58.1	n.a.	54.0	n.a.	57.8	60.5	54.3	54.0	51.1	50.9

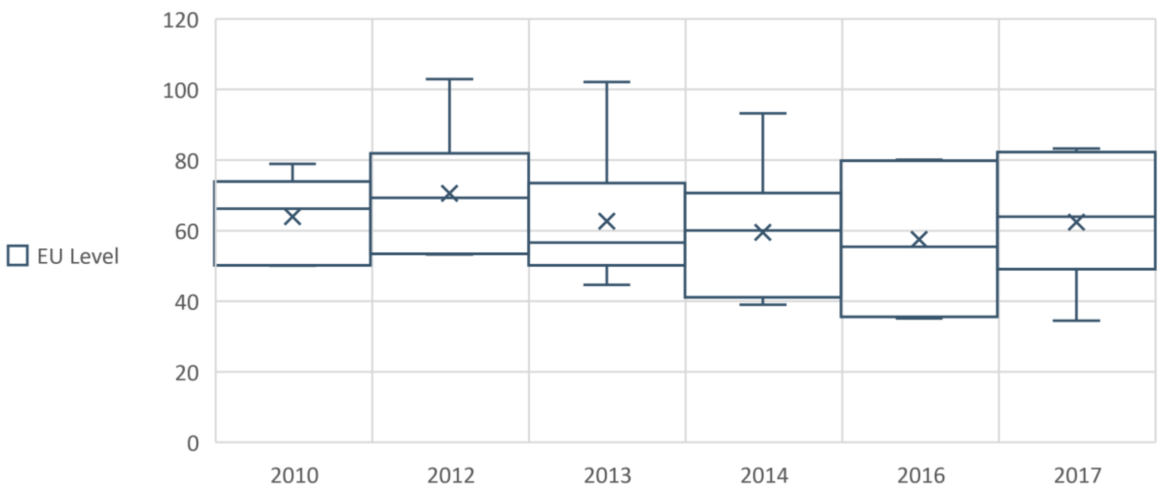
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NWE simple average	55.4	n.a.	54.4	n.a.	59.4	60.7	55.2	54.9	50.1	48.7
NWE weighted average	54.2	n.a.	53.0	n.a.	58.2	60.6	53.7	53.6	49.1	47.4

Note: Weighting factor: electricity purchased. At the EU level the number of observations were 12 in 2008, 16 in 2010 and 2012-2015 and 18 in 2016 and 2017.
Source: Authors' elaboration

BOF

Figure 132 shows that average electricity prices at the EU level slightly fluctuated between €57.5 and €70.6/MWh during the period 2010 to 2017. In 2017 alone, the electricity price at EU level was on average €62.4/MW with a minimum of €34.5/MWh and a maximum of €82.2/MWh. Prices in 2017 were lower than in 2010 (€64.0/MWh). There were not sufficient observations from the survey to allow us to provide information at regional level. Furthermore, at EU level, data for 2008 and 2015 are not shown for the same reason.

Figure 132 BOF - Electricity prices (€/MWh) – Box plots and simple averages



Note: At the EU level the number of observations were 2 in 2008, 6 in 2010 and 2012-2014, 4 in 2015 and 7 in 2016 and 2017. Since in 2008 there were only 2 observations and in 2015 only 4 observations, the data for these 2 years are not shown in the graph. Data for the CEE, NWE and SE regions are not displayed due to confidentiality reasons.
Source: Authors' elaboration

The electricity prices at EU level and sub-regional level are weighted against electricity consumption. Table 172 shows that the EU weighted average is lower than the simple averages, except in 2011, when they were the same. The reason for this could be the negotiating and bargaining power of larger consumers.

Table 172 BOF - Electricity prices (€/MWh) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EU simple average	Conf.	n.a.	64.0	n.a.	70.6	62.7	59.5	Conf.	57.6	62.4
EU weighted average	Conf.	n.a.	58.0	n.a.	63.2	57.6	52.3	Conf.	49.3	56.1

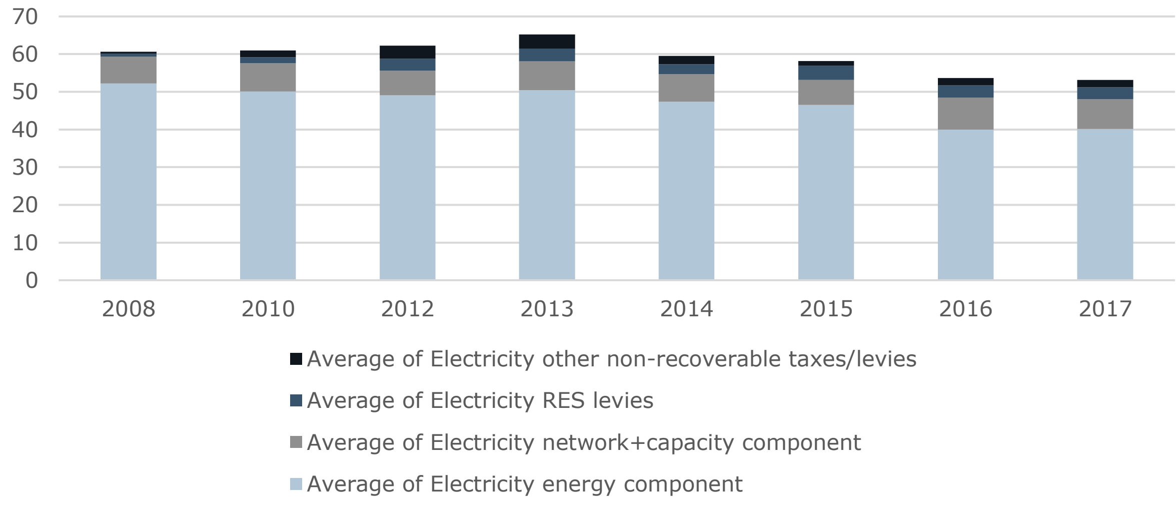
Note: Weighting factor: electricity purchased. At the EU level the number of observations were 2 in 2008, 6 in 2010 and 2012-2014, 4 in 2015 and 7 in 2016 and 2017.
Source: Authors' elaboration

Components of the electricity price[49]

EAF

Figure 133 and Figure 134 show the average of the various electricity components at the EU level. Throughout the 2008 to 2017 period the average of electricity energy components represented the highest share of the electricity price (€40.1/MWh in 2017), followed by the network and capacity component (€8.0/MWh in 2017). The relative share of the energy component declined from around 86% in 2008 to 76% in 2017. The electricity network and capacity component increased 13% from 2008 to 2017, while the other non-recoverable taxes/levies (€1.9/MWh in 2017) and the electricity RES levies more than doubled during the same period (€3.1/MWh in 2017). The energy component accounted for around 84% of the total price in 2008 while it accounted for 76% of the total price in 2017.

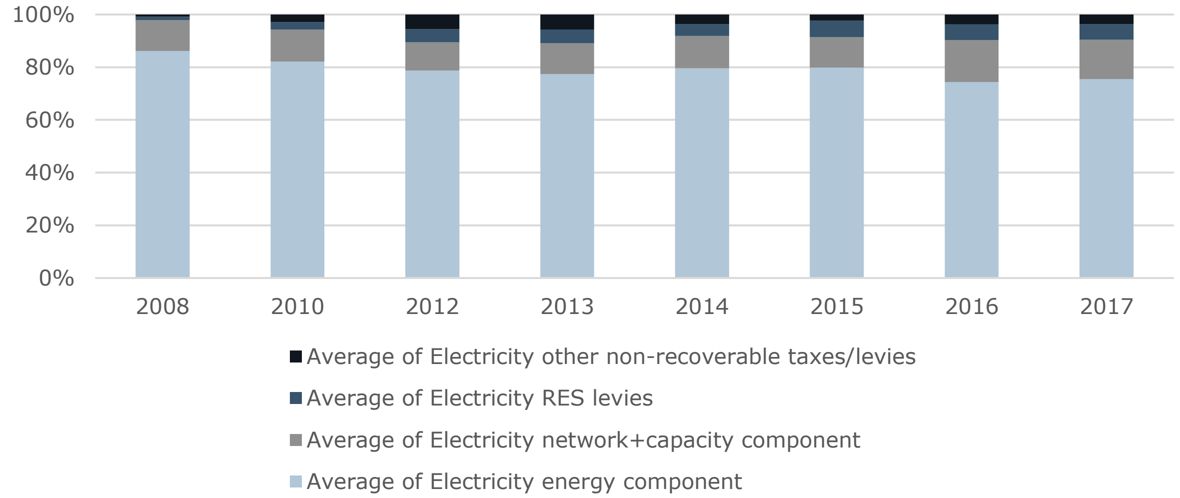
Figure 133 EAF - Components of the electricity price (€/MWh, EU) - Simple averages



Note: At the EU level the number of observations were 9 in 2008, 12 in 2010, 14 in 2012-2015 and 18 in 2016 and 2017.
Source: Authors' elaboration

[49] The sum of the electricity bill components does not necessarily add up to the total electricity price mentioned before, as there might be plants that did not provide a breakdown of the electricity bill components while still providing the total electricity price.

Figure 134 EAF - Components of the electricity price (%, EU) - Simple averages



Note: At the EU level the number of observations were 9 in 2008, 12 in 2010, 14 in 2012-2015 and 18 in 2016 and 2017.
Source: Authors' elaboration

The components of the electricity price at EU level are weighted against electricity consumption. Table 173 shows that for all indicators the weighted averages are lower than the simple averages. It can be observed that large consumers not only have better bargaining power (to negotiate more favourable contracts for the energy component) but also pay less for the network component and other regulatory components (RES and other non-recoverable taxes/levies) than their smaller counterparts.

Table 173 EAF - Components of the electricity price (€/MWh, EU) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Energy component simple average	52.3	n.a.	50.1	n.a.	49.1	50.4	47.4	46.5	39.9	40.1
Energy component weighted average	49.6	n.a.	46.5	n.a.	48.2	50.0	44.5	43.7	39.2	39.0
Network + capacity component simple average	7.1	n.a.	7.4	n.a.	6.6	7.6	7.3	6.7	8.6	8.0
Network + capacity component weighted average	5.9	n.a.	6.4	n.a.	6.0	7.1	7.1	6.8	7.7	7.7
RES levies simple average	0.8	n.a.	1.7	n.a.	3.1	3.4	2.6	3.7	3.2	3.1
RES levies weighted average	0.8	n.a.	1.3	n.a.	1.9	2.0	1.7	2.6	2.2	2.2
Other non-recoverable	0.5	n.a.	1.8	n.a.	3.5	3.7	2.2	1.3	2.0	1.9

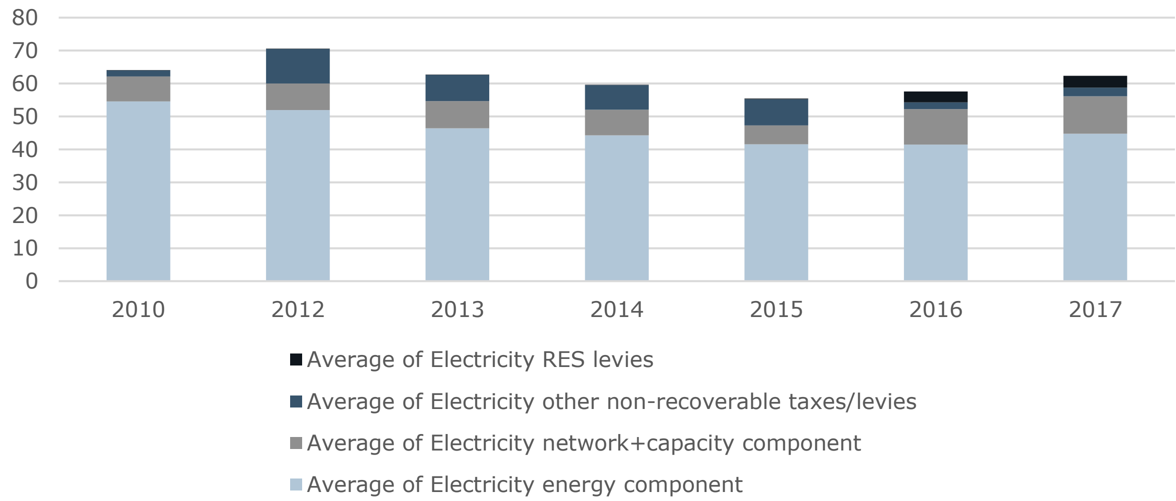
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
taxes/levies simple average										
Other non-recoverable taxes/levies weighted average	0.5	n.a.	0.9	n.a.	2.5	2.5	1.5	0.8	2.0	2.0

Note: Weighting factor: electricity purchased. At the EU level the number of observations were 9 in 2008, 12 in 2010, 14 in 2012-2015 and 18 in 2016 and 2017.
Source: Authors' elaboration

BOF

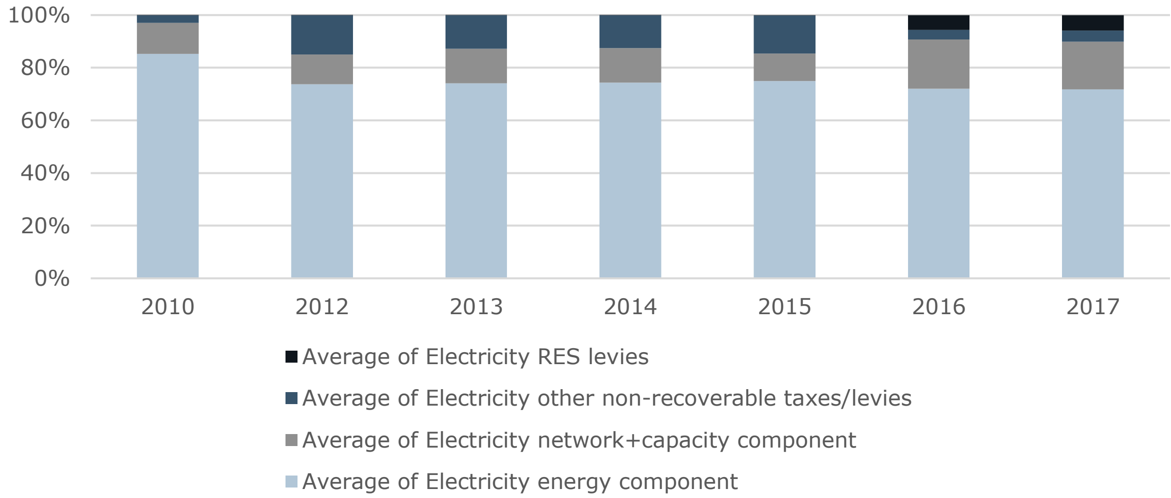
Figure 135 and Figure 136 show the average of the various electricity components at the EU level. Throughout the 2010 to 2017 period the average of electricity energy components represented the highest share of the electricity price (€44.8/MWh in 2017), followed by the network and capacity components (€11.3/MWh in 2017) (with exceptions in 2012 and 2015, when the share of this component was smaller than the share of non-recoverable taxes/levies). In 2010, the electricity component accounted for around 85% of the electricity price while in 2017 it made up 72%. The electricity RES levies increased substantially in 2016 and 2017 (€3.7/MWh in 2017) because a new plant that was added to the sample had to pay very high RES levies. It is important to note that this plant was reimbursed nearly 100% of the RES levies.

Figure 135 BOF - Components of the electricity price (€/MWh, EU) - Simple averages



Note: At the EU level the number of observations were 2 in 2008, 6 in 2010 and 2012-2014, 4 in 2015 and 7 in 2016 and 2017.
Source: Authors' elaboration

Figure 136 BOF - Components of the electricity price (%, EU) - Simple averages



Note: At the EU level the number of observations were 2 in 2008, 6 in 2010 and 2012-2014, 4 in 2015 and 7 in 2016 and 2017.
Source: Authors' elaboration

The components of the electricity price at EU level are weighted against the purchased electricity consumption. Table 174 shows that for all indicators the weighted averages are lower than the simple averages, except for the RES levies in 2015, when the weighted average was a little higher. It can be observed that large consumers not only have better bargaining power (to negotiate more favourable contracts for the energy component) but also pay less for the network component and other regulatory components (RES and other non-recoverable taxes/levies) than their smaller counterparts.

Table 174 BOF - Components of the electricity price (€/MWh, EU) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Energy component simple average	Conf.	n.a.	54.5	n.a.	52.0	46.5	44.3	41.6	41.5	44.8
Energy component weighted average	Conf.	n.a.	50.2	n.a.	49.8	45.6	42.1	41.2	38.5	44.6
Network + capacity component simple average	Conf.	n.a.	7.6	n.a.	8.1	8.2	7.8	5.8	10.8	11.3
Network + capacity component weighted average	Conf.	n.a.	6.7	n.a.	7.1	7.3	5.7	3.7	8.0	8.0
RES levies simple average	Conf.	n.a.	0.0	n.a.	0.0	0.0	0.1	0.1	3.2	3.7

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
RES levies weighted average	Conf.	n.a.	0.0	n.a.	0.0	0.0	0.1	0.2	1.5	1.6
Other non-recoverable taxes/levies simple average	Conf.	n.a.	1.8	n.a.	10.5	8.0	7.4	8.0	2.1	2.6
Other non-recoverable taxes/levies weighted average	Conf.	n.a.	1.1	n.a.	6.3	4.8	4.5	4.0	1.4	1.9

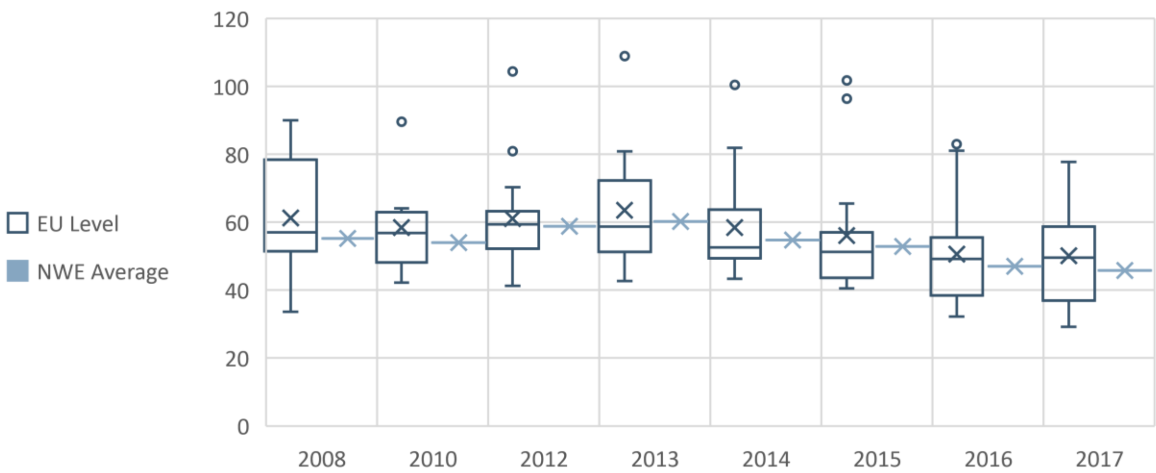
Note: Weighting factor: electricity purchased. At the EU level the number of observations were 2 in 2008, 6 in 2010 and 2012-2014, 4 in 2015 and 7 in 2016 and 2017.
Source: Authors' elaboration

Electricity costs

EAF

Figure 137 shows that average electricity costs in €/MWh at the EU level remained fairly stable from 2008 to 2013 and then decreased 21% from 2013 to 2017.[50] The NWE region experienced a 9% increase in electricity costs from 2008 to 2013 and a drop of 24% from 2013 to 2017. In 2017, the average electricity costs at EU level were €50.1/MWh and at NWE level they were €45.8/MWh. However, there are outliers; these are plants either in countries with high electricity prices or plants that have low electricity intensity while still experiencing high electricity prices. Note that in 2017, nine EAF plants received some form of reimbursement (e.g. from an interruptibility scheme). The difference between electricity price and electricity costs in €/MWh is caused by plants receiving some form of *ex post* reimbursement and compensation from an interruptibility scheme.

Figure 137 EAF - Electricity costs (€/MWh) – Box plots and simple averages



[50] Electricity prices in €/MWh are defined as follows: Total price paid to purchase electricity/Total electricity purchased. Electricity costs in €/MWh are defined 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).

Note: At the EU level the number of observations were 11 in 2008, 16 in 2010 and 2012-2014, 14 in 2015 and 15 in 2016 and 2017. Data for the CEE and SE regions are not displayed due to confidentiality reasons.
Source: Authors' elaboration

The electricity costs at EU level and sub-regional level are weighted against electricity consumption. Table 175 shows that the EU and NWE weighted averages are lower than the simple averages. The reason for this, as stated above, seems to be the negotiating and bargaining power of larger consumers as well as larger consumers' lower costs for the network component and other regulatory components (RES and other non-recoverable taxes/levies).

Table 175 EAF - Electricity costs (€/MWh) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EU simple average	61.3	n.a.	58.4	n.a.	61.1	63.5	58.4	56.1	50.6	50.1
EU weighted average	58.1	n.a.	53.7	n.a.	57.3	60.1	54.0	52.1	47.8	47.4
NWE simple average	55.2	n.a.	53.9	n.a.	58.8	60.2	54.8	52.9	47.1	45.8
NWE weighted average	54.1	n.a.	52.6	n.a.	57.6	60.1	53.3	51.5	46.4	44.3

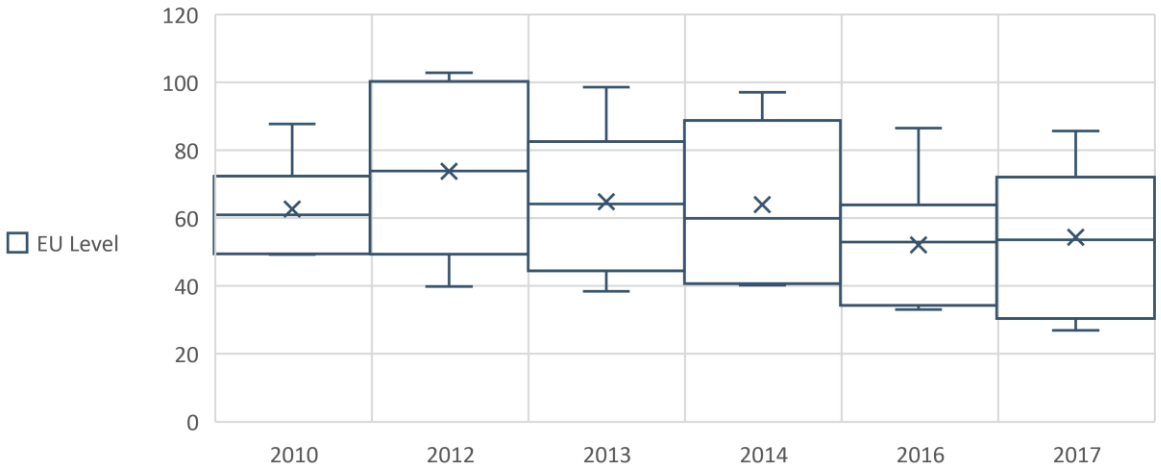
Note: Weighting factor: total electricity consumption. At the EU level the number of observations were 11 in 2008, 16 in 2010 and 2012-2014, 14 in 2015 and 15 in 2016 and 2017.
Source: Authors' elaboration

BOF

Figure 138 shows that average electricity costs in €/MWh at EU level were on a downward trend from 2010 to 2017, with a decrease of 13%.[51] In 2017 the electricity costs were €54.3/MWh, with a minimum value of €27.0/MWh and a maximum value of €85.6/MWh. There were not sufficient observations from the survey to allow us to provide information at regional level. Furthermore, at EU level, data for 2008 and 2015 are not shown for the same reason. The difference between electricity price and electricity costs in €/MWh is mostly caused by plants producing self-generated electricity on site.

[51] Electricity prices in €/MWh are defined as follows: Total price paid to purchase electricity/Total electricity purchased. Electricity costs in €/MWh are defined 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).

Figure 138 BOF - Electricity costs (€/MWh) – Box plots and simple averages



Note: At the EU level the number of observations were 3 in 2008, 5 in 2010, 6 in 2012-2014, 4 in 2015 and 7 in 2016 and 2017. In 2008 only 3 observations were obtained and in 2015 only 4 observations were received. Data for the CEE, NWE and SE regions are not displayed due to confidentiality reasons.
Source: Authors' elaboration

The electricity costs at EU level and sub-regional level are weighted against electricity consumption. Table 176 shows that EU and NWE weighted averages are lower than the simple averages. The reason for this, as stated above, could be the negotiating and bargaining power of larger consumers as well as larger consumers' lower costs for the network component and other regulatory components (RES and other non-recoverable taxes/levies).

Table 176 BOF - Electricity costs (€/MWh) – Simple and weighted averages

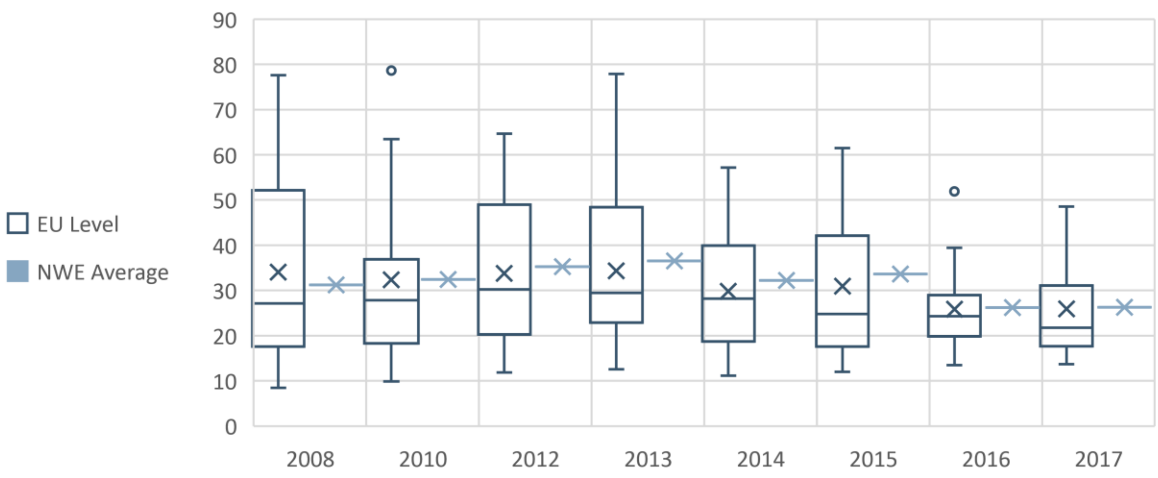
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EU simple average	Conf.	n.a.	62.6	n.a.	73.7	64.8	64.0	Conf.	52.1	54.3
EU weighted average	Conf.	n.a.	59.4	n.a.	68.9	62.8	59.4	Conf.	48.4	52.1

Note: Weighting factor: total electricity consumption. At the EU level the number of observations were 3 in 2008, 5 in 2010, 6 in 2012-2014, 4 in 2015 and 7 in 2016 and 2017.
Source: Authors' elaboration

EAF

Figure 139 shows that the average electricity costs (€/tonne) at EU level remained fairly stable from 2008 to 2013 but dropped 24% from 2013 to 2017. This seems to be a result of decreasing electricity prices. In 2017, they were at €25.9/tonne. At NWE level, the average electricity costs increased 17% from 2008 to 2013 and then decreased 28% from 2013 to 2017. The observations showed high ranges between minimum and maximum electricity costs, especially from 2008 to 2013, with the highest range in 2008, when the minimum was €8.5/tonne and the maximum €77.6/tonne. The outliers correspond to a plant with very high electricity intensity, which is also responsible for the maximum values in the years where no outlier is shown.

Figure 139 EAF - Electricity costs (€/tonne) – Box plots and simple averages



Note: At the EU level the number of observations were 11 in 2008, 16 in 2010 and 2012-2014, 14 in 2015 and 15 in 2016 and 2017. Data for the CEE region are not displayed due to confidentiality reasons.
Source: Authors' elaboration

The electricity costs (€/tonne) are weighted against production output. Table 177 shows that the EU and NWE weighted averages are lower than the simple averages, confirming better price conditions for larger consumers as well as economies of scale.

Table 177 EAF - Electricity costs (€/tonne) – Simple and weighted averages

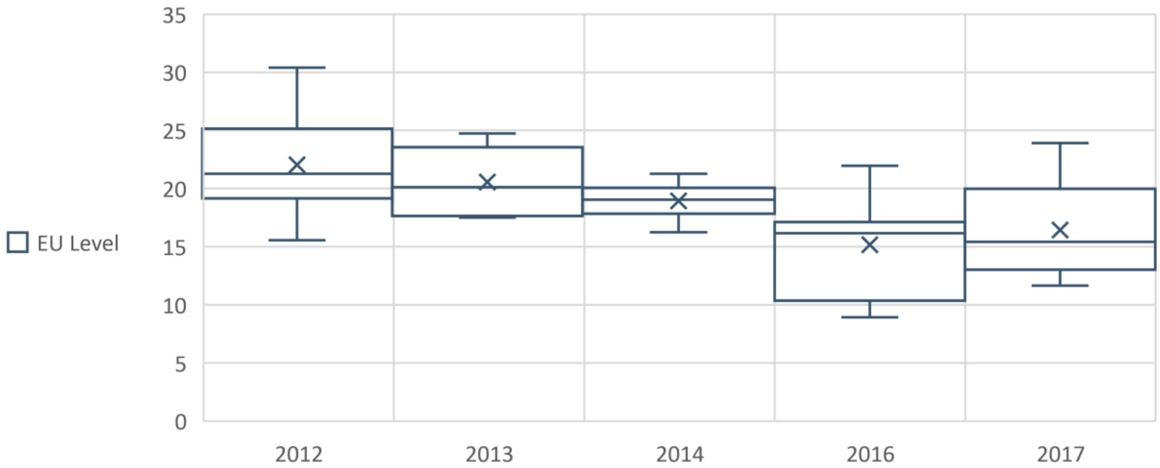
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EU simple average	34.1	n.a.	32.4	n.a.	33.8	34.3	29.8	30.9	25.8	25.9
EU weighted average	23.0	n.a.	22.9	n.a.	24.9	26.0	22.7	22.0	20.6	19.9
NWE simple average	31.2	n.a.	32.4	n.a.	35.3	36.5	32.2	33.6	26.2	26.3
NWE weighted average	20.8	n.a.	23.3	n.a.	25.6	26.8	23.4	22.9	20.9	19.3

Note: Weighting factor: production output. At the EU level the number of observations were 11 in 2008, 16 in 2010 and 2012-2014, 14 in 2015 and 15 in 2016 and 2017.
Source: Authors' elaboration

BOF

Figure 140 shows that the average electricity costs (€/tonne) at EU level saw a downward trend from 2012 to 2017; electricity costs decreased 25% from €22.0/tonne to €16.4/tonne. The sharp decrease from 2014 to 2016 is mainly caused by new plants that were added to the sample, which had lower electricity costs per tonne. There were not sufficient observations from the survey to allow us to provide information at regional level. Furthermore, at EU level, data for 2008, 2010 and 2015 are not shown for the same reason.

Figure 140 BOF - Electricity costs (€/tonne) – Box plots and simple averages



Note: At the EU level the number of observations were 3 in 2008, 5 in 2010, 6 in 2012-2014, 4 in 2015 and 7 in 2016 and 2017. Therefore, 2008, 2010 and 2015 box plots are not shown in the figure. Data for the CEE, NWE and SE regions are not displayed due to confidentiality reasons.
Source: Authors' elaboration

The electricity costs (€/tonne) are weighted against production output. Table 178 shows that the EU and NWE weighted averages are generally lower than the simple averages, confirming the better price conditions for larger consumers as well as economies of scale.

Table 178 BOF - Electricity costs (€/tonne) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EU simple average	Conf.	n.a.	Conf.	n.a.	22.0	20.6	18.9	Conf.	15.2	16.4
EU weighted average	Conf.	n.a.	Conf.	n.a.	21.7	20.7	18.6	Conf.	14.5	16.1

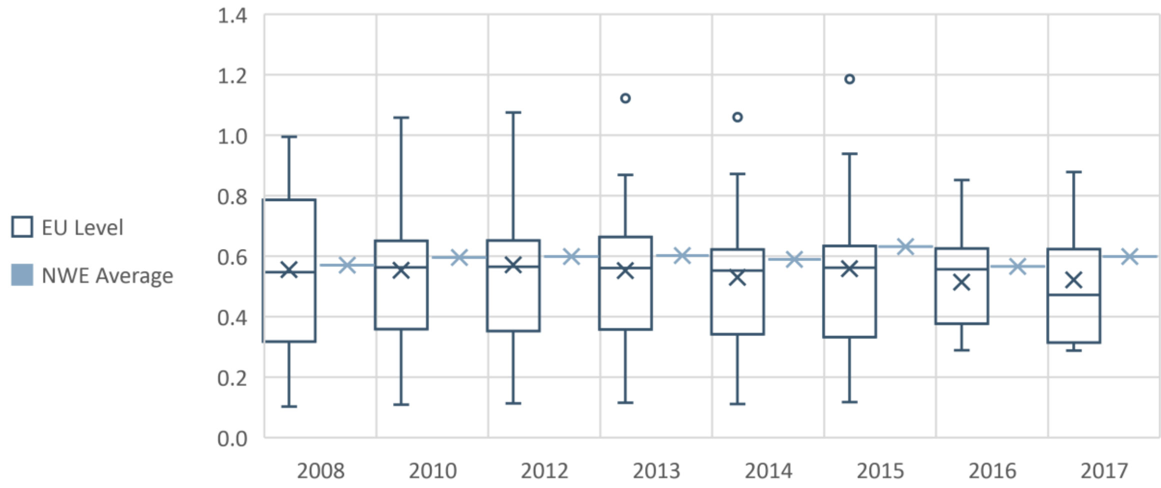
Note: Weighting factor: production output. At the EU level the number of observations were 3 in 2008, 5 in 2010, 6 in 2012-2014, 4 in 2015 and 7 in 2016 and 2017.
Source: Authors' elaboration

Electricity intensity

EAF

Figure 141 shows that the average electricity intensity at the EU level ranged from 0.51 to 0.58 MWh/tonne, decreasing slightly from 2008 (0.56 MWh/tonne) to 2017 (0.53 MWh/tonne). Overall, efficiency thus seems to be increasing. This trend is similar in the NWE region, where intensity was only slightly higher than the EU averages. In 2017, the EU average was 0.52 MWh/tonne and the NWE average was 0.60 MWh/tonne. The outliers correspond to a small plant that also represents the maximum value in other years. The minimum values from 2008 to 2015 correspond to a plant that experienced low electricity consumption.

Figure 141 EAF - Electricity intensity (MWh/tonne) – Box plots and simple averages



Note: At the EU level the number of observations were 13 in 2008, 16 in 2010 and 2012-2015 and 15 in 2016 and 2017. Data for the CEE region are not displayed due to confidentiality reasons.
Source: Authors' elaboration

The electricity intensity averages are weighted against product output. Table 179 shows that the EU and NWE weighted averages are lower than the simple averages. Larger plants thus seem to be more efficient, which may be due to economies of scale.

Table 179 EAF - Electricity intensity (MWh/tonne) – Simple and weighted averages

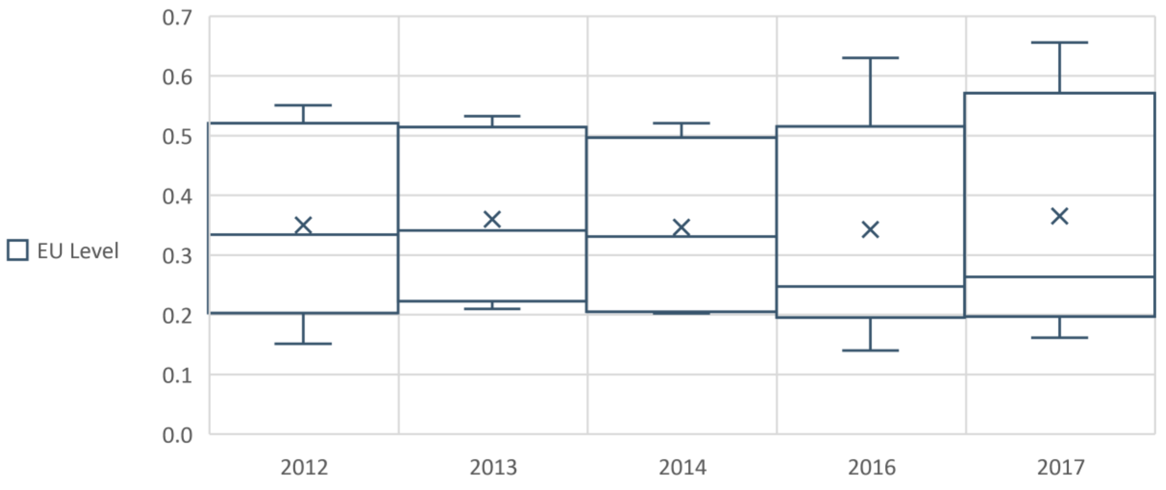
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EU simple average	0.56	n.a.	0.55	n.a.	0.57	0.55	0.53	0.56	0.51	0.53
EU weighted average	0.41	n.a.	0.43	n.a.	0.43	0.43	0.42	0.42	0.43	0.43
NWE simple average	0.57	n.a.	0.60	n.a.	0.60	0.60	0.59	0.63	0.57	0.60
NWE weighted average	0.41	n.a.	0.44	n.a.	0.44	0.45	0.44	0.45	0.45	0.45

Note: Weighting factor: production output. At the EU level the number of observations were 13 in 2008, 16 in 2010 and 2012-2015 and 15 in 2016 and 2017.
Source: Authors' elaboration

BOF

Figure 142 shows that the average electricity intensity at the EU level remained fairly stable at around 0.35 MWh/tonne throughout the period 2012-2017, with a slight increase of 6% between 2012 and 2017. The changing sample size is the main reason for this counterintuitive trend of stable or even decreasing efficiency. There were not sufficient observations from the survey to allow us to provide information at regional level. Furthermore, at EU level, data for 2008, 2010 and 2015 are not shown for the same reason.

Figure 142 BOF - Electricity intensity (MWh/tonne) – Box plots and simple averages



Note: At the EU level the number of observations were 2 in 2008, 5 in 2010, 6 in 2012-2014, 4 in 2015 and 7 in 2016 and 2017. Only 2 observations were obtained in 2008, 5 in 2010 and 4 in 2015. Therefore, these three years are not shown in the figure. Data for the CEE, NWE and SE regions are not displayed due to confidentiality reasons.
Source: Authors' elaboration

The electricity intensity averages are weighted against electricity consumption. Table 180 shows that EU and NWE weighted averages are lower than the simple averages, indicating that larger plants are more efficient than smaller ones when it comes to electricity.

Table 180 BOF - Electricity intensity (MWh/tonne) – Simple and weighted averages (MWh/tonne)

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EU simple average	Conf.	n.a.	Conf.	n.a.	0.35	0.36	0.35	Conf.	0.34	0.37
EU weighted average	Conf.	n.a.	Conf.	n.a.	0.32	0.33	0.31	Conf.	0.30	0.32

Note: Weighting factor: production output. At the EU level the number of observations were 2 in 2008, 5 in 2010, 6 in 2012-2014, 4 in 2015 and 7 in 2016 and 2017.
Source: Authors' elaboration

Additional information

In this Section we focus the analysis on plants that were surveyed for the current Assignment.

EAF

Plants provided data on the breakdown of their electricity contract type. Plants could select multiple types of contract, which means that the sum of contract types is higher than the total amount of 18; 78% of the plants have wholesale contracts, followed by provider contracts, which 28% of plants made use of.

Table 181 EAF - Electricity contract type

EU	Electricity Contract Type Breakdown	
Contract type	Count	% of plants
PPA	1	6%
Wholesale	14	78%
Provider	5	28%

Source: Authors' elaboration

The duration of electricity contracts was also provided by plants. Plants did not report any contracts with a duration of more than five years. Most of the plants (83%) reported contracts of up to five years. Only one plant (6%) reported contracts with an indeterminate duration. Two plants (i.e. the remaining 11%) did not report the electricity contract length.

Table 182 EAF - Electricity contract length

EU	Electricity Contract Length Breakdown	
Contract type	Count	% of plants
Indeterminate duration	1	6%
Up to 5 years	15	83%
More than 5 years	0	0%

Source: Authors' elaboration

Out of the 18 plants, 13 participated in a flexibility scheme for electricity.

The average number of outages and the average duration (in minutes) of these outages are divided into three types, namely planned outages, other planned outages and unplanned outages. The unplanned outages were spread over the three geographical regions.

Table 183 EAF - Electricity outages

EU	Planned outages		Other planned outages		Unplanned outages	
Year	Total number	Average duration	Total number	Average duration	Total number	Average duration
2015	3	140	NR	NR	2	1
2016	5	78	NR	NR	12	142
2017	4	165	NR	NR	34	409

Note: Planned outages are linked to flexibility schemes; other planned outages are not linked to flexibility schemes but notified in advance by the energy supplier; unplanned outages are not notified.
Source: Authors' elaboration

Participating EAF plants did not self-generate any electricity.

BOF

Plants provided data on the breakdown of their electricity contract type. Plants could select multiple types of contract, which means that the total of contract types is higher than the total amount of seven. The majority of the plants have wholesale contracts, followed by provider contracts. None of the plants had PPA contracts.

Table 184 BOF - Electricity contract type

EU	Electricity Contract Type Breakdown	
Contract type	**Count**	**% of plants**
PPA	0	0%
Wholesale	6	86%
Provider	3	43%

Source: Authors' elaboration

The duration of electricity contracts was also provided by plants. They did not report any contracts with indeterminate duration. Most of the plants reported contracts of up to five years. Only one of the plants reported contracts with a duration of more than five years.

Table 185 BOF - Electricity contract length

EU	Electricity Contract Length Breakdown	
Contract type	**Count**	**% of plants**
Indeterminate duration	0	0%
Up to 5 years	6	86%
More than 5 years	1	14%

Source: Authors' elaboration

Out of the seven plants, one participated in a flexibility scheme for electricity.

The average number of outages and the average duration (in minutes) of these outages are divided into three types, namely planned outages, other planned outages and unplanned outages. The unplanned outages were spread over the three geographical regions.

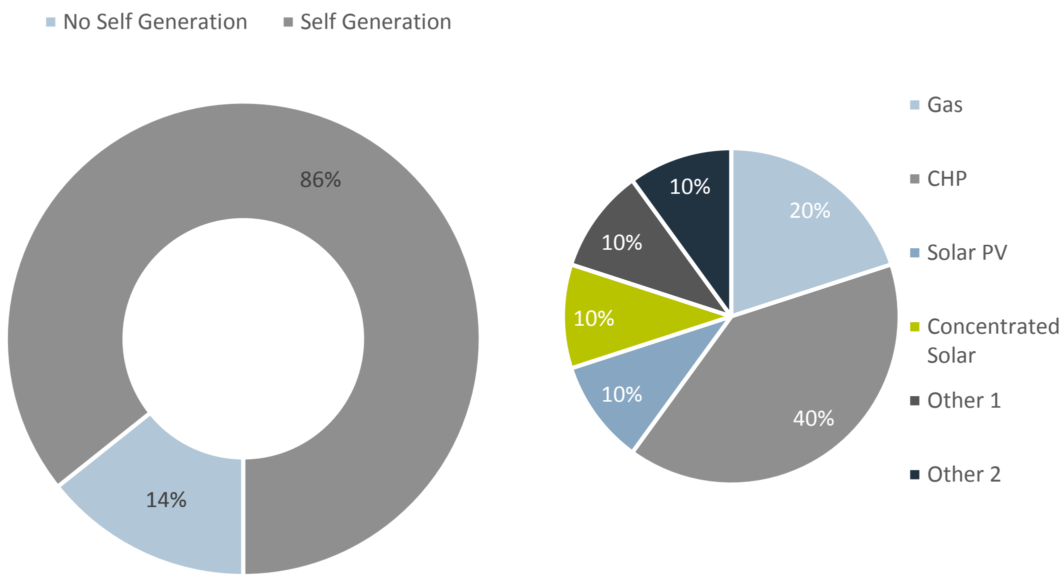
Table 186 BOF - Electricity outages

EU	Planned outages		Other planned outages		Unplanned outages	
Year	Total number	Average duration	Total number	Average duration	Total number	Average duration
2015	NR	NR	1	420	6	23
2016	NR	NR	1	120	5	4
2017	NR	NR	NR	NR	7	303

Note: Planned outages are linked to flexibility schemes; other planned outages are not linked to flexibility schemes but notified in advance by the energy supplier; unplanned outages are not notified.
Source: Authors' elaboration

All but one of the respondents produce self-generated electricity. Most of the self-generated electricity in the plants surveyed came from CHP (40%) and gas (20%). Two plants out of the seven sell self-generated electricity on the market.

Figure 143 BOF - Self-generation and self-generation type



Source: Authors' elaboration

7.3 Natural gas

The following tables summarise the natural gas data, including prices in €/MWh, costs in €/tonne and intensity in MWh/tonne. For EAF, it shows that after an initial increase to 2012, natural gas prices as well as costs decreased to 2017 and ended below the 2008 values. Natural gas intensity shows some fluctuations, finally resulting in a value in 2017 slightly below the value of 2008. For BOF the trends on natural gas prices and costs are similar. For natural gas intensity as well as total gas intensity (which includes the consumption of self-produced gases, i.e. waste gases) no clear trend is observed.

Table 187 EAF - Natural gas: summary table (EU) - Simple averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas prices (€/MWh)	26.3	n.a.	23.9	n.a.	31.8	30.4	29.6	26.3	19.2	20.2
Natural gas costs (€/tonne)	8.9	n.a.	8.7	n.a.	10.8	9.3	8.8	9.3	6.6	7.6
Natural gas intensity (MWh/tonne)	0.39	n.a.	0.36	n.a.	0.34	0.32	0.31	0.37	0.35	0.38

Source: Authors' elaboration

Table 188 BOF - Natural gas: summary table (EU) - Simple averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas prices (€/MWh)	31.1	n.a.	28.9	n.a.	30.3	30.4	29.3	23.6	17.2	19.3
Natural gas costs (€/tonne)	n.a.	n.a.	8.8	n.a.	6.4	7.5	7.0	6.7	5.1	6.4
Natural gas intensity (MWh/tonne)	0.36	n.a.	0.32	n.a.	0.22	0.25	0.25	0.29	0.27	0.31
Total gas intensity (MWh/tonne)	1.63	n.a.	1.35	n.a.	1.07	1.27	1.05	1.04	1.38	1.46

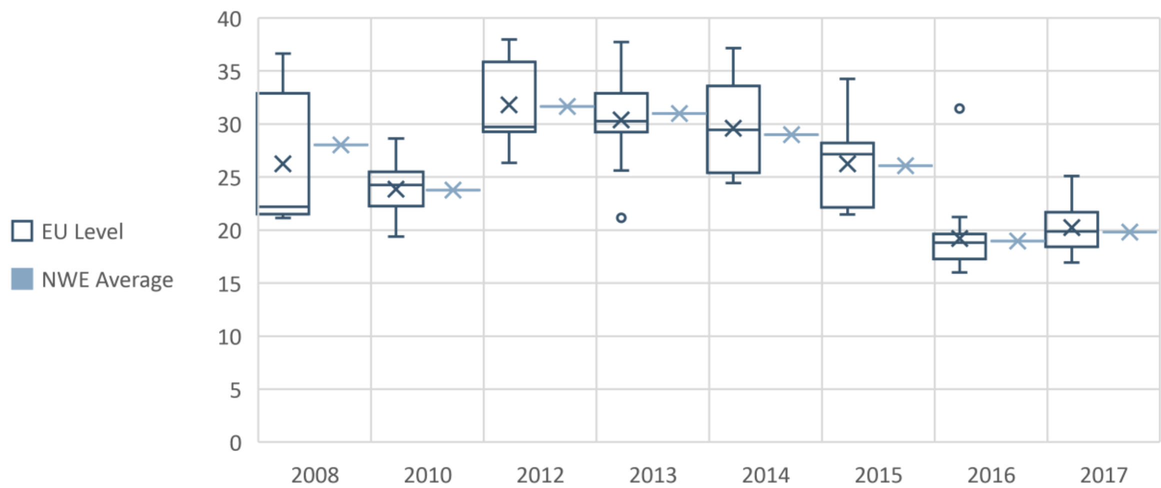
Source: Authors' elaboration

Natural gas prices

EAF

Figure 144 shows that the trend in natural gas prices for the EU and NWE are similar. The average gas prices dropped from 2008 to 2010, increased from 2010 to 2012 and then significantly decreased from 2012 to 2017. In 2017, they were at €20.2/MWh. Overall, the average natural gas price decreased 23% (EU) and 29% (NWE) during the 2008 to 2017 period. The outlier in 2013 corresponds to the plant that reported the minimum values shown in all other years, while the outlier in 2016 corresponds to the plant that reported the maximum values shown in most other years.

Figure 144 EAF - Natural gas prices (€/MWh) – Box plots and simple averages



Note: At the EU level the number of observations were 7 in 2008, 12 in 2010 and 2012-2015 and 17 in 2016 and 2017. Data for the SE and CEE regions are not displayed due to confidentiality reasons.
Source: Authors' elaboration

The natural gas prices at EU level and sub-regional level are weighted against natural gas consumption. Table 189 shows that the EU and NWE weighted averages are lower than the simple averages, except in 2012. The reason for this could be the negotiating and bargaining power of larger consumers.

Table 189 EAF - Natural gas prices (€/MWh) – Simple and weighted averages

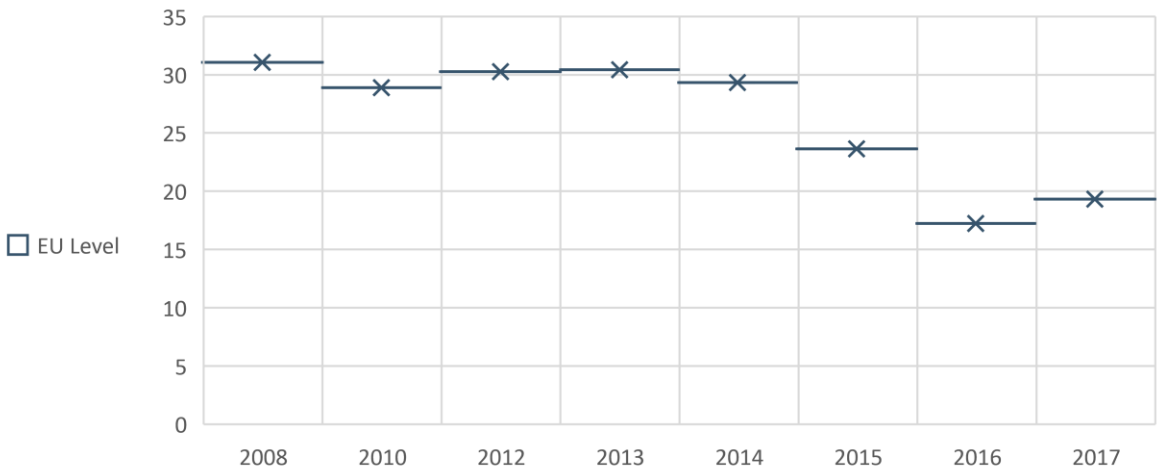
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EU simple average	26.3	n.a.	23.9	n.a.	31.8	30.4	29.6	26.3	19.2	20.2
EU weighted average	23.9	n.a.	23.7	n.a.	33.5	31.0	27.9	23.8	17.7	19.3
NWE simple average	28.0	n.a.	23.8	n.a.	31.6	31.0	29.0	26.1	19.0	19.8
NWE weighted average	24.4	n.a.	23.4	n.a.	33.2	30.9	26.3	23.3	17.0	18.6

Note: Weighting factor: natural gas purchased. At the EU level the number of observations were 7 in 2008, 12 in 2010 and 2012-2015 and 17 in 2016 and 2017.
Source: Authors' elaboration

BOF

In the EU, the average natural gas prices show a clearly descending trend, which is quite visible from 2013 to 2016, when prices dropped from €30.4/MWh to €17.2/MWh, equivalent to 37% (Figure 145). In 2017, prices were at €19.3/MWh. This decreasing trend, which can also be observed on international gas markets, was reinforced by two new plants that were added into the sample from 2013 onwards, which reported lower natural gas prices than other plants.

Figure 145 BOF - Natural gas prices (€/MWh) – Box plots and simple averages



Note: At the EU level the number of observations were 3 in 2008, 5 in 2010 and 2012-2014, 3 in 2015 and 4 in 2016 and 2017. Therefore, only simple averages and not box plots are shown above. Data for the SE, NWE and CEE regions are not displayed due to confidentiality reasons.
Source: Authors' elaboration

The natural gas prices at EU level are weighted against the natural gas purchased in MWh. Table 190 shows that the EU weighted averages are generally lower than the simple averages.

Table 190 BOF - Natural gas prices (€/MWh) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EU simple average	31.1	n.a.	28.9	n.a.	30.3	30.4	29.3	23.6	17.2	19.3
EU weighted average	31.7	n.a.	26.8	n.a.	26.9	28.6	26.8	23.0	16.6	19.1

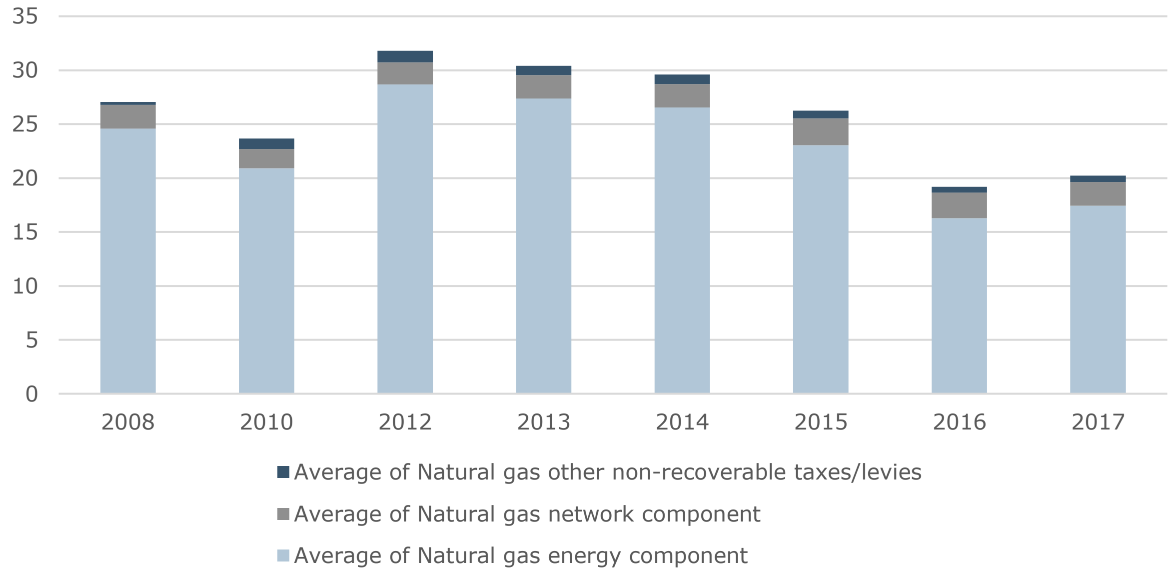
Note: Weighting factor: natural gas purchased. At the EU level the number of observations were 3 in 2008, 5 in 2010 and 2012-2014, 3 in 2015 and 4 in 2016 and 2017.
Source: Authors' elaboration

Components of the natural gas price[52]

EAF

The components of the natural gas price (€/MWh) are shown in Figure 146 and Figure 147. The average of the natural gas energy component has the largest share of the natural gas price in every year. In 2008, the energy component accounted for 91% of the natural gas price (€24.6/MWh), while in 2017 it accounted for around 86% of the natural gas price (€17.4/MWh in 2017). The energy component increased 17% from 2008 to 2012 but decreased 39% from 2012 to 2017. The average of natural gas network components showed a fairly stable trend, with the values in 2008 and 2017 being nearly the same (€2.2/MWh in 2017). The average of the other non-recoverable taxes/levies component increased almost 270% from 2008 to 2012, but then plunged 45% from 2012 to 2017 (€0.6/MWh in 2017).

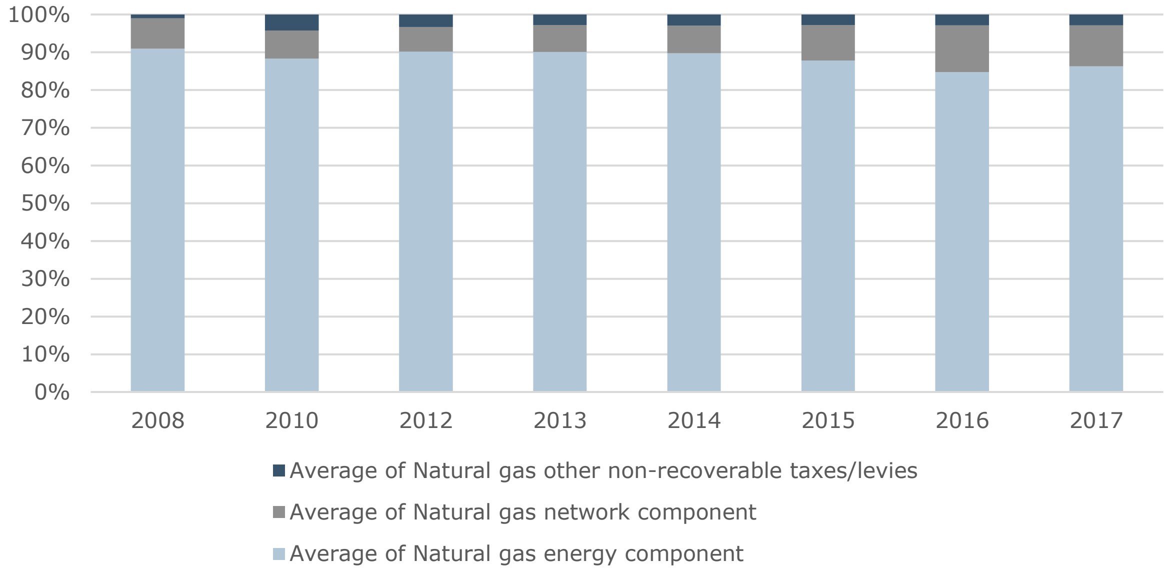
Figure 146 EAF - Components of the natural gas price (€/MWh, EU) – Simple averages



Note: At the EU level the number of observations were 6 in 2008, 11 in 2010, 12 in 2012-2015 and 17 in 2016 and 2017.
Source: Authors' elaboration

[52] The sum of the natural gas bill components does not necessarily add up to the total natural gas price mentioned before, as there might be plants that did not provide a breakdown of the natural gas bill components while still providing the total natural gas price.

Figure 147 EAF - Components of the natural gas price (%, EU) – Simple averages



Note: At the EU level the number of observations were 6 in 2008, 11 in 2010, 12 in 2012-2015 and 17 in 2016 and 2017.
Source: Authors' elaboration

The components of the natural gas price are weighted against the natural gas purchased in MWh. Table 191 shows that the weighted averages are lower than the simple averages, except in 2010, 2012 and 2013, when the weighted average of the energy components was somewhat higher than the simple average. It can be observed that large consumers do not necessarily have better bargaining power (to negotiate more favourable contracts for the energy component) but more importantly pay less for network and other regulatory components (i.e. other non-recoverable taxes/levies) than their smaller counterparts.

Table 191 EAF - Components of the natural gas price (€/MWh, EU) – Simple and weighted averages

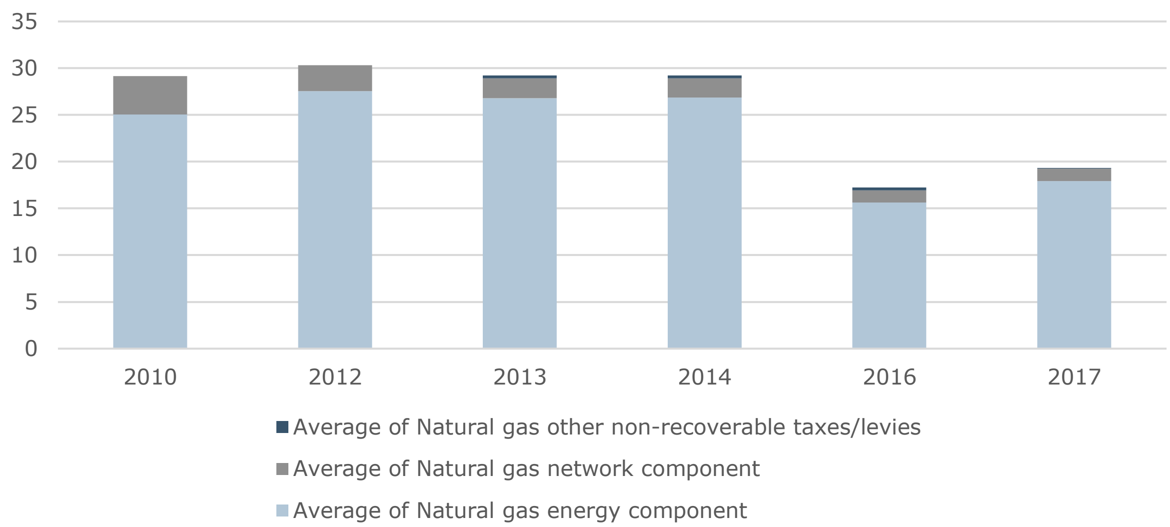
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Energy component simple average	24.6	n.a.	20.9	n.a.	28.7	27.4	26.6	23.0	16.3	17.4
Energy component weighted average	23.1	n.a.	22.0	n.a.	31.6	29.1	26.0	21.7	15.7	17.5
Network component simple average	2.2	n.a.	1.8	n.a.	2.1	2.2	2.1	2.5	2.4	2.2
Network component weighted average	0.7	n.a.	1.0	n.a.	1.4	1.3	1.3	1.4	1.4	1.4
Other non-recoverable taxes/levies simple average	0.3	n.a.	1.0	n.a.	1.1	0.8	0.9	0.7	0.6	0.6
Other non-recoverable taxes/levies weighted average	0.2	n.a.	0.6	n.a.	0.6	0.5	0.6	0.7	0.5	0.5

Note: Weighting factor: natural gas purchased. At the EU level the number of observations were 6 in 2008, 11 in 2010, 12 in 2012-2015 and 17 in 2016 and 2017.
Source: Authors' elaboration

BOF

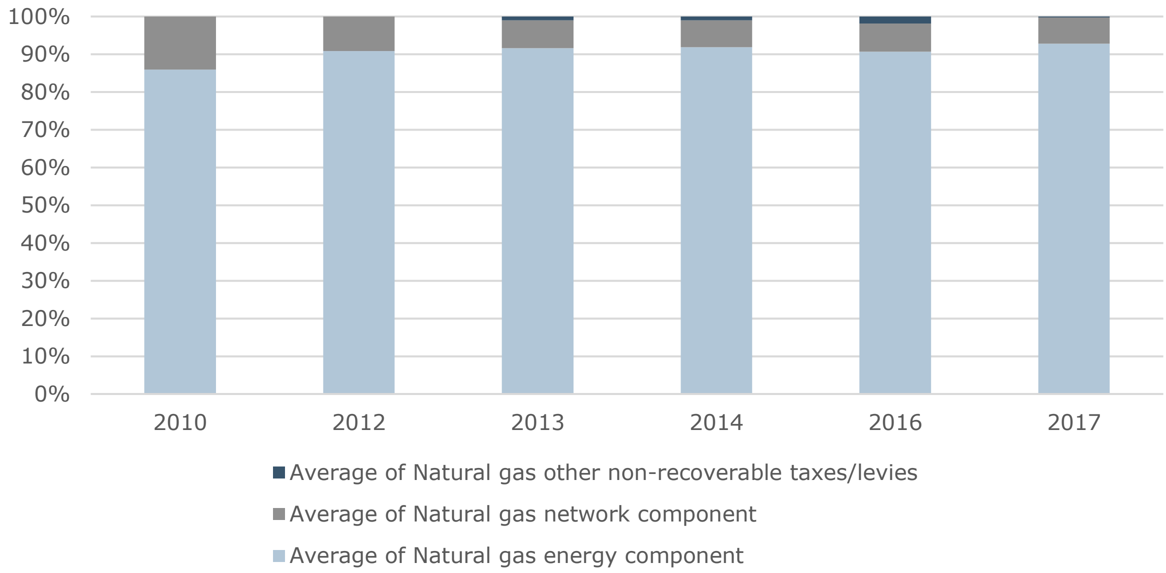
The components of the natural gas price (€/MWh) are shown in Figure 148 and Figure 149. The share of natural gas energy components was the largest of the natural gas price in every year. It accounted for around 86% in 2010 and 93% in 2017 (€17.9/MWh in 2017). It increased 10% from 2010 to 2012 but decreased 35% from 2012 to 2017. This decreasing trend, which can also be observed on the international gas markets, was reinforced by two new plants that were added to the sample from 2013 onwards, which reported lower natural gas prices than other plants. The average of the natural gas network component showed a downward trend from 2010 to 2017 (€1.4/MWh in 2017). The average of the other non-recoverable taxes/levies component only appears in 2013 with a low value of €0.3/MWh, which remains constant until 2016. Data for 2008 and 2015 are not shown in the figures due to confidentiality reasons.

Figure 148 BOF - Components of the natural gas price (€/MWh, EU) – Simple averages



Note: At the EU level the number of observations were 2 in 2008, 3 in 2010 and 2012, 4 in 2013 and 2014, 2 in 2015 and 4 in 2016 and 2017. In 2008 and 2015 there were only 2 observations; therefore, for confidentiality reasons they are not displayed on the graph.
Source: Authors' elaboration

Figure 149 BOF - Components of the natural gas price (%, EU) – Simple averages



Note: At the EU level the number of observations were 2 in 2008, 3 in 2010 and 2012, 4 in 2013 and 2014, 2 in 2015 and 4 in 2016 and 2017. In 2008 and 2015 there were only 2 observations; therefore, for confidentiality reasons they are not displayed on the graph.
Source: Authors' elaboration

The components of the natural gas price are weighted against the natural gas purchased in MWh. Table 192 shows that the weighted averages are lower than the simple averages of the energy component, except in 2010 and 2012, when the weighted average was slightly higher. For the network component, the weighted averages are always lower than the simple averages, indicating that larger consumers pay on average less for network connection than small consumers. For non-recoverable taxes/levies, the weighted averages were slightly higher. Overall, large consumers seem to pay less for the network component, while this does not hold for the energy component and other regulatory components.

Table 192 BOF - Components of the natural gas price (€/MWh, EU) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Energy component simple average	Conf.	n.a.	25.0	n.a.	27.5	26.8	26.8	Conf.	15.6	17.9
Energy component weighted average	Conf.	n.a.	26.2	n.a.	28.4	26.1	24.8	Conf.	14.9	17.9
Network component simple average	Conf.	n.a.	4.1	n.a.	2.8	2.1	2.1	Conf.	1.3	1.4
Network component weighted average	Conf.	n.a.	3.1	n.a.	2.7	1.4	1.1	Conf.	1.1	1.2
Other non-recoverable taxes/levies simple average	Conf.	n.a.	0.0	n.a.	0.0	0.3	0.3	Conf.	0.3	0.0

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Other non-recoverable taxes/levies weighted average	Conf.	n.a.	0.0	n.a.	0.0	0.6	0.6	Conf.	0.6	0.1

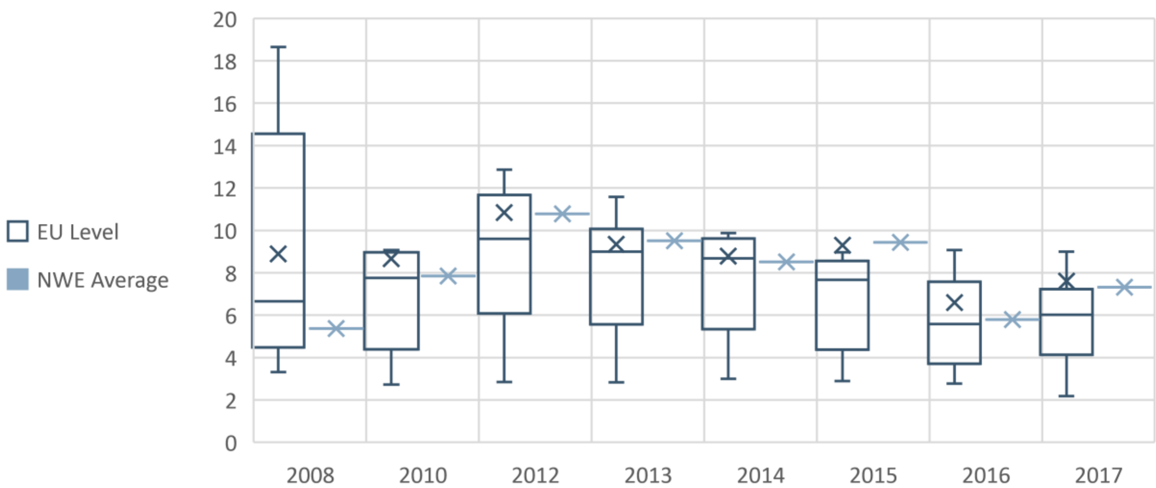
Note: Weighting factor: natural gas purchased. At the EU level the number of observations were 2 in 2008, 3 in 2010 and 2012, 4 in 2013 and 2014, 2 in 2015 and 4 in 2016 and 2017.
Source: Authors' elaboration

Natural gas costs

EAF

Figure 150 shows that the average costs of natural gas (in €/tonne) in the EU and NWE was volatile throughout the 2008 to 2017 period. Overall, during this timeframe the costs in the EU decreased 15%, while they increased 35% in NWE. In 2017, the average costs were similar in the EU and NWE regions, at €7.6/tonne (EU) and €7.3/tonne (NWE). A statistical outlier that is still representative for plants operating in the sector causes the average value to sometimes lie outside the upper and lower quartiles in 2015. Note that the outlier has been hidden in the figure to allow for an easier visual interpretation.

Figure 150 EAF - Natural gas costs (in €/tonne) – Box plots and simple averages



Note: At the EU level the number of observations were 6 in 2008, 12 in 2010 and 2012-2014, 10 in 2015 and 14 in 2016 and 2017. Data for the SE and CEE regions are not displayed due to confidentiality reasons.
Source: Authors' elaboration

The natural gas costs (€/tonne) are weighted against production output. Table 193 shows that the EU and NWE weighted averages are again generally lower than the simple averages; this may be due to the lower natural gas prices for large consumers and economies of scale.

Table 193 EAF - Natural gas costs (€/tonne) – Simple and weighted averages

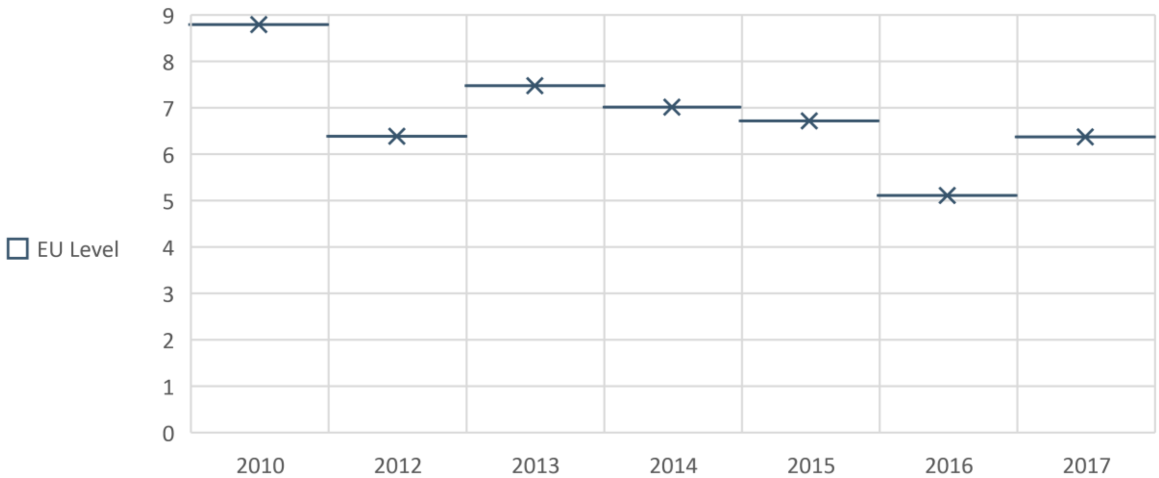
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EU simple average	8.9	n.a.	8.7	n.a.	10.8	9.3	8.8	9.3	6.6	7.6
EU weighted average	7.8	n.a.	7.7	n.a.	10.6	9.6	8.3	7.7	5.8	6.2
NWE simple average	5.4	n.a.	7.9	n.a.	10.8	9.5	8.5	9.4	5.8	7.3
NWE weighted average	6.8	n.a.	7.5	n.a.	10.7	9.7	8.0	7.6	5.5	5.9

Note: Weighting factor: production output. At the EU level the number of observations were 6 in 2008, 12 in 2010 and 2012-2014, 10 in 2015 and 14 in 2016 and 2017.
Source: Authors' elaboration

BOF

Figure 151 shows that the average costs of natural gas (in €/tonne) at the EU level decreased by 27% from 2010 to 2017. In 2017, the costs were at €6.4/tonne. Data for 2008, as well as data for the NWE, CEE and SE regions, are not shown in the figure due to confidentiality reasons.

Figure 151 BOF - Natural gas costs (in €/tonne) – Box plots and simple averages (in €/tonne)



Note: At the EU level the number of observations received ranged from 2 to 5. Therefore, only simple averages and not box plots are shown above. In 2008, only 2 observations were received, therefore, these data points are not included in the figure. Data for the SE, NWE and CEE regions are not displayed due to confidentiality reasons.
Source: Authors' elaboration

The natural gas costs (€/tonne) are weighted against production output. Table 194 shows that the EU and NWE weighted averages are generally lower than the simple averages; this may be due to lower natural gas prices for large consumers and economies of scale.

Table 194 BOF - Natural gas costs (€/tonne) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EU simple average	Conf.	n.a.	8.8	n.a.	6.4	7.5	7.0	6.7	5.1	6.4
EU weighted average	Conf.	n.a.	7.1	n.a.	6.4	7.5	6.7	7.2	4.8	6.1

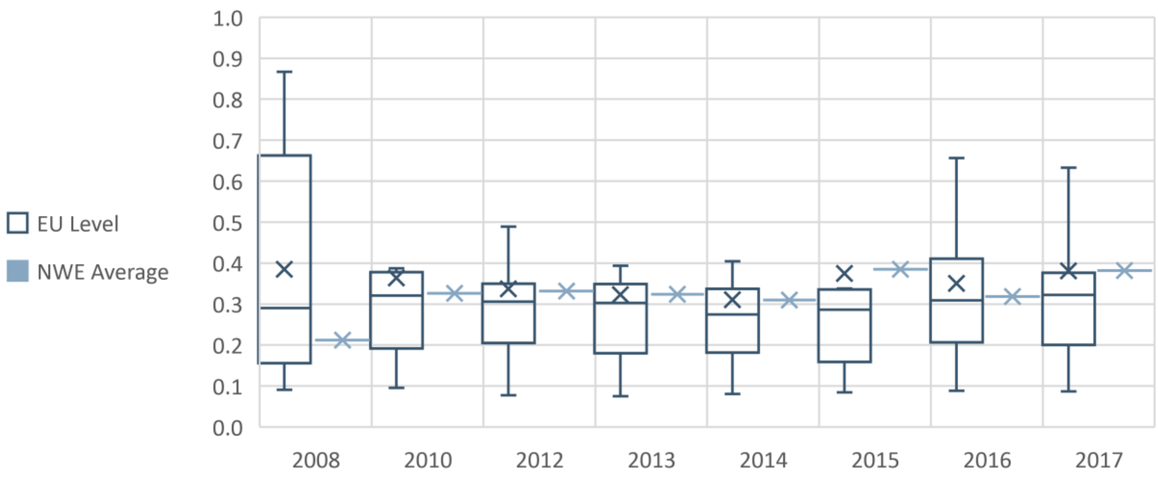
Note: Weighting factor: production output. At the EU level the number of observations received ranged from 2 to 5. In 2008, only 2 observations were received, therefore, these data points are not included in the figure.
Source: Authors' elaboration

Natural gas intensity

EAF

Figure 152 indicates that average natural gas intensity at the EU level remained fairly stable at around 0.35 MWh/tonne throughout the period 2008 to 2017, with only a 2–3% overall decrease in that period. Overall, efficiency thus increased slightly. In 2017, the average natural gas intensity was 0.38 MWh/tonne for both the EU and the NWE region. A statistical outlier that is still representative for plants operating in the sector causes the average value to lie outside the upper and lower quartiles in 2015. Note that the outlier has been hidden in the figure to allow for an easier visual interpretation.

Figure 152 EAF - Natural gas intensity (MWh/tonne) – Box plots and simple averages



Note: At the EU level the number of observations were 6 in 2008, 12 in 2010 and 2012-2014, 10 in 2015 and 14 in 2016 and 2017. Data for the SE and the CEE regions are not displayed due to confidentiality reasons.
Source: Authors' elaboration

The natural gas intensity is weighted against production output. Table 195 shows that the EU and NWE weighted averages are lower than the simple averages, except in 2008 when the weighted average for NWE is higher than the simple average. This may indicate that larger plants are more efficient than smaller ones.

Table 195 EAF - Natural gas intensity (MWh/tonne) – Simple and weighted averages

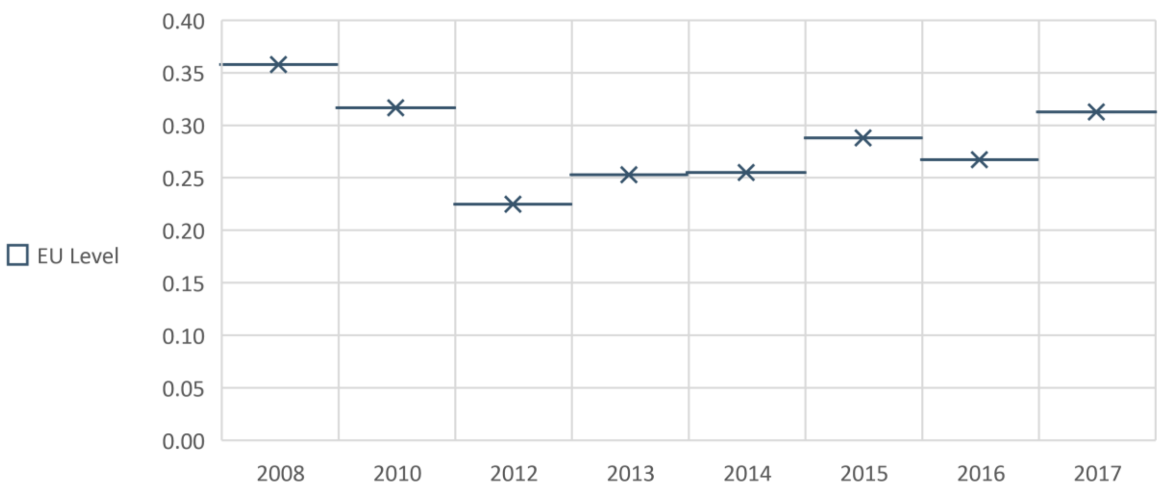
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EU simple average	0.39	n.a.	0.36	n.a.	0.34	0.32	0.31	0.37	0.35	0.38
EU weighted average	0.34	n.a.	0.33	n.a.	0.32	0.31	0.30	0.31	0.32	0.31
NWE simple average	0.21	n.a.	0.33	n.a.	0.33	0.32	0.31	0.38	0.32	0.38
NWE weighted average	0.29	n.a.	0.32	n.a.	0.32	0.31	0.30	0.31	0.32	0.32

Note: Weighting factor: production output. At the EU level the number of observations were 6 in 2008, 12 in 2010 and 2012-2014, 10 in 2015 and 14 in 2016 and 2017.
Source: Authors' elaboration

BOF

Figure 153 indicates that average natural gas intensity at the EU level dropped 39% from 2008 to 2012, but increased 41% from 2012 to 2017. Note again that this is – as for electricity intensity – mainly caused by a changing sample. In 2017, the average natural gas intensity was 0.31 MWh/tonne. It is important to note that this figure only considers the gas that is purchased by the plants. Values for total gas intensity including both purchased gas and waste gases are shown below. Data for the NWE, CEE and SE regions are not shown in the figure due to confidentiality reasons.

Figure 153 BOF - Natural gas intensity (MWh/tonne) – Box plots and simple averages



Note: At the EU level the number of observations were 3 in 2008, 4 in 2010, 5 in 2012-2014, 3 in 2015 and 4 in 2016 and 2017. Therefore, only simple averages and not box plots are shown above. Data for the SE, NWE and CEE regions are not displayed due to confidentiality reasons.
Source: Authors' elaboration

The natural gas intensity is weighted against production output. Table 196 shows that the EU and NWE weighted averages are lower than the simple averages, except in 2012, 2013 and 2015. As the weighted average for natural gas is not always below the simple average, larger plants do not necessarily seem to be more efficient than smaller ones.

Table 196 BOF - Natural gas intensity (MWh/tonne) – Simple and weighted averages

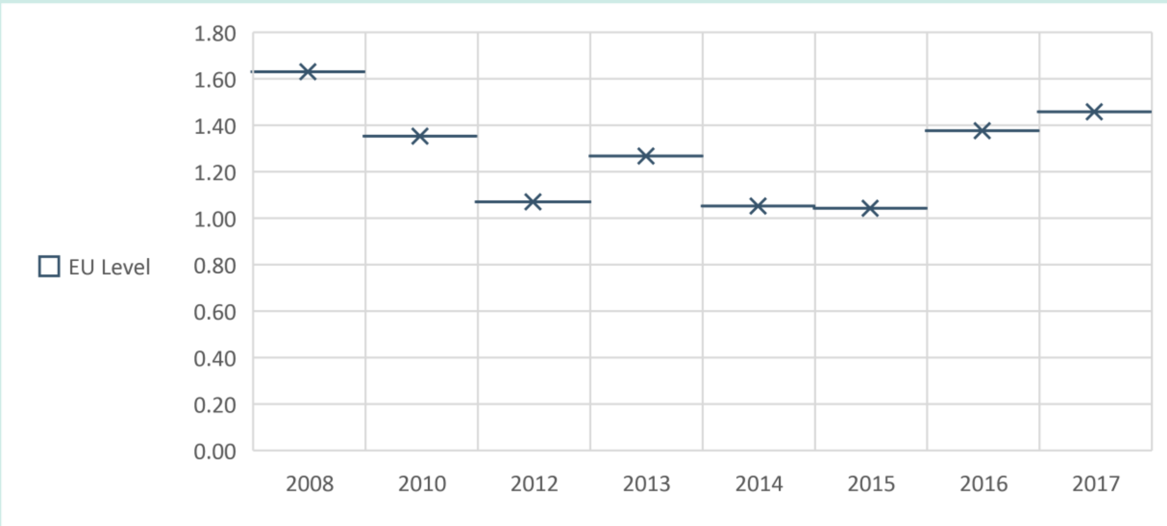
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EU simple average	0.36	n.a.	0.32	n.a.	0.22	0.25	0.25	0.29	0.27	0.31
EU weighted average	0.25	n.a.	0.27	n.a.	0.24	0.26	0.25	0.31	0.23	0.27

Note: Weighting factor: production output. At the EU level the number of observations were 3 in 2008, 4 in 2010, 5 in 2012-2014, 3 in 2015 and 4 in 2016 and 2017.
Source: Authors' elaboration

Box 13 BOF - Total gas intensity (in MWh/tonne)

Figure 154 includes data from gas purchased and waste gases consumed. It shows that the total gas intensity at the EU level dropped from 2008 to 2015 by 36%, and then increased by 40%, reaching 1.46 MWh/tonne. Data for the NWE, CEE and SE regions are not shown in the figure due to confidentiality reasons.

Figure 154 Total gas intensity (MWh/tonne) – Box plots and simple averages



Note: At the EU level the number of observations were 3 in 2008, 4 in 2010, 6 in 2012-2014, 4 in 2015 and 6 in 2016 and 2017. Therefore, only simple averages and not box plots are shown above. Data for the SE, NWE and CEE regions are not displayed due to confidentiality reasons.
Source: Authors' elaboration

The total natural gas intensity is weighted against production output. Table 197 shows that the EU and NWE weighted averages are not necessarily below the simple averages.

Table 197 Total gas intensity (MWh/tonne) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EU simple average	1.63	n.a.	1.35	n.a.	1.07	1.27	1.05	1.04	1.38	1.46
EU weighted average	1.50	n.a.	1.30	n.a.	1.13	1.41	1.10	1.34	1.31	1.41

Note: Weighting factor: production output. At the EU level the number of observations were 3 in 2008, 4 in 2010, 6 in 2012-2014, 4 in 2015 and 6 in 2016 and 2017. Therefore, only simple averages and not box plots are shown above. Data for the SE, NWE and CEE regions are not displayed due to confidentiality reasons.
Source: Authors' elaboration

Additional information

In this Section we focus the analysis on plants that were surveyed for the current Assignment.

EAF

Plants provided data on the breakdown of their natural gas contract type. Plants could select multiple types of contract, which means that the number of contract types could in theory be higher than the total amount of 18 (note: here it is not the case). Most of the plants (78%) used the provider contract type, followed by wholesale contracts (22%).

Table 198 EAF - Natural gas contract type

EU	Electricity Contract Type Breakdown	
Contract type	**Count**	**% of plants**
Wholesale	4	22%
Provider	14	78%

Source: Authors' elaboration

In terms of natural gas contract duration, interviewees did not report any contracts with a duration of more than five years; 78% of the plants reported contracts of up to five years, and 17% of the plants reported contracts of indeterminate duration, which is automatically renewed each year. One plant did not respond to the question.

Table 199 EAF - Natural gas contract length

EU	Electricity Contract Length Breakdown	
Contract type	**Count**	**% of plants**
Indeterminate duration	3	17%
Up to 5 years	14	78%
More than 5 years	0	0%

Source: Authors' elaboration

None of the plants surveyed participated in a flexibility/interruptibility scheme for natural gas. Participating companies did not report on any outages.

Participating EAF plants did not self-generate any gas.

BOF

Plants provided data on the breakdown of their natural gas contract type. Plants could select multiple types of contract. The majority of plants (71%) have the provider contract type, followed by wholesale contracts (one plant).

Table 200 BOF - Natural gas contract type

EU	Electricity Contract Type Breakdown	
Contract type	**Count**	**% of plants**
Wholesale	1	14%
Provider	5	71%

Source: Authors' elaboration

In terms of natural gas contract duration, interviewees did not report any contracts of an indeterminate duration; 71% of the plants reported contracts of up to five years, and 29% reported contracts of more than five years. One plant reported that it was not able to renew its existing five-year duration contract as the supplier indicated that it would no longer offer such long-term contracts due to market and regulation uncertainty.

Table 201 BOF - Natural gas contract length

EU	Electricity Contract Length Breakdown	
Contract type	**Count**	**% of plants**
Indeterminate duration	0	0%
Up to 5 years	5	71%
More than 5 years	2	29%

Source: Authors' elaboration

None of the plants was taking part in a flexibility/interruptibility scheme for natural gas. Participating companies did not report on any outages and 86% of the plants surveyed produced gas themselves; 29% of the plants sell at least part of the self-produced gas.

7.4 Competitiveness

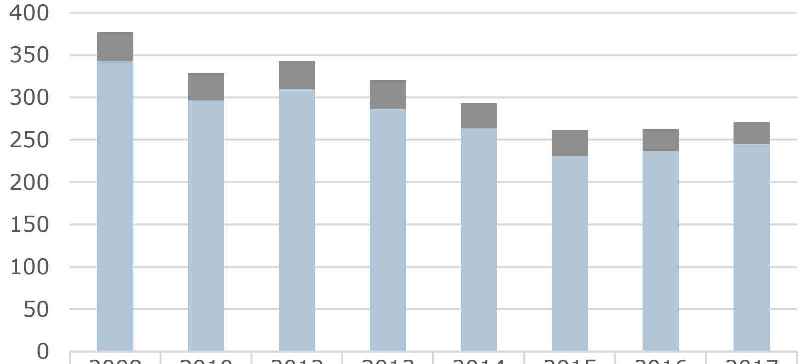
Cost competitiveness

Electricity

EAF

The average of other production costs per tonne of product decreased by 29% from €343.2/tonne in 2008 to €245.0/tonne in 2017 (see Figure 155). The average costs for electricity per tonne of product decreased 24%, from €34.1/tonne in 2008 to €25.9/tonne in 2017. Electricity costs per tonne make up around 10% of the total production costs per tonne. This share increased slightly from 9.0% in 2008 to 9.6% to 2017.

Figure 155 EAF - Electricity costs as a share of production costs (€/tonne, EU) – Simple averages



	2008	2010	2012	2013	2014	2015	2016	2017
Average of Electricity cost €/tonne	34.1	32.4	33.8	34.3	29.8	30.9	25.8	25.9
Average of other Production costs €/tonne	343.2	296.5	309.5	286.1	263.3	230.8	236.9	245.0

Note: For electricity costs, there were 11 observations in 2008, 16 in 2010-2014, 14 observations in 2015 and 15 observations in 2016 and 2017. For production costs, there were 10 observations in 2008 to 2015 and 8 observations in 2016 and 2017.
Source: Authors' elaboration

The electricity costs and production costs are weighted against production output. Table 202 shows that weighted averages for electricity costs are lower than the simple averages. The reason for this could be the negotiating and bargaining power of larger consumers. At the same time, for production costs, the weighted average is higher than the simple average.

Table 202 EAF - Electricity costs vs. production costs (€/tonne) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity costs simple average (€/MWh)	34.1	n.a.	32.4	n.a.	33.8	34.3	29.8	30.9	25.8	25.9
Electricity costs weighted average (€/tonne)	23.0	n.a.	22.9	n.a.	24.9	26.0	22.7	22.0	20.6	19.9
Production costs simple average (€/tonne)	377.3	n.a.	328.8	n.a.	343.2	320.4	293.1	261.8	262.7	271.0
Production costs weighted average (€/tonne)	381.3	n.a.	318.4	n.a.	341.0	313.1	293.1	263.2	257.0	296.8
Electricity costs as a share of production costs simple averages (%)	9.0%	n.a.	9.8%	n.a.	9.8%	10.7%	10.2%	11.8%	9.8%	9.6%

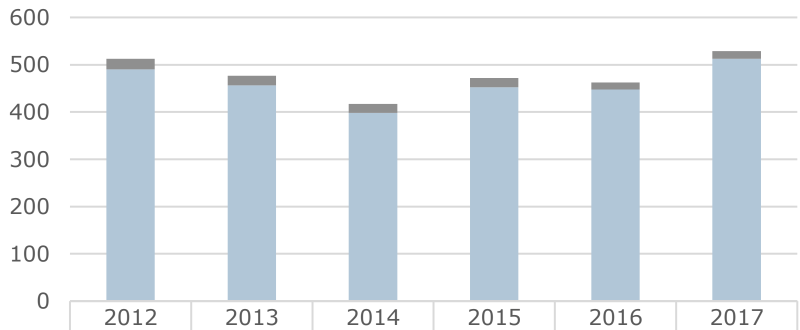
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity costs as a share of production costs weighted averages (%)	6.0%	n.a.	7.2%	n.a.	7.3%	8.3%	7.7%	8.3%	8.0%	6.7%

Note: Weighting factor: production output. For electricity costs, there were 11 observations in 2008, 16 in 2010-2014, 14 observations in 2015 and 15 observations in 2016 and 2017
Source: Authors' elaboration

BOF

The average of other production costs per tonne of product increased from €490.5 €/tonne in 2012 to €512.3/tonne in 2017 (i.e. 4.5%). The average costs for electricity per tonne of product decreased 25%, from €22.0/tonne in 2012 to €16.4/tonne in 2017. Electricity costs per tonne make up around 3% of total production costs, being relatively smaller when compared to EAF. This share decreased slightly from 4.3% in 2012 to 3.1% in 2017.

Figure 156 Electricity costs as a share of production costs (€/tonne, EU) – Simple averages



	2012	2013	2014	2015	2016	2017
Average of Electricity cost €/tonne	22.0	20.6	18.9	19.6	15.2	16.4
Average of other Production costs €/tonne	490.5	456.2	398.4	452.4	447.4	512.3

Note: For electricity costs, there were 3 observations in 2008, 5 observations in 2010, 6 observations in 2012-2014, 4 observations in 2015 and 7 observations in 2016 and 2017. For production costs, there were 2 observations in 2008 and 2010, 4 observations in 2012-2014, 3 observations in 2015 and 5 observations in 2016 and 2017. Since in 2008 and 2010 there were only 2 observations the data for these 2 years is not shown in the graph
Source: Authors' elaboration

The electricity costs and production costs are weighted against production output. Table 203 shows that the EU average electricity costs are generally lower than the simple averages. For production costs the weighted averages are sometimes lower and sometimes higher than the simple average.

Table 203 BOF - Electricity costs vs. production costs (€/tonne) – Simple and weighted averages

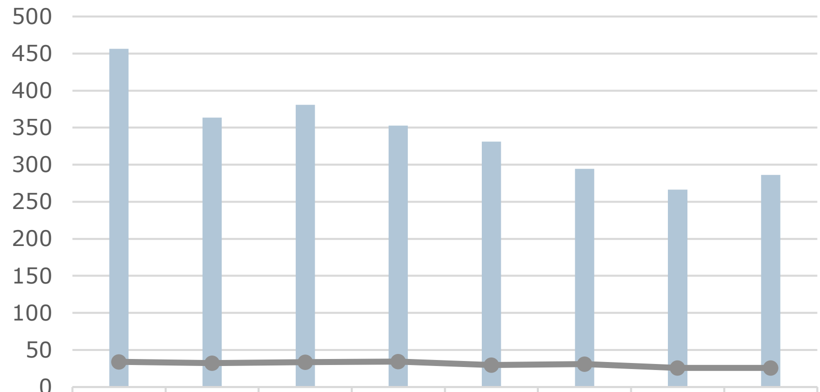
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity costs simple average (€/MWh)	17.7	n.a.	20.9	n.a.	22.0	20.6	18.9	19.6	15.2	16.4
Electricity costs weighted average (€/tonne)	16.6	n.a.	19.5	n.a.	21.7	20.7	18.6	19.8	14.5	16.1
Production costs simple average (€/tonne)	Conf.	n.a.	Conf.	n.a.	512.6	476.7	417.3	472.0	462.5	528.7
Production costs weighted average (€/tonne)	Conf.	n.a.	Conf.	n.a.	504.0	487.3	413.0	428.3	475.0	548.4
Electricity costs as a share of production costs simple averages (%)	Conf.	n.a.	Conf.	n.a.	4.3%	4.3%	4.5%	4.2%	3.3%	3.1%
Electricity costs as a share of production costs weighted averages (%)	Conf.	n.a.	Conf.	n.a.	4.3%	4.2%	4.5%	4.6%	3.1%	3.0%

Note: Weighting factor: production output. For electricity costs, there were 3 observations in 2015, 5 observations in 2010, 6 observations in 2012-2014, 4 observations in 2015 and 7 observations in 2016 and 2017. For production costs, there were 2 observations in 2008 and 2010, 4 observations in 2012-2014, 3 observations in 2015 and 5 observations in 2016 and 2017. Since in 2008 and 2010 there were only 2 observations the data for these 2 years is not shown in the graph
Source: Authors' elaboration

EAF

The average turnover per unit of production decreased 37%, from €456.2/tonne in 2008 to €286.1/tonne in 2017. The electricity costs per unit of production decreased 24% from €34.1/tonne in 2008 to €25.9/tonne in 2017. The share of electricity costs in relation to turnover increased from about 7.5% in 2008 to 9.1% in 2017.

Figure 157 EAF - Electricity costs versus turnover (€/tonne, EU) – Simple averages



	2008	2010	2012	2013	2014	2015	2016	2017
Average of Turnover €/tonne	456.2	363.6	380.7	352.9	331.2	294.3	266.5	286.1
Average of Electricity cost €/tonne	34.1	32.4	33.8	34.3	29.8	30.9	25.8	25.9

Note: For electricity costs, there were 11 observations in 2008, 16 in 2010-2014, 14 observations in 2015 and 15 observations in 2016 and 2017. For turnover per tonne, there were 10 observations in 2008 to 2015 and 7 observations in 2016 and 2017.
Source: Authors' elaboration

The electricity costs and turnover are weighted against production output. Table 204 shows that weighted averages for electricity costs are lower than the simple averages. This also holds for turnover except for 2016 and 2017.

Table 204 EAF - Electricity costs vs. turnover (€/tonne) – Simple and weighted averages

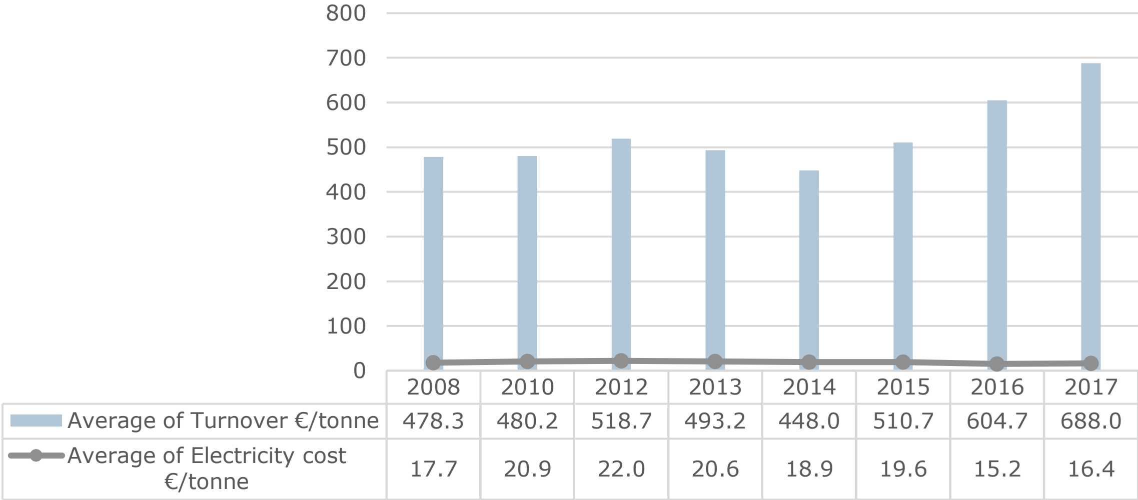
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity costs simple average (€/tonne)	34.1	n.a.	32.4	n.a.	33.8	34.3	29.8	30.9	25.8	25.9
Electricity costs weighted average (€/tonne)	23.0	n.a.	22.9	n.a.	24.9	26.0	22.7	22.0	20.6	19.9
Turnover simple average (€/tonne)	456.2	n.a.	363.6	n.a.	380.7	352.9	331.2	294.3	266.5	286.1
Turnover weighted average (€/tonne)	441.9	n.a.	332.1	n.a.	355.7	332.6	320.8	286.9	272.0	302.3
Electricity costs as a share of turnover simple averages (%)	7.5%	n.a.	8.9%	n.a.	8.9%	9.7%	9.0%	10.5%	9.7%	9.1%
Electricity costs as a share of turnover weighted averages (%)	5.2%	n.a.	6.9%	n.a.	7.0%	7.8%	7.1%	7.7%	7.6%	6.6%

Note: Weighting factor: production output. For electricity costs, there were 11 observations in 2008, 16 in 2010-2014, 14 observations in 2015 and 15 observations in 2016 and 2017. For turnover per tonne, there were 10 observations in 2008 to 2015 and 7 observations in 2016 and 2017.
Source: Authors' elaboration

BOF

The average turnover per unit of production increased 44%, from €478.3/tonne in 2008 to €688.0/tonne in 2017 (see Figure 158). The average costs for electricity per tonne of product decreased 7%, from €17.7/tonne in 2008 to €16.4/tonne in 2017. The share of electricity costs in relation to turnover decreased from about 3.7% in 2008 to 2.4% in 2017.

Figure 158 BOF - Electricity costs versus turnover (€/tonne, EU) – Simple averages



Note: For electricity costs, there were 3 observations in 2015, 5 observations in 2010, 6 observations in 2012-2014, 4 observations in 2015 and 7 observations in 2016 and 2017. For turnover, there were 3 observations in 2008 and 2010, 4 observations in 2012-2014, 3 observations in 2015 and 5 observations in 2016 and 2017.
Source: Authors' elaboration

The electricity costs and turnover are weighted against production output. Table 205 shows that weighted averages for electricity costs are generally lower than the simple averages. For turnover the weighted average is also lower than the simple average, except in 2010 and 2013.

Table 205 BOF - Electricity costs vs. turnover (€/tonne) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity costs simple average (€/tonne)	17.7	n.a.	20.9	n.a.	22.0	20.6	18.9	19.6	15.2	16.4
Electricity costs weighted average (€/tonne)	16.6	n.a.	19.5	n.a.	21.7	20.7	18.6	19.8	14.5	16.1

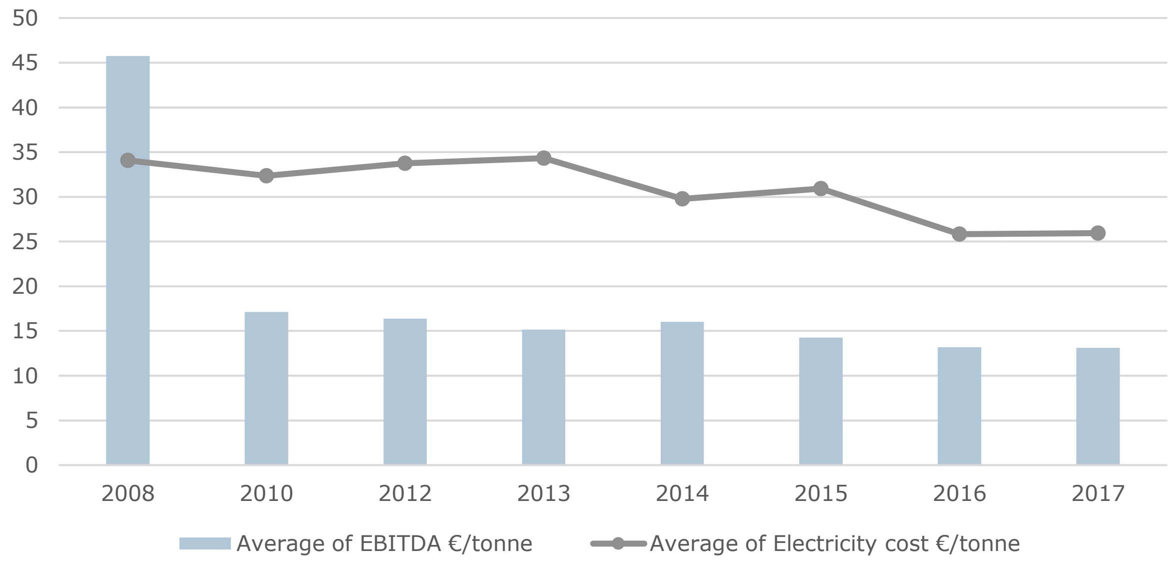
Turnover simple average (€/tonne)	478.3	n.a.	480.2	n.a.	518.7	493.2	448.0	510.7	604.7	688.0
Turnover weighted average (€/tonne)	449.5	n.a.	503.0	n.a.	511.9	506.5	443.8	465.0	587.0	671.3
Electricity costs as a share of turnover simple averages (%)	3.7%	n.a.	4.3%	n.a.	4.2%	4.2%	4.2%	3.8%	2.5%	2.4%
Electricity costs as a share of turnover weighted averages (%)	3.7%	n.a.	3.9%	n.a.	4.2%	4.1%	4.2%	4.3%	2.5%	2.5%

Note: Weighting factor: production output. For electricity costs, there were 3 observations in 2015, 5 observations in 2010, 6 observations in 2012-2014, 4 observations in 2015 and 7 observations in 2016 and 2017. For turnover, there were 3 observations in 2008 and 2010, 4 observations in 2012-2014, 3 observations in 2015 and 5 observations in 2016 and 2017.
Source: Authors' elaboration

EAF

EBITDA per tonne (simple averages) underwent a 63% decrease from 2008 to 2010 but then remained fairly stable at around €13 to €17/tonne.

Figure 159 EAF - Electricity costs versus EBITDA (€/tonne, EU) – Simple averages



Note: For electricity costs, there were 11 observations in 2008, 16 in 2010-2014, 14 observations in 2015 and 15 observations in 2016 and 2017. For EBITDA per tonne, there were 9 observations in 2008 to 2015 and 7 observations in 2016 and 2017.
Source: Authors' elaboration

The electricity costs and EBITDA are weighted against production output. Table 206 shows that weighted averages for electricity costs are lower than the simple averages. For EBITDA the weighted average is in most of the cases higher than the simple averages.

Table 206 EAF - Electricity costs vs. EBITDA (€/tonne) – Simple and weighted averages

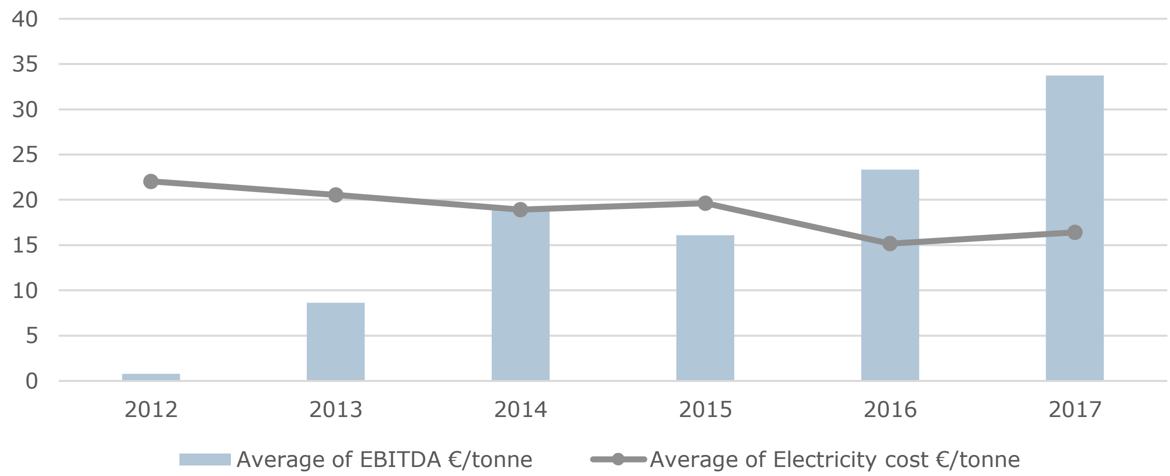
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity costs simple average (€/tonne)	34.1	n.a.	32.4	n.a.	33.8	34.3	29.8	30.9	25.8	25.9
Electricity costs weighted average (€/tonne)	23.0	n.a.	22.9	n.a.	24.9	26.0	22.7	22.0	20.6	19.9
EBITDA simple average (€/tonne)	45.8	n.a.	17.1	n.a.	16.4	15.2	16.0	14.3	13.2	13.1
EBITDA weighted average (€/tonne)	61.1	n.a.	17.9	n.a.	18.0	13.4	15.8	14.8	19.8	11.2

Note: Weighting factor: production output. For electricity costs, there were 11 observations in 2008, 16 in 2010-2014, 14 observations in 2015 and 15 observations in 2016 and 2017. For EBITDA per tonne, there were 9 observations in 2008 to 2015 and 7 observations in 2016 and 2017.
Source: Authors' elaboration

BOF

EBITDA per tonne increased substantially from €0.8/tonne in 2012 to €33.74/tonne in 2017 (see Figure 160).

Figure 160 BOF - Electricity costs versus EBITDA (€/tonne, EU) – Simple averages



Note: For electricity costs, there were 3 observations in 2015, 5 observations in 2010, 6 observations in 2012-2014, 4 observations in 2015 and 7 observations in 2016 and 2017. For EBITDA/tonne, there were 2 observations in 2008 to 2010, 4 observations in 2012-2014, 3 observations in 2015 and 5 observations in 2016 and 2017. EBITDA is therefore not shown for 2008 and 2010.
Source: Authors' elaboration

The electricity costs and EBITDA are weighted against production output. Table 207 shows that the weighted averages for electricity costs are generally lower than the simple averages. For EBITDA, the weighted average is in most cases higher than the simple average, which means that larger plants seem to have higher EBITDA per tonne than smaller plants.

Table 207 BOF - Electricity costs vs. EBITDA (€/tonne) – Simple and weighted averages

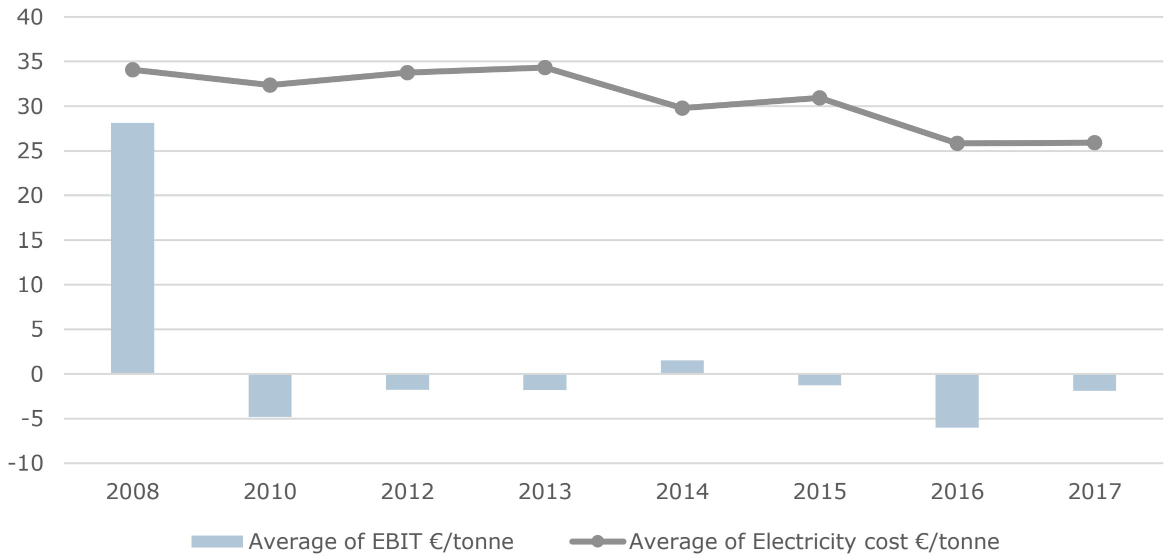
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity costs simple average (€/tonne)	17.7	n.a.	20.9	n.a.	22.0	20.6	18.9	19.6	15.2	16.4
Electricity costs weighted average (€/tonne)	16.6	n.a.	19.5	n.a.	21.7	20.7	18.6	19.8	14.5	16.1
EBITDA simple average (€/tonne)	Conf.	n.a.	Conf.	n.a.	0.8	8.6	18.9	16.1	23.3	33.7
EBITDA weighted average (€/tonne)	Conf.	n.a.	Conf.	n.a.	1.8	8.9	19.5	18.8	22.2	34.3

Note: Weighting factor: production output. For electricity costs, there were 3 observations in 2015, 5 observations in 2010, 6 observations in 2012-2014, 4 observations in 2015 and 7 observations in 2016 and 2017. For EBITDA/tonne, there were 2 observations in 2008 to 2010, 4 observations in 2012-2014, 3 observations in 2015 and 5 observations in 2016 and 2017. EBITDA is therefore not shown for 2008 and 2010.
Source: Authors' elaboration

EAF

Figure 161 shows that EBIT per unit of production (simple averages) decreased substantially from 2008 (€28.12/tonne) to 2010 (-€4.8/tonne). It is important to note, however, that 2008 seems to be an exceptional year (outlier), which might also to some extent have been triggered by the lower number of observations. It can also be seen that EBIT per unit of production from 2010 to 2017 fluctuates. In 2017, it was -€1.9/tonne.

Figure 161 EAF - Electricity costs versus EBIT (€/tonne, EU) – Simple averages



Note: For electricity costs, there were 11 observations in 2008, 16 in 2010-2014, 14 observations in 2015 and 15 observations in 2016 and 2017. For EBIT per tonne, there were 9 observations in 2008 to 2015 and 7 observations in 2016 and 2017.
Source: Authors' elaboration

The electricity costs and EBIT are weighted against production output. Table 208 shows that weighted averages for electricity costs are lower than the simple averages, while for EBIT the weighted average is higher than the simple average.

Table 208 EAF - Electricity costs vs. EBIT (€/tonne) – Simple and weighted averages

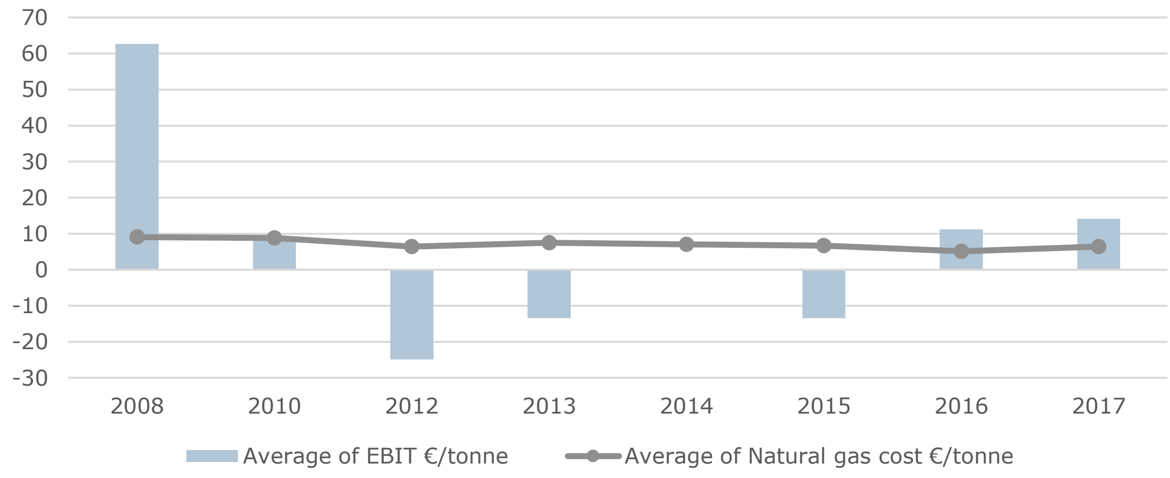
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity costs simple average (€/tonne)	34.1	n.a.	32.4	n.a.	33.8	34.3	29.8	30.9	25.8	25.9
Electricity costs weighted average (€/tonne)	23.0	n.a.	22.9	n.a.	24.9	26.0	22.7	22.0	20.6	19.9
EBIT simple average (€/tonne)	28.1	n.a.	-4.8	n.a.	-1.8	-1.8	1.5	-1.3	-6.0	-1.9
EBIT weighted average (€/tonne)	46.5	n.a.	1.9	n.a.	2.9	-0.5	3.7	2.3	4.8	-1.4

Note: Weighting factor: production output. For electricity costs, there were 11 observations in 2008, 16 in 2010-2014, 14 observations in 2015 and 15 observations in 2016 and 2017. For EBIT per tonne, there were 9 observations in 2008 to 2015 and 7 observations in 2016 and 2017.
Source: Authors' elaboration

BOF

Figure 162 shows a 7% decrease in average electricity costs from 2008 to 2017. The EBIT, in contrast, shows a somewhat fluctuating trend. From 2012 to 2017, a clearly increasing trend in EBIT can be observed. EBIT continuously increased from -€24.9/tonne in 2012 to €14.1/tonne in 2017.

Figure 162 BOF - Electricity costs versus EBIT (€/tonne, EU) – Simple averages



Note: For electricity costs, the number of observations were 3 in 2008, 5 in 2010, 6 in 2012-2014, 4 in 2015 and 7 in 2016 and 2017. For EBIT/tonne, there were 3 observations in 2008 to 2014, 2 observations in 2015 and 4 observations in 2016 and 2017. 2015 is thus excluded.
Source: Authors' elaboration

The electricity costs and EBIT are weighted against production output. Table 209 shows that the weighted averages for electricity costs are generally lower than the simple averages. For EBIT, weighted averages are also higher than simple averages except from 2008.

Table 209 BOF - Electricity costs vs. EBIT (€/tonne) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity costs simple average (€/tonne)	17.7	n.a.	20.9	n.a.	22.0	20.6	18.9	19.6	15.2	16.4
Electricity costs weighted average (€/tonne)	16.6	n.a.	19.5	n.a.	21.7	20.7	18.6	19.8	14.5	16.1
EBIT simple average (€/tonne)	62.6	n.a.	8.5	n.a.	-24.9	-13.4	0.0	Conf.	11.2	14.1
EBIT weighted average (€/tonne)	53.7	n.a.	8.7	n.a.	-20.5	-10.1	3.4	Conf.	14.9	14.6

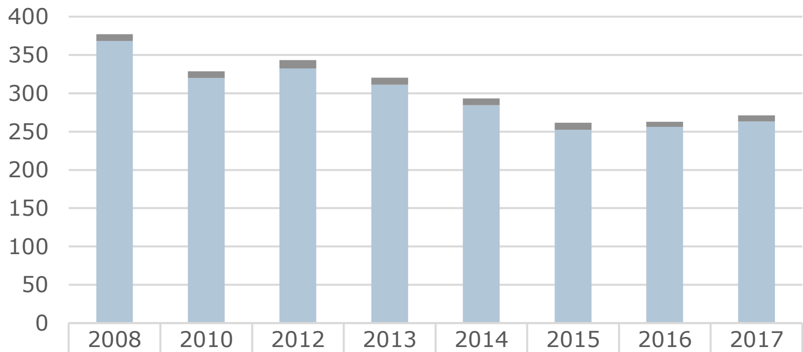
Note: Weighting factor: production output. For electricity costs, there were 3 observations in 2015, 5 observations in 2010, 6 observations in 2012-2014, 4 observations in 2015 and 7 observations in 2016 and 2017. For EBIT/tonne, there were 3 observations in 2008 to 2014, 2 observations in 2015 and 4 observations in 2016 and 2017.
Source: Authors' elaboration

Natural gas

EAF

In Figure 163, we see that costs for natural gas make up around 3% of total production costs. This increased slightly from 2.4% in 2008 to 2.8% in 2017. From 2008 to 2017, both the natural gas costs and average of other production costs decreased, by 15% and 29% respectively.

Figure 163 EAF - Natural gas costs as a share of production costs (€/tonne, EU) – Simple averages



	2008	2010	2012	2013	2014	2015	2016	2017
Average of Natural gas cost €/tonne	8.9	8.7	10.8	9.3	8.8	9.3	6.6	7.6
Average of other Production costs €/tonne	368.4	320.1	332.4	311.1	284.3	252.5	256.1	263.3

Note: For natural gas costs, there were 6 observations in 2008, 12 in 2010-2014, 10 observations in 2015 and 14 observations in 2016 and 2017. For other production costs per

tonne, there were 10 observations in 2008 to 2015 and 8 observations in 2016 and 2017.
Source: Authors' elaboration

The natural gas costs and production costs are weighted against production output. Table 210 shows that weighted averages for natural gas costs are lower than the simple averages, except in 2013. For production costs the weighted average is higher than the simple averages, in all cases.

Table 210 EAF - Natural gas costs vs. production costs (€/tonne) – Simple and weighted averages

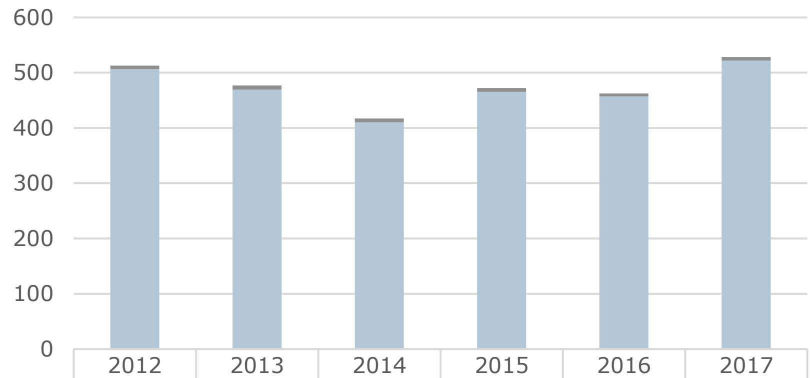
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas costs simple average (€/tonne)	8.9	n.a.	8.7	n.a.	10.8	9.3	8.8	9.3	6.6	7.6
Natural gas costs weighted average (€/tonne)	7.8	n.a.	7.7	n.a.	10.6	9.6	8.3	7.7	5.8	6.2
Production costs simple average (€/tonne)	377.3	n.a.	328.8	n.a.	343.2	320.4	293.1	261.8	262.7	271.0
Production costs weighted average (€/tonne)	381.3	n.a.	318.4	n.a.	341.0	313.1	293.1	263.2	257.0	296.8
Natural gas costs as a share of production costs simple averages (%)	2.4%	n.a.	2.6%	n.a.	3.2%	2.9%	3.0%	3.6%	2.5%	2.8%
Natural gas costs as a share of production costs weighted averages (%)	2.0%	n.a.	2.4%	n.a.	3.1%	3.1%	2.8%	2.9%	2.2%	2.1%

Note: Weighting factor: production output. For natural gas costs, there were 6 observations in 2008, 12 in 2010-2014, 10 observations in 2015 and 14 observations in 2016 and 2017. For other production costs per tonne, there were 10 observations in 2008 to 2015 and 8 observations in 2016 and 2017.
Source: Authors' elaboration

BOF

From Figure 164, we see that costs for natural gas make up around 1.1% to 1.7% of total production costs. From 2012 to 2017, the natural gas costs remained at between €5.1 and €7.5/tonne, while the average of other production costs increased 3% during the same period, from €506.2/tonne to €522.3/tonne. Observations in 2008 and 2010 were not sufficient and therefore for confidentiality reasons these are not shown.

Figure 164 BOF - Natural gas costs as a share of production costs (€/tonne, EU) – Simple averages



	2012	2013	2014	2015	2016	2017
Average of Natural gas cost €/tonne	6.4	7.5	7.0	6.7	5.1	6.4
Average of other Production costs €/tonne	506.2	469.2	410.3	465.3	457.4	522.3

Note: For natural gas costs, there were 2 observations in 2008, 4 observations in 2010, 5 observations in 2012-2014, 3 observations in 2015 and 5 observations in 2016 and 2017. For other production costs, there were 2 observations in 2008 to 2010, 4 observations in 2013-2014, 3 observations in 2015 and 5 observations in 2016 and 2017. Values for 2008 and 2010 are therefore not shown.
Source: Authors' elaboration

The natural gas costs and production costs are weighted against production output. Table 211 shows that weighted averages for natural gas costs are lower than the simple averages, except in 2015. For production costs the weighted average is sometimes lower and sometimes higher than the simple average.

Table 211 BOF - Natural gas costs vs. production costs (€/tonne) – Simple and weighted averages

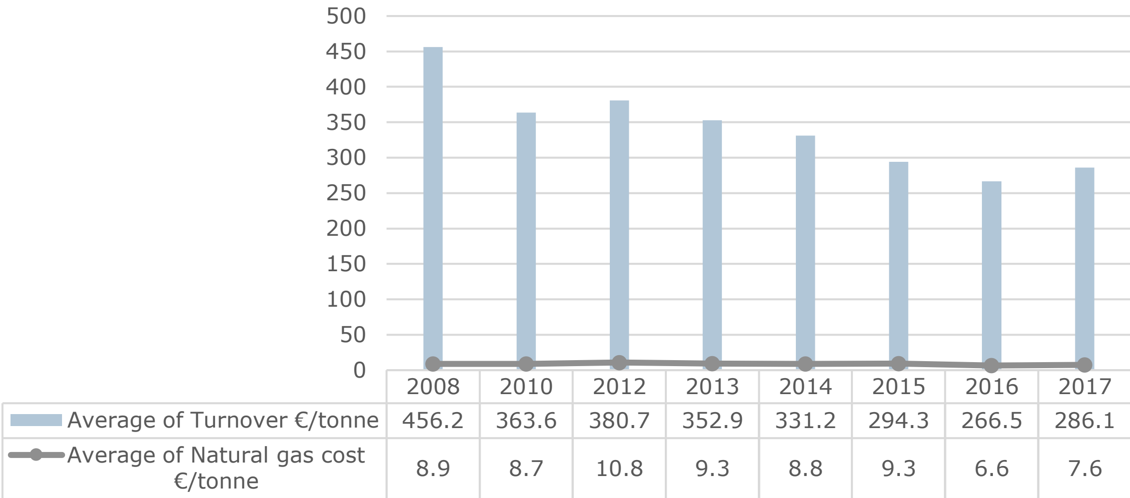
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas costs simple average (€/tonne)	Conf.	n.a.	8.8	n.a.	6.4	7.5	7.0	6.7	5.1	6.4
Natural gas costs weighted average (€/tonne)	Conf.	n.a.	7.1	n.a.	6.4	7.5	6.7	7.2	4.8	6.1
Production costs simple average (€/tonne)	Conf.	n.a.	Conf.	n.a.	512.6	476.7	417.3	472.0	462.5	528.7
Production costs weighted average (€/tonne)	Conf.	n.a.	Conf.	n.a.	504.0	487.3	413.0	428.3	475.0	548.4
Natural gas costs as a share of production costs simple averages (%)	Conf.	n.a.	Conf.	n.a.	1.2%	1.6%	1.7%	1.4%	1.1%	1.2%
Natural gas costs as a share of production costs weighted averages (%)	Conf.	n.a.	Conf.	n.a.	1.3%	1.5%	1.6%	1.7%	1.0%	1.1%

Note: Weighting factor: production output. For natural gas costs, there were 2 observations in 2008, 4 observations in 2010, 5 observations in 2012-2014, 3 observations in 2015 and 5 observations in 2016 and 2017. For other production costs, there were 2 observations in 2008 to 2010, 4 observations in 2013-2014, 3 observations in 2015 and 5 observations in 2016 and 2017. Values for 2008 and 2010 are therefore not shown.
Source: Authors' elaboration

EAF

The average turnover per unit of production decreased 37%, from €456.2/tonne in 2008 to €286.1/tonne in 2017. The natural gas costs per unit of production decreased 15% from €8.9/tonne in 2008 to €7.6/tonne in 2017. Natural gas costs are between 2.0% (2008) and 3.2% (2015) of the average sectoral turnover.

Figure 165 EAF - Natural gas costs versus turnover (€/tonne, EU) – Simple averages



Note: For natural gas costs, there were 6 observations in 2008, 12 in 2010-2014, 10 observations in 2015 and 14 observations in 2016 and 2017. For turnover per tonne, there were 10 observations in 2008 to 2015 and 7 observations in 2016 and 2017
Source: Authors' elaboration

The natural gas costs and turnover are weighted against production output. Table 212 shows that weighted averages for natural gas costs are lower than the simple averages, except in 2013. For turnover the weighted average is lower than the simple averages except for 2016 and 2017.

Table 212 EAF - Natural gas costs vs. turnover (€/tonne) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas costs simple average (€/tonne)	8.9	n.a.	8.7	n.a.	10.8	9.3	8.8	9.3	6.6	7.6
Natural gas costs weighted average (€/tonne)	7.8	n.a.	7.7	n.a.	10.6	9.6	8.3	7.7	5.8	6.2

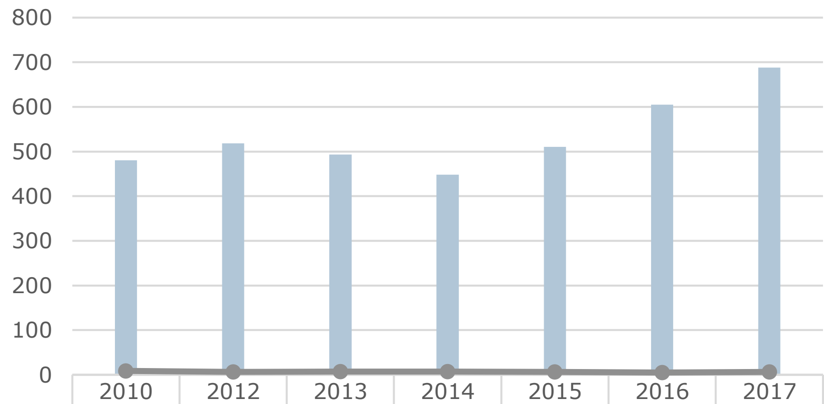
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Turnover simple average (€/tonne)	456.2	n.a.	363.6	n.a.	380.7	352.9	331.2	294.3	266.5	286.1
Turnover weighted average (€/tonne)	441.9	n.a.	332.1	n.a.	355.7	332.6	320.8	286.9	272.0	302.3
Natural gas costs as a share of turnover simple averages (%)	2.0%	n.a.	2.4%	n.a.	2.8%	2.6%	2.7%	3.2%	2.5%	2.7%
Natural gas costs as a share of turnover weighted averages (%)	1.8%	n.a.	2.3%	n.a.	3.0%	2.9%	2.6%	2.7%	2.1%	2.1%

Note: Weighting factor: production output. For natural gas costs, there were 6 observations in 2008, 12 in 2010-2014, 10 observations in 2015 and 14 observations in 2016 and 2017. For turnover per tonne, there were 10 observations in 2008 to 2015 and 7 observations in 2016 and 2017
Source: Authors' elaboration

BOF

The average turnover per unit of production increased 44% from 2010 to 2017 (see Figure 166). The natural gas costs per unit of production fluctuated between €5.1/tonne and €8.8/tonne during the same period. Natural gas costs made up between 1.8% (2010) and 0.9% (2017) of the average sectoral turnover.

Figure 166 BOF - Natural gas costs versus turnover (€/tonne, EU) – Simple averages



	2010	2012	2013	2014	2015	2016	2017
Average of Turnover €/tonne	480.2	518.7	493.2	448.0	510.7	604.7	688.0
Average of Natural gas cost €/tonne	8.8	6.4	7.5	7.0	6.7	5.1	6.4

Note: For natural gas costs, there were 2 observations in 2008, 4 observations in 2010, 5 observations in 2012-2014, 3 observations in 2015 and 5 observations in 2016 and 2017. For turnover, there were 3 observations in 2008 to 2010, 4 observations in 2012-2014, 3 observations in 2015 and 5 observations in 2016 and 2017. Values for 2008 are therefore not shown.
Source: Authors' elaboration

The natural gas costs and turnover are weighted against production output. Table 213 shows that weighted averages for natural gas costs are lower than the simple averages, except in 2015. For turnover the weighted average is lower than the simple averages, except in 2010 and 2013.

Table 213 BOF - Natural gas costs vs. turnover (€/tonne) – Simple and weighted averages

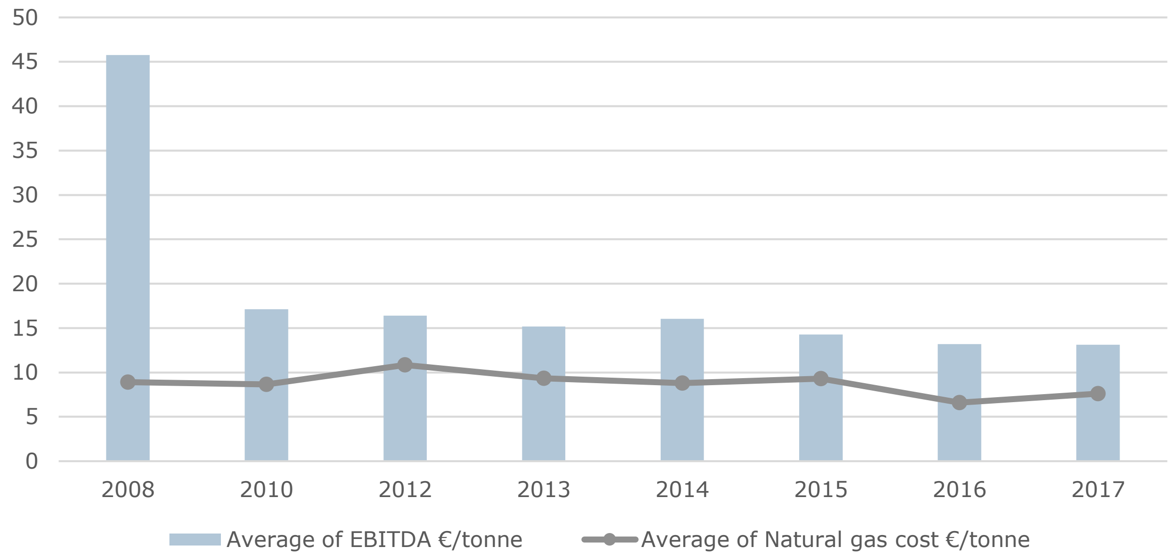
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas costs simple average (€/tonne)	Conf.	n.a.	8.8	n.a.	6.4	7.5	7.0	6.7	5.1	6.4
Natural gas costs weighted average (€/tonne)	Conf.	n.a.	7.1	n.a.	6.4	7.5	6.7	7.2	4.8	6.1
Turnover simple average (€/tonne)	478.3	n.a.	480.2	n.a.	518.7	493.2	448.0	510.7	604.7	688.0
Turnover weighted average (€/tonne)	449.5	n.a.	503.0	n.a.	511.9	506.5	443.8	465.0	587.0	671.3
Natural gas costs as a share of turnover simple averages (%)	Conf.	n.a.	1.8%	n.a.	1.2%	1.5%	1.6%	1.3%	0.8%	0.9%
Natural gas costs as a share of turnover weighted averages (%)	Conf.	n.a.	1.4%	n.a.	1.3%	1.5%	1.5%	1.6%	0.8%	0.9%

Note: Weighting factor: production output. For natural gas costs, there were 2 observations in 2008, 4 observations in 2010, 5 observations in 2012-2014, 3 observations in 2015 and 5 observations in 2016 and 2017. For turnover, there were 3 observations in 2008 to 2010, 4 observations in 2012-2014, 3 observations in 2015 and 5 observations in 2016 and 2017. Values for 2008 are therefore not shown.
Source: Authors' elaboration

EAF

EBITDA per tonne (simple averages) underwent a 63% decrease from 2008 to 2010 but then remained fairly stable at around €13 to €17/tonne.

Figure 167 EAF - Natural gas costs versus EBITDA (€/tonne, EU) – Simple averages



Note: For natural gas costs, there were 6 observations in 2008, 12 in 2010-2014, 10 observations in 2015 and 14 observations in 2016 and 2017. For EBITDA, there were 9 observations from 2008, 2010 and 2012-2015 and 7 for 2016 and 2017. Source: Authors' elaboration

The natural gas costs and EBITDA are weighted against production output. Table 214 shows that weighted averages for natural gas costs are lower than the simple averages, except in 2013. For EBITDA the weighted average is higher than the simple averages, except in 2013, 2014 and 2017.

Table 214 EAF - Natural gas costs vs. EBITDA (€/tonne) – Simple and weighted averages

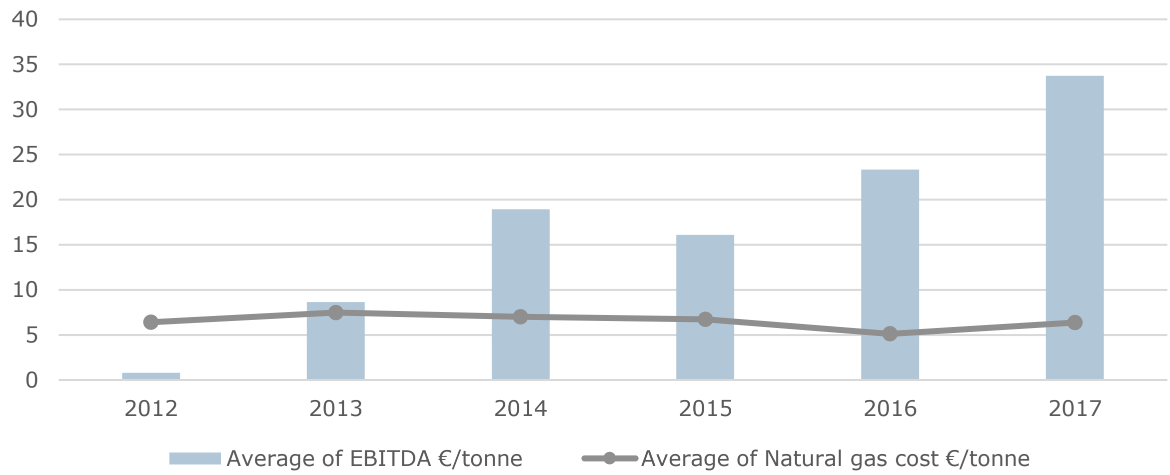
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas costs simple average (€/tonne)	8.9	n.a.	8.7	n.a.	10.8	9.3	8.8	9.3	6.6	7.6
Natural gas costs weighted average (€/tonne)	7.8	n.a.	7.7	n.a.	10.6	9.6	8.3	7.7	5.8	6.2
EBITDA simple average (€/tonne)	45.8	n.a.	17.1	n.a.	16.4	15.2	16.0	14.3	13.2	13.1
EBITDA weighted average (€/tonne)	61.1	n.a.	17.9	n.a.	18.0	13.4	15.8	14.8	19.8	11.2

Note: Weighting factor: production output. For natural gas costs, there were 6 observations in 2008, 12 in 2010-2014, 10 observations in 2015 and 14 observations in 2016 and 2017. For EBITDA, there were 9 observations from 2008, 2010 and 2012-2015 and 7 for 2016 and 2017.
Source: Authors' elaboration

BOF

EBITDA per tonne increased substantially from €0.8/tonne in 2012 to €33.74/tonne in 2017.

Figure 168 BOF - Natural gas costs versus EBITDA (€/tonne, EU) – Simple averages



Note: For natural gas costs, there were 2 observations in 2008, 4 observations in 2010, 5 observations in 2012-2014, 3 observations in 2015 and 5 observations in 2016 and 2017. For EBITDA, there were 2 observations for 2008 and 2010, 4 for 2012-2014, 3 for 2015 and 5 for 2016 and 2017. 2008 and 2010 are therefore not shown.
Source: Authors' elaboration

The natural gas costs and EBITDA are weighted against production output. Table 215 shows that weighted averages for natural gas costs are lower than the simple averages, except in 2015. For EBITDA the weighted average is higher than the simple averages, except in 2016.

Table 215 BOF - Natural gas costs vs. EBITDA (€/tonne) – Simple and weighted averages

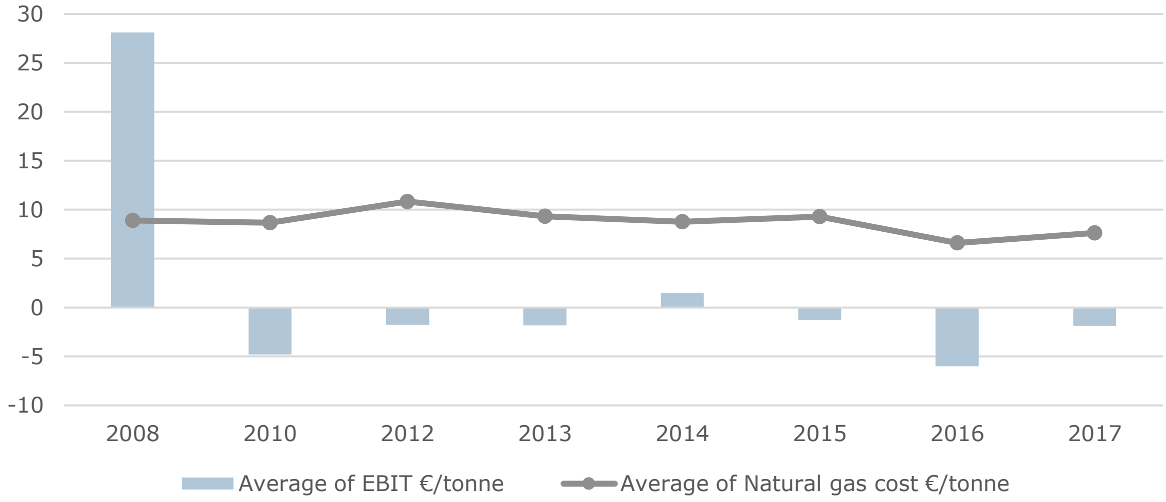
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas costs simple average (€/tonne)	Conf.	n.a.	8.8	n.a.	6.4	7.5	7.0	6.7	5.1	6.4
Natural gas costs weighted average (€/tonne)	Conf.	n.a.	7.1	n.a.	6.4	7.5	6.7	7.2	4.8	6.1
EBITDA simple average (€/tonne)	Conf.	n.a.	Conf.	n.a.	0.8	8.6	18.9	16.1	23.3	33.7
EBITDA weighted average (€/tonne)	Conf.	n.a.	Conf.	n.a.	1.8	8.9	19.5	18.8	22.2	34.3

Note: Weighting factor: production output. For natural gas costs, there were 2 observations in 2008, 4 observations in 2010, 5 observations in 2012-2014, 3 observations in 2015 and 5 observations in 2016 and 2017. For EBITDA, there were 2 observations for 2008 and 2010, 4 for 2012-2014, 3 for 2015 and 5 for 2016 and 2017.
Source: Authors' elaboration

EAF

Figure 169 shows that EBIT per unit of production (simple averages) decreased substantially from 2008 (€28.12/tonne) to 2010 (-€4.8/tonne). It is important to note, however, that 2008 seems to be an exceptional year (outlier), which might also to some extent have been triggered by the lower number of observations. It can also be seen that EBIT per unit of production from 2010 to 2017 fluctuates. In 2017, it was -€1.9/tonne.

Figure 169 EAF - Natural gas costs versus EBIT (€/tonne, EU) – Simple averages



Note: For natural gas costs, there were 6 observations in 2008, 12 in 2010-2014, 10 in 2015 and 14 in 2016 and 2017. For EBIT/tonne, there were 9 observations in 2008 to 2015 and 7 observations in 2016 and 2017.
Source: Authors' elaboration

The natural gas costs and EBIT are weighted against production output. Table 216 shows that weighted averages for natural gas costs are lower than the simple averages, except in 2012 and 2013. For EBIT the weighted average is higher than the simple averages, in all cases.

Table 216 EAF - Natural gas costs vs. EBIT (€/tonne) – Simple and weighted averages

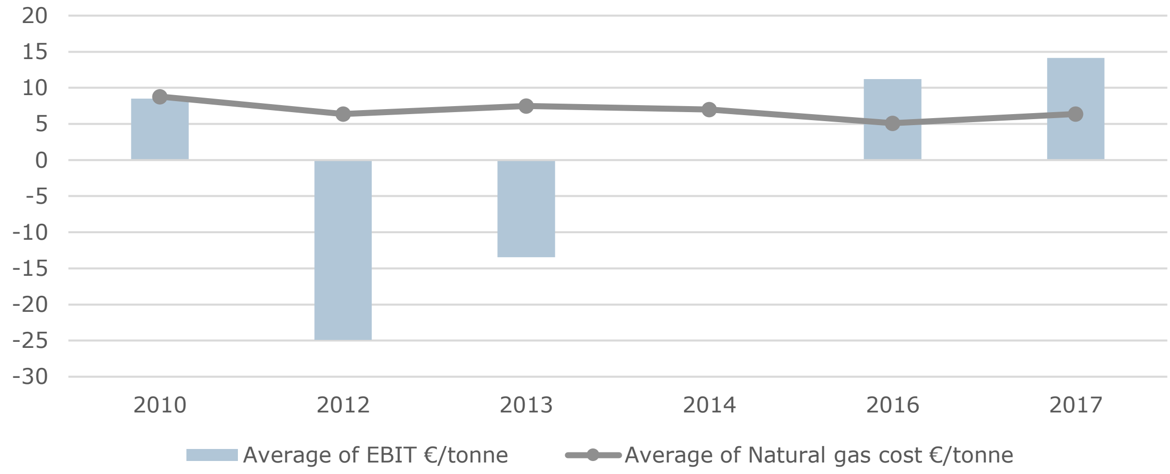
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas costs simple average (€/tonne)	8.9	n.a.	8.7	n.a.	10.8	9.3	8.8	9.3	6.6	7.6
Natural gas costs weighted average (€/tonne)	7.8	n.a.	7.7	n.a.	10.6	9.6	8.3	7.7	5.8	6.2
EBIT simple average (€/tonne)	28.1	n.a.	-4.8	n.a.	-1.8	-1.8	1.5	-1.3	-6.0	-1.9
EBIT weighted average (€/tonne)	46.5	n.a.	1.9	n.a.	2.9	-0.5	3.7	2.3	4.8	-1.4

Note: Weighting factor: production output. For natural gas costs, there were 6 observations in 2008, 12 in 2010-2014, 10 in 2015 and 14 in 2016 and 2017. For EBIT/tonne, there were 9 observations in 2008 to 2015 and 7 observations in 2016 and 2017.
Source: Authors' elaboration

BOF

Figure 170 shows a 28% decrease in average natural gas costs from 2010 to 2017. The EBIT, in contrast, shows a somewhat fluctuating trend. From 2012 to 2017, a clearly increasing trend in EBIT can be observed. EBIT continuously increased from -€24.9/tonne in 2012 to €14.1/tonne in 2017.

Figure 170 BOF - Natural gas costs versus EBIT (€/tonne, EU) – Simple averages



Note: For natural gas costs, there were 2 observations in 2008, 4 observations in 2010, 5 observations in 2012-2014, 3 observations in 2015 and 5 observations in 2016 and 2017. For EBIT/tonne, there were 3 observations in 2008 to 2014, 2 observations in 2015 and 4 observations in 2016 and 2017. Therefore, 2008 and 2015 are not shown.
Source: Authors' elaboration

The natural gas costs and EBIT are weighted against production output. Table 217 shows that weighted averages for natural gas costs are lower than the simple averages, except in 2015. For EBIT the weighted average is higher than the simple averages, in most cases.

Table 217 BOF - Natural gas costs vs. EBIT (€/tonne) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas costs simple average (€/tonne)	Conf.	n.a.	8.8	n.a.	6.4	7.5	7.0	6.7	5.1	6.4
Natural gas costs weighted average (€/tonne)	Conf.	n.a.	7.1	n.a.	6.4	7.5	6.7	7.2	4.8	6.1
EBIT simple average (€/tonne)	62.6	n.a.	8.5	n.a.	-24.9	-13.4	0.0	Conf.	11.2	14.1
EBIT weighted average (€/tonne)	53.7	n.a.	8.7	n.a.	-20.5	-10.1	3.4	Conf.	14.9	14.6

Note: Weighting factor: production output. For natural gas costs, there were 2 observations in 2008, 4 observations in 2010, 5 observations in 2012-2014, 3 observations in 2015 and 5 observations in 2016 and 2017. For EBIT/tonne, there were 3 observations in 2008 to 2014, 2 observations in 2015 and 4 observations in 2016 and 2017.
Source: Authors' elaboration

International competitiveness

This Section compares energy prices and costs borne by EU crude steel producers with those borne by crude steel producers based in third countries. Both EAF and BOF are distinguished. The Section relies on primary data for the EU (collected at the plant level and presented before) as well as international data acquired from the consultancy CRU[53]. The Research Team relies on such third-party data as none of the participating steel producers was able to provide primary international data on energy prices and costs from their facilities outside the EU. In terms of third countries, China, Russia and Turkey were selected as these are major countries exporting to the EU.

The following Section on 'Energy prices' presents average electricity and natural gas prices borne by steel producers in the EU compared with those in China, Russia and Turkey. The time period considered is 2010 to 2016. 2010 to 2015 data is reused data published in the 2016 EPC Study[54], while the 2016 data was acquired from CRU. As the international data from CRU is based on weighted averages, we also use weighted average values for the EU to allow for a meaningful and consistent comparison between EU and international data. The Section on 'International Competitiveness', in contrast, compares key performance indicators of EU steel producers with those of the international counterparts above. In line with the methodology used by CRU, this Section also presents weighted averages in the figures.

It is important to note that international data from CRU refers to rebar, hot-rolled coil and liquid steel plants only, while the EU level data may include steel plants producing steel products going beyond the three steel types above.

International energy prices

Figure 171 compares electricity prices borne by steel producers in the EU (EU EAF, NWE EAF and EU BOF) with those in China, Russia and Turkey for the years 2010, 2014, 2015 and 2016. In 2016, EU producers had medium level prices in comparison to their counterparts. EAFs in the EU observed a price of €51.5/MWh, EAFs in NWE a price of €47.4/MWh and BOFs in the EU a price of €49.3/MWh. At the same time, China observed relatively high electricity prices with €82.1/MWh in 2016. Also, Turkey observed quite high electricity prices, i.e. €73.8/MWh. Russia, in comparison, had by far the lowest electricity prices with €38.2/MWh in 2016.

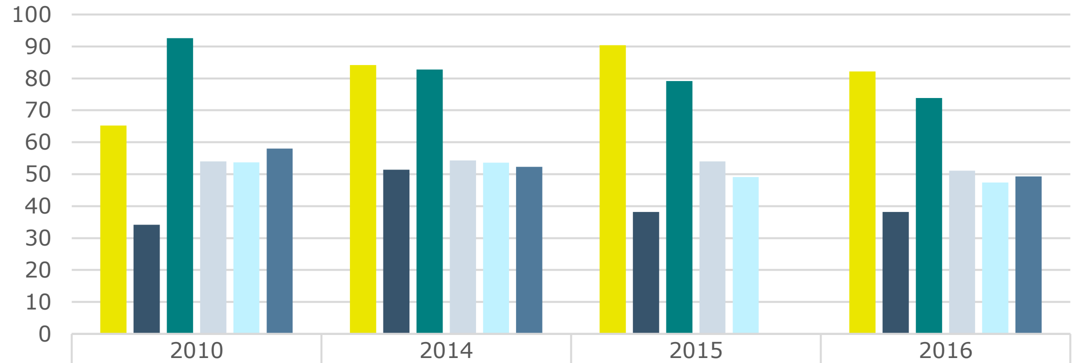
When comparing the electricity price development over time, it shows that prices in Turkey significantly decreased from 2010 to 2016 (-20%). EU prices also decreased from 2010 to 2016. 2016 prices are substantially lower than prices in 2014 and 2010; the decrease is, however, less strong than in Turkey. China, in contrast, seemed to experience much higher electricity prices in 2016 (€82.1/MWh) than in 2010 (€65.2/MWh), corresponding to an increase of 26%. From 2010 to 2016, prices in Russia remained fairly stable except for 2014, where there was a high peak.

Overall, EU prices for steel producers seem to be in a medium to low range in comparison to the assessed competing countries.

[53] CRU specialises in mining, metal and fertiliser commodities, delivering global business intelligence through analysis, prices, consulting and events: https://www.crugroup.com/

[54] Note that the data in the 2016 EPC Study were also acquired from CRU.

Figure 171 Electricity prices (€/MWh) – Weighted averages



	2010	2014	2015	2016
China	65.2	84.2	90.4	82.1
Russia	34.2	51.4	38.1	38.2
Turkey	92.6	82.8	79.2	73.8
EU EAF	54.0	54.3	54.0	51.1
NWE EAF	53.7	53.6	49.1	47.4
EU BOF	58.0	52.3	0.0	49.3

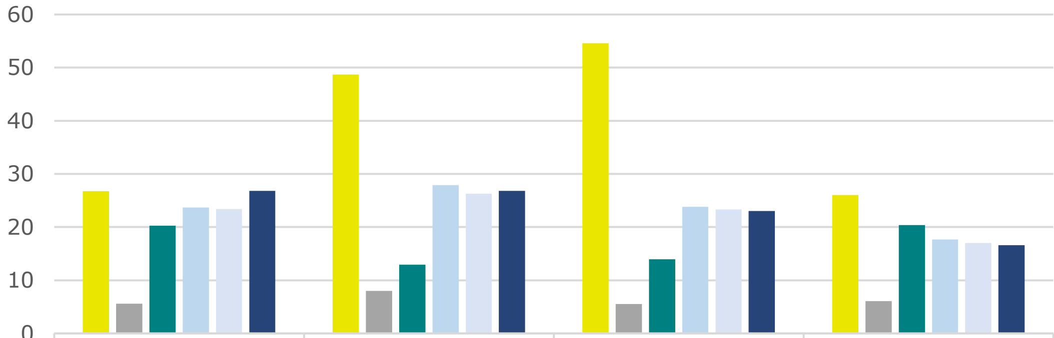
Note: weighting factor: purchased electricity; data for the EU relies on primary data collected at the plant level as part of this study (EU EAF with 18 observations in 2016, EU BOF with 7 observations in 2016); EU BOF data for 2015 cannot be shown due to confidentiality reasons; international data are retrieved from CRU; international data do not distinguish prices between EAF and BOF production technology.
Source: Authors' elaboration

Figure 172 compares natural gas prices borne by steel producers in the EU (EU EAF, NWE EAF and EU BOF) with those in China, Russia and Turkey for the years 2010, 2014, 2015 and 2016. In 2016, EU producers had medium level prices in comparison to their international counterparts. EAFs in the EU observed a price of €17.7/MWh, EAFs in NWE a price of €17.0/MWh and BOFs in the EU a price of €16.6/MWh. At the same time, China observed relatively high natural gas prices with €26/MWh in 2016. Also, Turkey observed higher natural gas prices than the EU with €20.4/MWh. Russia, in contrast, had by far the lowest natural gas prices with €6.1/MWh in 2016.

When comparing the natural gas price development over time, it shows that prices in Turkey first sharply decreased from 2010 to 2014 but since then steadily increased again to 2016, when the price, at €20.4/MWh was comparable to the price in 2010. EU prices, in comparison, increased from 2010 to 2014 but then steadily decreased till 2016. Natural gas prices in 2016 were substantially lower than those in 2010 for all; EU EAF, NWE EAF and EU BOF. China, in contrast, after having seen a steep increase from 2010 to 2015, seems to experience similar natural gas prices in 2016 (€26.0/MWh) as in 2010 (€26.8/MWh). From 2010 to 2016, prices in Russia remained fairly stable except for 2014, where there was a high peak.

Overall, EU prices for steel producers seem to be in a medium range in comparison to the assessed competing countries.

Figure 172 Natural gas prices (€/MWh) – Weighted averages



	2010	2014	2015	2016
China	26.8	48.7	54.6	26.0
Russia	5.6	8.0	5.5	6.1
Turkey	20.3	13.0	14.0	20.4
EU EAF	23.7	27.9	23.8	17.7
NWE EAF	23.4	26.3	23.3	17.0
EU BOF	26.8	26.8	23.0	16.6

Note: weighting factor: purchased natural gas; data for the EU relies on primary data collected at the plant level as part of this study (EU EAF with 17 observations in 2016, EU BOF with 4 observations in 2016); international data are retrieved from CRU; international data do not distinguish prices between EAF and BOF production technology.
Source: Authors' elaboration

International competitiveness

Figure 173 and Figure 174 compare electricity and natural gas costs as well as turnover and production costs borne by steel producers in the EU (EU EAF and EU BOF) with those in China, Russia and Turkey for 2016.

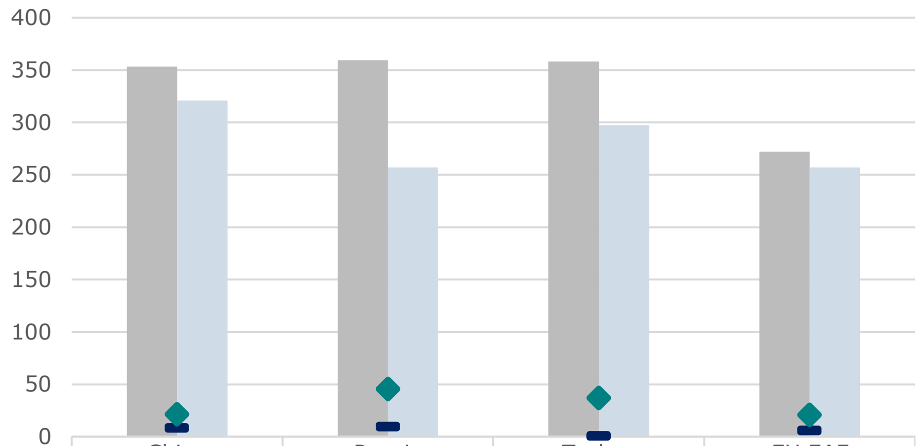
It is important to note that the international data purchased from CRU does not distinguish all economic key performance indicators between EAF and BOF technology, notably turnover and EBITDA. Consequently, in the following assessment only production costs, natural gas costs and electricity costs are distinguished for the international data of China, Russia and Turkey.

Figure 173 shows that on average, EU EAFs with €272.0/tonne seem to face lower turnover per tonne of output than their counterparts (note again that international data for turnover is not distinguished by EAF and BOF technology here, which might lead to some bias). Average of EAF and BOF plants in China (€353.3/tonne), Russia (€359.6/tonne) and Turkey (€358.2/tonne), in contrast, seem to have turnover of a very similar magnitude. When comparing the production costs between regions, it can be observed that EAF plants in the EU and Russia have the lowest production costs with €257.0 and €257.1/MWh respectively. EAFs in China and Turkey, in contrast, observe much higher production costs, i.e. €321.0 and €297.4/tonne respectively. These high production costs might be induced by the much higher electricity and natural gas prices in China and Turkey in comparison to the EU and Russia in 2016, which was shown above.

Figure 173 also shows that EAF plants in China and Russia seem to have the highest natural gas costs per tonne of output with €8.2 and €9.4/tonne respectively. While EAF plants in the EU face medium natural gas costs of €5.8/tonne, plants in Turkey have very low natural gas costs of €0.7/tonne. One reason for this could be that EAF plants in Turkey replace natural gas with other energy carriers. Electricity costs per tonne of output in the EU with €20.6/tonne are the lowest in comparison to their counterparts. It is lower by more than factor 2 than in

Russia, which has the highest electricity costs with €45.5/tonne. As Russian EAFs experience the lowest electricity prices (see Figure 171), the high electricity costs per tonne could be caused by a higher electricity intensity per tonne of output in Russia. Electricity costs for EAFs in China (€21.3/tonne) are at a similar level to those in the EU (€20.6/tonne). Overall, the EU seems to face the lowest natural gas and electricity costs per tonne of output in comparison to major competing countries.

Figure 173 EAF - Electricity and natural gas costs vs production costs and turnover (€/tonne, 2016) – Weighted averages



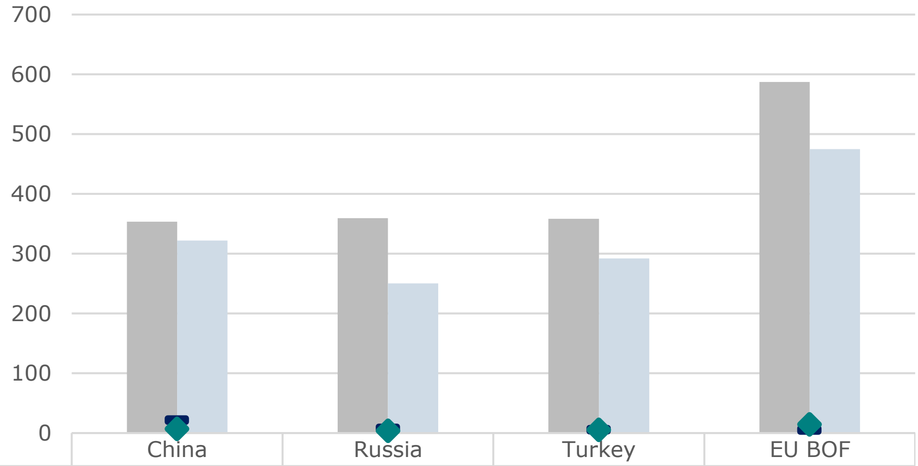
	China	Russia	Turkey	EU EAF
Turnover (€/tonne)	353.3	359.6	358.2	272.0
Production costs (€/tonne)	321.0	257.1	297.4	257.0
Natural gas costs (€/tonne)	8.2	9.4	0.7	5.8
Electricity costs (€/tonne)	21.3	45.5	36.8	20.6

Note: weighting factor: production output; data for the EU relies on primary data collected at the plant level as part of this study (7 observations for turnover, 8 observations for production costs, 15 observations for electricity costs, 14 observations for natural gas costs); international data is retrieved from CRU; international data do not distinguish turnover between EAF and BOF production technology.
Source: Authors' elaboration

Figure 173 shows that, on average, EU BOF plants with €587.0/tonne seem to face higher turnover per tonne of output than their counterparts (note again that international data for turnover cannot be distinguished by EAF and BOF technology). Average of EAF and BOF plants in China (€353.3/tonne), Russia (€359.6/tonne) and Turkey (€358.2/tonne) seem to have turnover of a very similar magnitude. When comparing the production costs between regions, it can be observed that BOF plants in Russia and Turkey have the lowest production costs with €250.6 and €292.3/MWh respectively. BOFs in China and the EU, in contrast, observe much higher production costs, i.e. €322.2 and €475.0/tonne respectively. The reason for the high discrepancy between the EU and their counterparts may likely be due to methodological differences in the way the international and the EU data are collected and calculated. It might also be caused by the low sample size of BOFs in the EU.

Figure 174 also shows that BOF plants in China have by far the highest natural gas costs per tonne of output with €21.0/tonne followed by Russia with €7.2/tonne. BOF plants in the EU face the lowest natural gas costs with €4.8/tonne, while plants in Turkey have similar natural gas costs of €5.0/tonne. Electricity costs per tonne of output in the EU with €14.5/tonne, in contrast, are the highest in comparison to the counterparts. It is higher by more than factor 3 than in Russia, which has the lowest electricity costs with €3.7/tonne. As Russia has the lowest electricity prices (see Figure 171), this seems reasonable. Electricity costs for BOFs in China (€6.5/tonne) are at a similar level to those in Turkey (€5.4/tonne). Overall, the EU seems to face the lowest natural gas costs but also the highest electricity costs per tonne of output in comparison to major competing countries. Again, note that there might be some bias due to the low sample size for BOFs in the EU.

Figure 174 BOF - Electricity and natural gas costs vs production costs and turnover (€/tonne, 2016) – Weighted averages

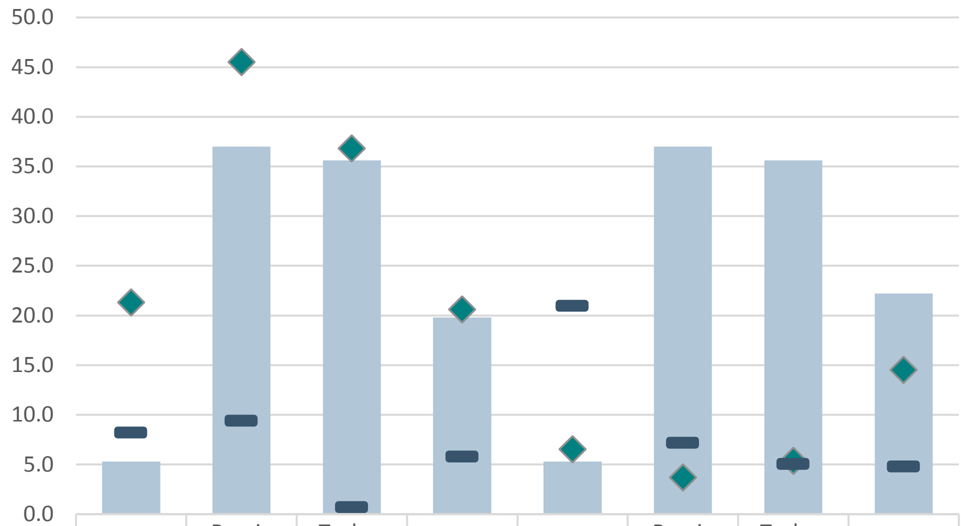


	China	Russia	Turkey	EU BOF
Turnover (€/tonne)	353.3	359.6	358.2	587.0
Production costs (€/tonne)	322.2	250.6	292.3	475.0
Natural gas costs (€/tonne)	21.0	7.2	5.0	4.8
Electricity costs (€/tonne)	6.5	3.7	5.4	14.5

Note: weighting factor: production output; data for the EU relies on primary data collected at the plant level as part of this study (5 observations for turnover, 5 observations for production costs, 7 observations for electricity costs, 5 observations for natural gas costs); international data are retrieved from CRU; international data do not distinguish turnover between EAF and BOF production technology.
Source: Authors' elaboration

Figure 175 compares electricity and natural gas costs and EBITDA (note that international data for EBITDA cannot be distinguished by EAF and BOF technology) borne by steel producers in the EU (both EAF and BOF) with those in China, Russia and Turkey for the year 2016 (both EAF and BOF). The comparison of EBITDA per tonne of output shows that steel plants in Russia face the highest EBITDA with €37.0/tonne in 2016, closely followed by Turkey with €35.6/tonne. EAF and BOF plants in the EU have EBITDA of €19.8 and €22.2/tonne respectively, which is thus lower than EBITDA in Russia and Turkey. Steel plants in China, in contrast, experienced the lowest EBITDA in 2016 with €5.3/tonne. China is also the only country where both natural gas costs and electricity costs are higher than EBITDA per tonne for both EAF and BOF. As described above, EAF plants in Russia face the highest electricity costs per tonne (€45.5/tonne), whereas BOF plants the experience the lowest electricity costs in 2016 (€3.68/tonne). EAF plants in the EU record the lowest electricity costs in 2016 (€20.6/tonne); BOF plants in the EU face the highest electricity costs (€14.5/tonne). When it comes to natural gas costs for the EAF plants, Turkey is the more competitive (€0.7/tonne); BOF plants in the EU are those with the lowest natural gas costs (€4.8/tonne).

Figure 175 EAF and BOF – Electricity and natural gas costs vs EBITDA (€/tonne, 2016) – Weighted averages (2016)



	China EAF	Russia EAF	Turkey EAF	EU EAF	China BOF	Russia BOF	Turkey BOF	EU BOF
EBITDA (€/tonne)	5.3	37.0	35.6	19.8	5.3	37.0	35.6	22.2
Electricity cost (€/tonne)	21.3	45.5	36.8	20.6	6.5	3.7	5.4	14.5
Natural gas cost (€/tonne)	8.2	9.4	0.7	5.8	21.0	7.2	5.0	4.8

Note: weighting factor: production output; data for the EU relies on primary data collected at the plant level as part of this study (5 observations for EBITDA, 7 observations for electricity costs, 5 observations for natural gas costs); international data are retrieved from CRU; international data do not distinguish EBITDA between EAF and BOF production technology.
Source: Authors' elaboration

8 Nitrogen fertilisers

Box 14 Highlights – Nitrogen fertilisers

In the nitrogen fertiliser sector, while electricity costs represented around 5–7% of total production costs (simple average) between 2008 and 2017, natural gas costs represented around 51–66% of total production costs (simple average).

Electricity

- Average **electricity prices** (simple average) at the EU level in 2017 were at a similar level as in 2008 (€69/MWh). Prices peaked in 2011 at €92/MWh and then continuously decreased again. In every year, the electricity energy component accounted for the largest share in the electricity price (€48/MWh in 2017), followed by the electricity network and capacity component (€12/MWh in 2017) (except in 2011). The energy component accounted for around 74% of the total price in 2008 (€50/MWh), while it accounted for 69% of the total price in 2017 (€48/MWh in 2017). Large consumers seem to be able to negotiate more favourable deals on the energy component, but do not pay less for the network component and other regulatory components such as RES levies and other non-recoverable taxes/levies.
- The average **electricity costs in €/MWh** (simple average) at the EU level 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/MWh. The difference between electricity price and electricity costs in €/MWh is caused by plants that received some form of reimbursement (mainly tax reimbursements) and/or used self-generated electricity on site. It is worth noting that in 2011 a plant that payed very high other non-recoverable taxes/levies received a significant reimbursement, which lead to a very high difference between electricity price and electricity costs. 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, the average **electricity costs in €/tonne** (simple average) at EU level decreased, ranging between €11 and €13/tonne. In 2017, the electricity costs per tonne were at their lowest level of €11/tonne.
- The average **electricity intensity** (simple average) at the EU level 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.

Gas

- In the EU, the average **natural gas prices** (simple average) show a volatile trend throughout the 2008 to 2017 period, with the lowest average in 2009 and the highest in 2013. Prices followed the international natural gas price developments. In 2017, the price was €21/MWh, while it was €27/MWh in 2008. The average of the natural gas energy component made up the largest share of the natural gas price in every year from 2008 to 2017 (€19/MWh in 2017), followed by the average of the natural gas network component (€2/MWh in 2017) and negligible other non-recoverable taxes/levies. The energy component accounted for around 96% of the total price in 2008 with €26/MWh, while it accounted for 89% of the total price in 2017 (€19/MWh in 2017). Larger consumers seem to be able to negotiate more favourable deals on the energy component, while at the same time also paying less for the network component and other regulatory components.
- The average **natural gas costs in €/tonne** (simple average) at the EU level followed a similar trend to the natural gas prices. The costs increased from 2009 to 2013 and decreased from 2013 to 2017. In 2017, they were at around €99/tonne, while in 2008 costs were around €133/tonne.

- The average **natural gas intensity** (simple average) at the EU level 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.

Competitiveness

- **Electricity costs** per tonne made up around 5–7% of the **total production costs** per tonne (simple average). They increased from 5.5% in 2008 to 7.1% in 2017. While the average **electricity costs** (simple average) decreased by 11% from €12/tonne in 2008 to around €11/tonne in 2017, the average of **other production costs** (simple average) decreased by 32% from €205/tonne in 2008 to €139/tonne in 2017.
- **Natural gas costs** accounted for 51% to around 66% of **total production costs** (simple average). They increased slightly from 61.2% in 2008 to 66.2% in 2017. Between 2008 and 2017, natural gas costs in €/tonne underwent a contraction of around 25%, while production costs per tonne decreased by around 31%.
- The share of electricity costs in relation to **turnover** (simple average) went up from about 4% in 2008 to 6% in 2017. Natural gas costs ranged between 41% and 54% of the average sectoral turnover. The average turnover per unit of production decreased by 33% during the period 2008 to 2017.
- **EBITDA** per tonne (simple average) underwent a volatile trend from 2008 to 2017. Comparing 2008 and 2017, EBITDA per tonne decreased by almost 50% from €49/tonne in 2008 to €25/tonne (simple average) in 2017. **EBIT** per unit of production (simple average) also decreased from 2008 (€36/tonne) to 2010 (€14/tonne). In all years, EBIT was positive. 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 (more details on the point are provided in Annex B to this Study).

Sample and limitations

- The **sample** includes eight plants across the EU, representing about **19% of total ammonia capacity** in the EU. About 50% of the sample is composed of plants based in the CEE region, while 38% of the sample is composed of plants in SE. Only 13% of the sample is based in NWE. Therefore, the CEE and SE regions are over-represented in the sample, while the NWE region is under-represented.
- The sample includes only plants operating in the entire period under observation; therefore, results may **overestimate profitability indicators and underestimate production costs and energy costs**, if one considers that between 2008 and 2017 a number of relatively less efficient plants and companies left the market.
- For some indicators, the number of available observations varies across years; therefore, the trend may be affected by **changes in the sample size**. More details about the number of observations are provided underneath each figure and table.

No regional averages can be shown for confidentiality reasons.

8.1 Composition of the sample

Sampling strategy

The sampling strategy for the fertiliser sector considers the following sampling criteria:

- Production technology
- Geographical distribution
- Company ownership/size.

For subsectors (i.e. production technology), the sample focuses only on the major production technology used in fertiliser production, i.e. nitrogen fertilisers from ammonia. This fertiliser type makes up 68% of EU fertiliser consumption. Other fertiliser types, such as phosphate and potash fertilisers, have much smaller shares in total EU fertiliser consumption of 17% and 15% (Fertilizers Europe, 2015)[55]. A further reason for focusing on the production of ammonia-based nitrogen fertilisers is that the process is much more energy intensive than the process for the other two fertiliser types, especially in terms of natural gas consumption. In addition, the number of plant sites for phosphate and potash fertiliser production in the EU is fairly low, potentially leading to confidentiality issues if not all plant sites participated.

For the geographical distribution, we aim for a sample of typical production sites taking into account the fertiliser sector's geographical distribution in terms of capacity over the three selected regions (Southern, Central-Eastern and North-Western Europe). Capacity data is obtained from Fertilizers Europe.

When it comes to company ownership/size, the manufacturing of fertilisers and nitrogen compounds (NACE rev.2 20.15) is fairly concentrated and dominated by large companies. In fact, more than 71% of turnover is generated by companies with more than 250 employees. In this context, the company size does not appear to be *ex ante* a relevant sampling criterion. With regards to ownership, we tried to ensure the coverage of both global as well as regional players.

The Research Team approached European fertiliser companies through the fertiliser sector's official representative body at the EU level: Fertilizers Europe.

Against this background and keeping in mind international best practices for collecting data on regulatory costs, the Research Team aimed to have a minimum number of 15 nitrogen fertiliser plant sites in the sample, five for each geographical region (Table 218).

Table 218 Minimum number of plants to be surveyed

Geographical regions	Fertiliser (nitrogen fertilisers from ammonia)
Southern Europe	5
Central Eastern Europe	5
North-Western Europe	5
Total	**15**

Source: Authors' elaboration

Box 15 Key features of the nitrogen fertiliser sector

The European nitrogen fertiliser industry is an energy and greenhouse gas intensive industry. Production of the industry's key building block, ammonia, requires by far the largest share of energy in the whole production process. The most common fuel used in the process of ammonia production is natural gas.

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.

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 USA.

[55]http://www.Fertilisers Europe.com/fileadmin/user_upload/publications/all_publications/Annual_Overview_2015_HD.pdf

A 'typical plant':

- As ammonia is by far the most energy intensive production step when producing nitrogen fertiliser and as most statistical data is readily available for ammonia, we here describe features of a typical ammonia plant.
- The average ammonia plant has a capacity of 400 kt/a. The largest ammonia plant has an annual capacity of 750 kt/a, whereas the smallest has an annual capacity of only 54 kt/a.
- The first step in the process is the production of ammonia (NH_3) via the Haber-Bosch process. As a second step in the process, part of the ammonia is transformed into nitric acid, which is then mixed with the rest of the ammonia to produce ammonium nitrate (AN). The ammonia may also be mixed with liquid carbon dioxide to produce urea. Both urea and AN can be mixed with water to form urea ammonium nitrate solution (UAN).
- Based on the refineries in the sample, the average natural gas intensity is 10.8 MWh/tonne and the average electricity intensity is 0.18 MWh/tonne.

Snapshot in figures:

- There are 47 ammonia plants in the EU, with a total production capacity of 18,822 kt/a.
- The largest share of ammonia capacity is within three countries: Germany (16%), Poland (15%) and the Netherlands (15%).
- In 2016 alone, the EU exported more than 2 million tonnes of fertilisers and nitrogen compounds to Brazil, followed by 0.8 million tonnes to Turkey and 0.7 million tonnes to the USA.
- Imported fertilisers and nitrogen compounds from Russia have been steadily increasing since 2012, reaching more than 7 million tonnes in 2016.

Sample statistics

The Research Team together with Fertilizers Europe asked Fertilizers Europe member companies to participate in the Study and respond to the questionnaire via email and phone. To improve the participation rate, some companies beyond the members of Fertilizers Europe were also approached. Overall, around 38 from a total of 47 nitrogen fertiliser plant sites in Europe were contacted. In the end, eight out of these 47, i.e. 17%, responded to the questionnaire (see Table 219); one plant shared electricity and gas bills for validation purposes.

Table 219 Plants participating in the survey

Geographical regions	Plants contacted	Questionnaires collected	Number of plants sharing supporting evidence
CEE	17	4	1
NWE	18	1	0
SE	3	3	0
Total	**38**	**8**	**1**

Source: Authors' elaboration

The coverage of the EU population shows the share of the capacity of surveyed plants in total EU capacity (i.e. the total production capacity of the sample divided by the total EU production capacity) in each year.

According to the data shared by Fertilizers Europe, the total ammonia capacity used for the production of nitrogen fertilisers in the EU is around 18,822 kt/year. As the respondents accounted for more than 3,500 kt/year in 2016 and 2017, we covered around 19.0% from 2008 to 2015, 16.6% in 2016 and 12.9% in 2017 of total EU capacity (see Table 220).

Table 220 Capacity of sampled plants out of total capacity in the EU (%)

Sector	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Nitrogen fertiliser	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	16.6	12.9

Source: Authors' elaboration based on data obtained from Fertilizers Europe.

About 50% of the sample is composed of plants based in the CEE region, while 38% of the sample is composed of plants in SE. Only 13% of the sample is based in NWE. As a consequence, the CEE and SE regions are over-represented in the sample, while the NWE region is under-represented.

As for mitigation measures, we did the following to increase the response rate:

- We asked for additional support from the EU association (Fertilizers Europe), who helped convince companies to participate.
- We sent out reminders via email to all companies for which we had contact details.
- We called companies whenever we had a phone number.
- We tried to contact companies other than Fertilizers Europe members.

8.2 Electricity

Table 221 summarises the electricity data from sampled plants, including electricity prices and electricity costs in €/MWh, electricity costs in €/tonne and electricity intensity in MWh/tonne. The table shows that electricity prices and costs per MWh increased over the first years analysed but decreased from 2012, returning to the same level as in the first years. Electricity intensity saw only minor fluctuations; it was the same in 2017 as in 2008.

Table 221 Electricity: summary table (EU) - Simple averages

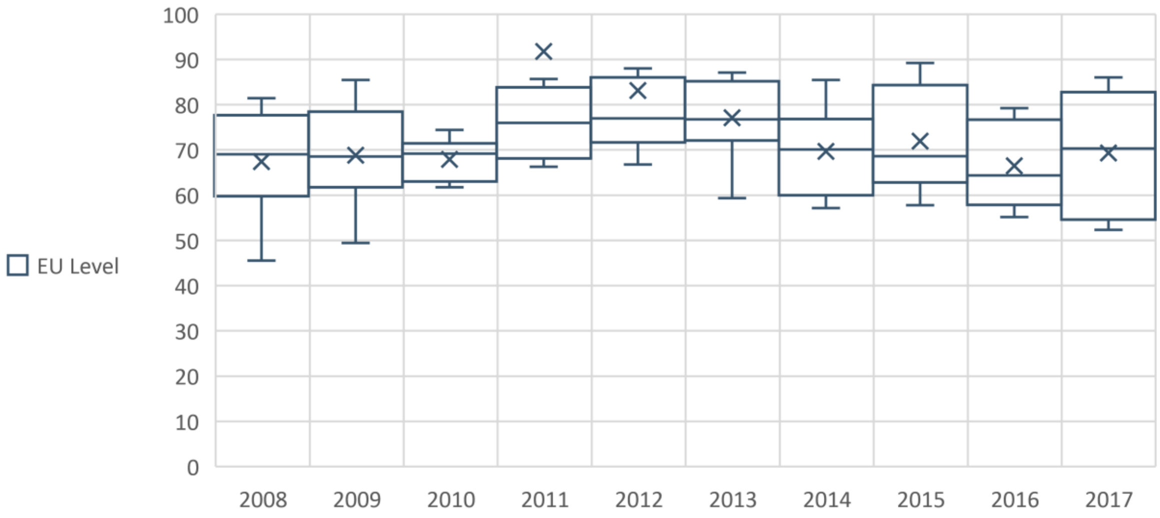
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity prices (€/MWh)	67.4	68.9	67.9	91.7	83.1	77.1	69.7	72.0	66.5	69.3
Electricity costs (€/MWh)	64.0	67.9	66.3	73.4	70.0	75.0	65.2	64.7	60.3	65.2
Electricity costs (€/tonne)	12.0	12.1	11.1	12.3	11.8	13.4	11.3	11.0	11.4	10.7
Electricity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

At the EU level the number of observations were 8 in 2008-2015, 7 in 2016 and 6 in 2017.
Source: Authors' elaboration

Electricity prices

Figure 176 shows that average electricity prices at the EU level in 2017 were at a similar level as in 2008 with €69.3/MWh. Prices peaked in 2011 at €91.7/MWh. Not enough observations were received to be able to calculate the average electricity prices at the NWE, SE and CEE levels. There are statistical outliers in 2011 and 2012 that are still representative for plants operating in the sector, which cause the average value to lie outside the upper quartile in 2011. These are hidden in the figure to allow for easier visualisation. The outlier in 2011 corresponds to a plant that paid a high electricity price while receiving a much higher reimbursement in comparison to other years. The one in 2012 corresponds to a plant that purchased less electricity in this respective year as it produced more electricity on site, resulting in a higher price per MWh for purchased electricity.

Figure 176 Electricity prices (€/MWh) – Box plots and simple averages



Note: At the EU level the number of observations were 8 in 2008-2015, 7 in 2016 and 6 in 2017. Data for the NWE, SE and CEE regions are not displayed due to confidentiality reasons.
Source: Authors' elaboration

The electricity prices at EU level are weighted against purchased electricity in MWh. Table 222 shows that the EU weighted averages are lower than the simple averages, except in 2011 and 2013. This probably indicates that large plants are able to negotiate more favourable contracts in this sector.

Table 222 Electricity prices (€/MWh) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EU simple average	67.4	68.9	67.9	91.7	83.1	77.1	69.7	72.0	66.5	69.3
EU weighted average	65.2	66.4	67.9	106.1	77.7	78.0	69.5	67.9	62.5	62.2

Note: Weighting factor: purchased electricity. At the EU level the number of observations were 8 in 2008-2015, 7 in 2016 and 6 in 2017.
Source: Authors' elaboration

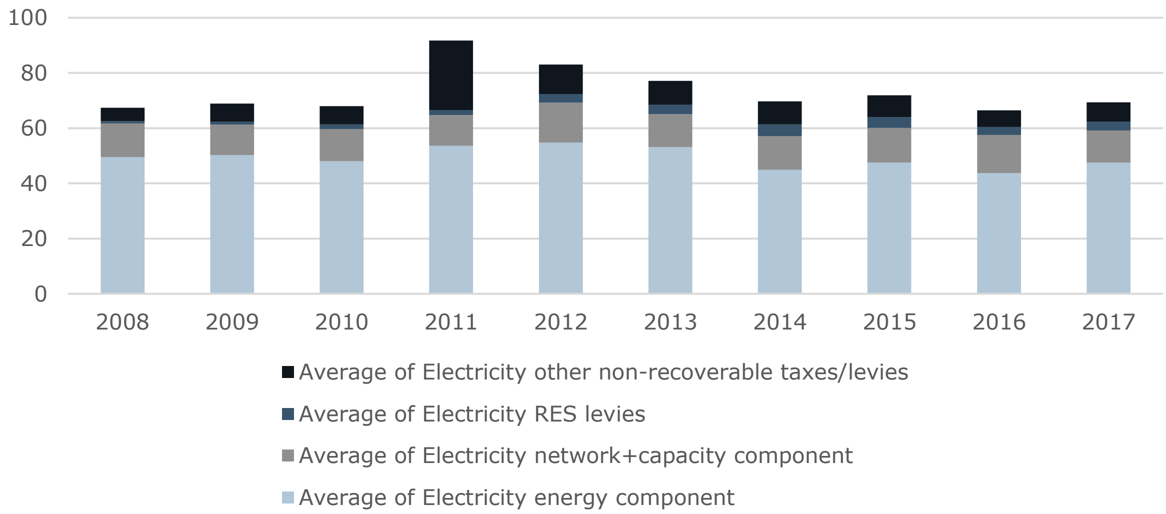
<u>Components of the electricity price[56]</u>

Figure 177 shows the average of the various electricity components at the EU level. In every year, the electricity energy component represented the largest share, followed by the electricity network and capacity component (except in 2011). The energy component accounted for around 74% of the total price in 2008 while it accounted for 69% of the total price in 2017 (€47.5/MWh in 2017). Throughout the 2008 to 2012 period the average of the electricity energy component underwent a slight upward trend, then decreased from 2012 to 2017. The average of the electricity network and capacity component shows a fairly stable trend (€11.6/MWh in 2017). The average of electricity other non-recoverable taxes/levies shows an upward trend until 2012 and a slight downward trend from 2012 to 2017 (€7.0/MWh in 2017). It is important to note that 2011 is dominated by the outlier already mentioned

[56] The sum of the electricity bill components does not necessarily add up to the total electricity price mentioned before, as there might be plants that did not provide a breakdown of the electricity bill components while still providing the total electricity price.

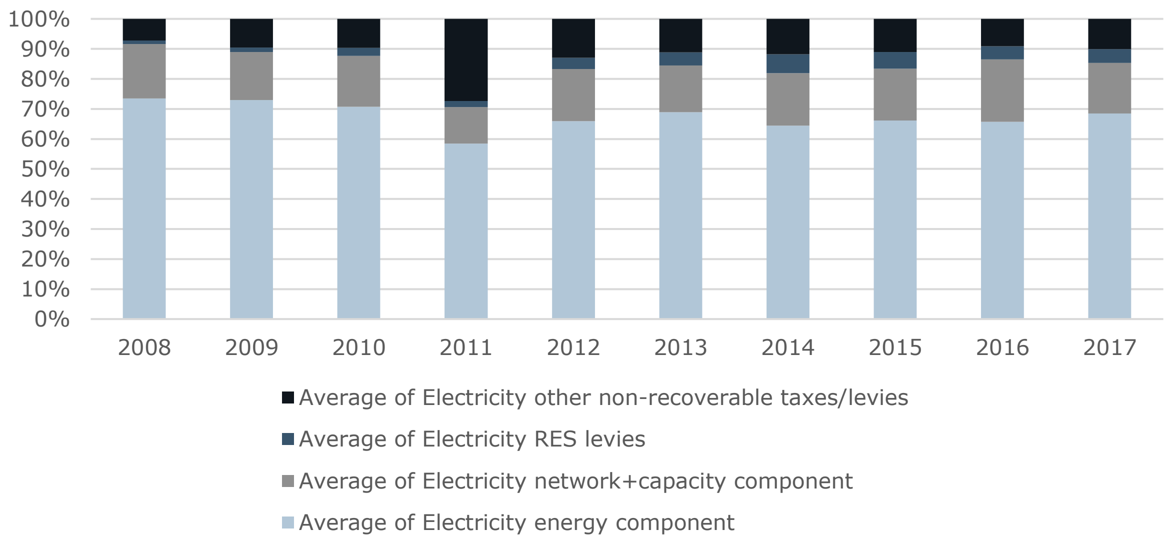
above; it corresponds to a plant that paid very high other non-recoverable taxes/levies in 2011 while receiving a significant reimbursement in this respective year 2011 in comparison to other years. The reimbursement is, however, not shown in Figure 177 and Figure 178. The average electricity RES levies show a substantial upward trend up to 2014 with a slight decrease from 2014 to 2017 (€3.2/MWh in 2017).

Figure 177 Components of the electricity price (€/MWh, EU) - Simple averages



Note: At the EU level the number of observations were 8 in 2008-2015, 7 in 2016 and 6 in 2017.
Source: Authors' elaboration

Figure 178 Components of the electricity price (%, EU) - Simple averages



Note: At the EU level the number of observations were 8 in 2008-2015, 7 in 2016 and 6 in 2017.
Source: Authors' elaboration

The components of the electricity price at EU level are weighted against the purchased electricity in MWh. Table 223 shows that for the energy component the weighted averages are always significantly lower than the simple averages, indicating the higher bargaining power of larger consumers. For the network and capacity components, in contrast, most of the weighted averages are higher than the simple averages. For the RES levies and other non-recoverable taxes/levies, the weighted averages are also higher in all cases. A reason could be that larger consumers are able to negotiate more favourable deals on the energy but are not able to influence the regulated components.

Table 223 Components of the electricity price (€/MWh, EU) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Energy component simple average	49.5	50.2	48.1	53.6	54.8	53.2	44.9	47.6	43.7	47.5
Energy component weighted average	45.0	44.7	45.5	49.4	51.8	50.3	42.0	41.5	38.1	39.0
Network + capacity component simple average	12.2	11.0	11.5	11.2	14.4	11.9	12.2	12.5	13.8	11.6
Network + capacity component weighted average	12.0	11.6	12.9	11.8	13.2	12.8	13.2	13.0	14.0	10.5
RES levies simple average	0.8	1.1	1.8	1.8	3.1	3.4	4.3	3.9	2.9	3.2
RES levies weighted average	1.1	1.7	2.4	2.7	3.5	4.8	5.2	4.5	3.0	4.1
Other non-recoverable taxes/levies simple average	4.8	6.5	6.5	25.1	10.7	8.6	8.2	8.0	6.1	7.0
Other non-recoverable taxes/levies weighted average	7.2	8.4	7.1	42.3	9.2	10.1	9.1	9.0	7.5	8.6

Note: Weighting factor: purchased electricity. At the EU level the number of observations were 8 in 2008-2015, 7 in 2016 and 6 in 2017.
Source: Authors' elaboration

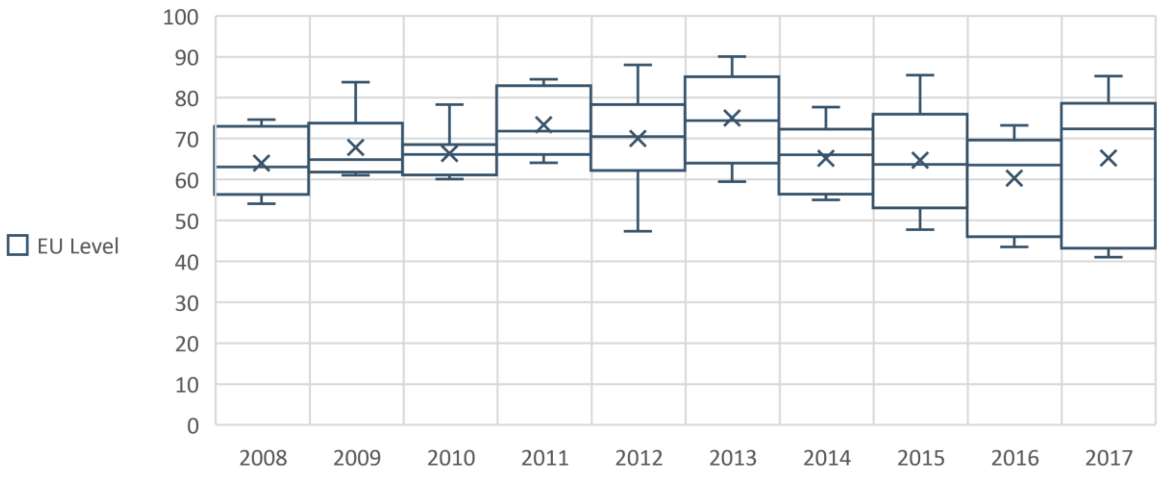
Electricity costs

Figure 179 shows that average electricity costs at the EU level 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 EU level were €65.2/MWh, with a minimum of €41.0/MWh and a maximum of €85.3/MWh.[57] Some of the minimum values include a plant that experienced high electricity prices and *ex post* reimbursements, plants that received reimbursements and plants that produced their own electricity. Note that in 2017, two plants received some form of reimbursement. The difference between electricity price and electricity costs in €/MWh is caused by plants that received some form of reimbursement (mainly tax reimbursements)

[57] Electricity prices in €/MWh are defined as follows: Total price paid to purchase electricity/Total electricity purchased. Electricity costs in €/MWh are defined 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).

and/or used self-generated electricity on site. It is worth noting that in 2011 a plant that paid very high other non-recoverable taxes/levies received a significant reimbursement, which lead to a very high difference between electricity price and electricity.

Figure 179 Electricity costs (€/MWh) – Box plots and simple averages



Note: At the EU level the number of observations were 8 in 2008-2015, 7 in 2016 and 6 in 2017. Data for NWE, SE and CEE are not displayed due to confidentiality reasons.
Source: Authors' elaboration

The electricity costs at EU level are weighted against electricity consumption. Table 224 shows that the EU weighted averages are lower than the simple averages, except for 2013. As stated above, the reason for this could be the higher bargaining power of larger consumers.

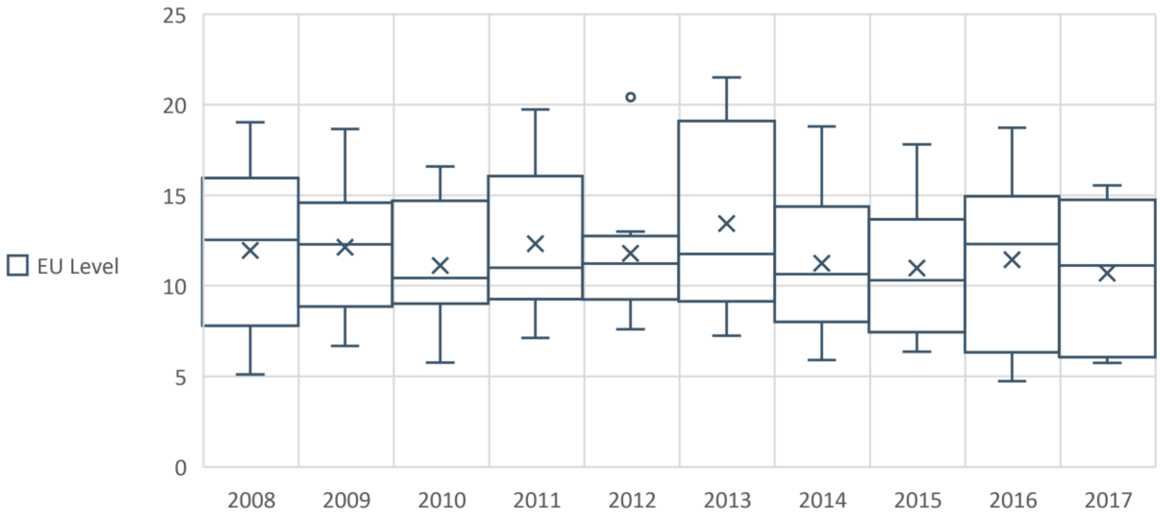
Table 224 Electricity costs (€/MWh) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EU simple average	64.0	67.9	66.3	73.4	70.0	75.0	65.2	64.7	60.3	65.2
EU weighted average	63.2	64.9	66.1	72.2	64.6	76.5	64.4	60.3	57.9	60.5

Note: Weighting factor: total electricity consumption. At the EU level the number of observations were 8 in 2008-2015, 7 in 2016 and 6 in 2017.
Source: Authors' elaboration

Figure 180 shows that the average electricity costs (€/tonne) at EU level decreased from 2008 to 2017, while ranging from €10.7 to €13.4/tonne. In 2017, the electricity costs were at their lowest value of €10.7/tonne. The observations showed high variations between minimum and maximum electricity costs, with the highest range in 2013, when the minimum was €7.2/tonne and the maximum was €21.5/tonne. The outlier in 2012 is the maximum value in all other years.

Figure 180 Electricity costs (€/tonne) – Box plots and simple averages



Note: At the EU level the number of observations were 8 in 2008-2015, 7 in 2016 and 6 in 2017. Data for the NWE, SE and CEE are not displayed due to confidentiality reasons.
Source: Authors' elaboration

The electricity costs (€/tonne) are weighted against production output. Table 225 shows that in all cases the EU weighted averages are higher than the simple averages. It may thus be concluded that economies of scale do not seem to have an impact on the electricity costs and that larger plants experience higher costs per tonne of production than smaller plants, even if they pay lower electricity prices; this could be due to higher electricity intensity for larger producers.

Table 225 Electricity costs (€/tonne) – Simple and weighted averages

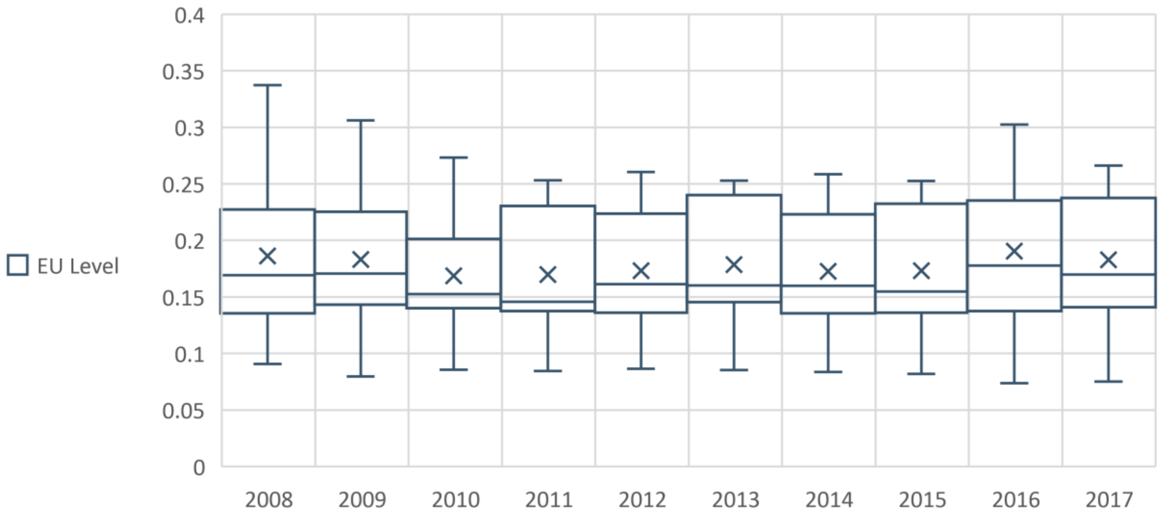
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EU simple average	12.0	12.1	11.1	12.3	11.8	13.4	11.3	11.0	11.4	10.7
EU weighted average	13.1	12.8	12.1	13.5	12.3	15.0	12.2	11.5	12.2	11.4

Note: Weighting factor: production output. At the EU level the number of observations were 8 in 2008-2015, 7 in 2016 and 6 in 2017.
Source: Authors' elaboration

Electricity intensity

Figure 181 shows that the average electricity intensity at the EU level ranged from 0.17 to 0.19 MWh/tonne, decreasing slightly from 2008 (0.19 MWh/tonne) to 2017 (0.18 MWh/tonne). Overall, efficiency thus increased slightly. Not enough observations were received to be able to calculate the average electricity intensity at the NWE, SE and CEE levels.

Figure 181 Electricity intensity (MWh/tonne) – Box plots and simple averages



Note: At the EU level the number of observations were 8 in 2008-2015, 7 in 2016 and 2017. Data for the NWE, SE and CEE region are not displayed due to confidentiality reasons.
Source: Authors' elaboration

The electricity intensity averages are weighted against product output. Table 226 shows that in all cases the EU weighted averages are higher than the simple averages. Larger plants (at least those in our sample) are thus more electricity intensive than smaller plants in the fertiliser sector.

Table 226 Electricity intensity (MWh/tonne) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EU simple average	0.19	0.18	0.17	0.17	0.17	0.18	0.17	0.17	0.19	0.18
EU weighted average	0.21	0.20	0.18	0.19	0.19	0.20	0.19	0.19	0.21	0.20

Note: Weighting factor: production output. At the EU level the number of observations were 8 in 2008-2015, 7 in 2016 and 2017.
Source: Authors' elaboration

Additional information

All eight plants provided data on the breakdown of their electricity contract type. Plants could select multiple types of contract, which means in theory that the number of contract types could be higher than the total number of eight. Here, however, this is not the case. Most plants had wholesale contracts (63%), followed by provider contracts (25%).

Table 227 Electricity contract type

EU	Electricity Contract Type Breakdown	
Contract type	Count	% of plants
PPA	1	13%
Wholesale	5	63%
Provider	2	25%

Source: Authors' elaboration

The duration of electricity contracts was provided by seven plants. They did not report any contracts with a duration of more than five years. Out of all the plants, 63% reported contracts of up to five years, and 25% reported contracts of indeterminate duration.

Table 228 Electricity contract length

EU	Electricity Contract Length Breakdown	
Contract type	Count	% of plants
Indeterminate duration	2	25%
Up to 5 years	5	63%
More than 5 years	0	0%

Source: Authors' elaboration

Out of the eight plants, two participated in a flexibility scheme for electricity. The average number of outages and the average duration (in minutes) of these outages are divided into three types, namely planned outages, other planned outages and unplanned outages. The unplanned outages were spread over the three geographical regions.

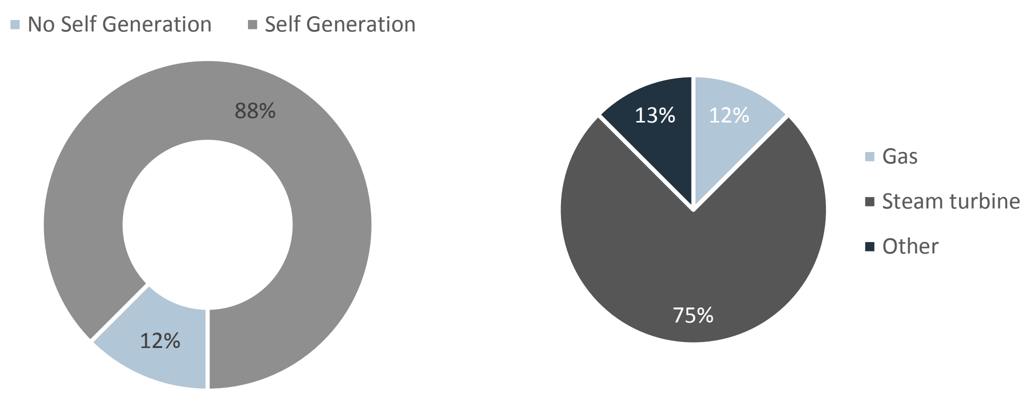
Table 229 Electricity outages

EU	Planned outages		Other planned outages		Unplanned outages	
Year	Total number	Average duration	Total number	Average duration	Total number	Average duration
2015	NR	NR	0	-	1	846
2016	NR	NR	0	-	1	NR
2017	NR	NR	1	415	1	45

Note: Planned outages are linked to flexibility schemes; other planned outages are not linked to flexibility schemes, but notified in advance by the energy supplier; unplanned outages are not notified.
Source: Authors' elaboration

Some 88% of interviewees used self-generated electricity. Most of this self-generated electricity came from steam turbines (75%), followed by other technologies (13%) and gas (12%). None of the plants that responded are selling electricity to the grid.

Figure 182 Self-generation and self-generation type



Source: Authors' elaboration

8.3 Natural gas

The following table summarises the natural gas data for sampled plants, including prices in €/MWh, costs in €/tonne and intensity in MWh/tonne. Like electricity prices, natural gas prices saw an increase over the first couple of years followed by a decrease from 2013 onwards, resulting in prices lower than the 2008 starting point. Natural gas intensity remained fairly stable throughout the range of years. The fluctuations (decrease, increase and then strong decrease) in the natural gas costs are stronger than the fluctuations in the natural gas prices.

Table 230 Natural gas: summary table (EU) - Simple averages

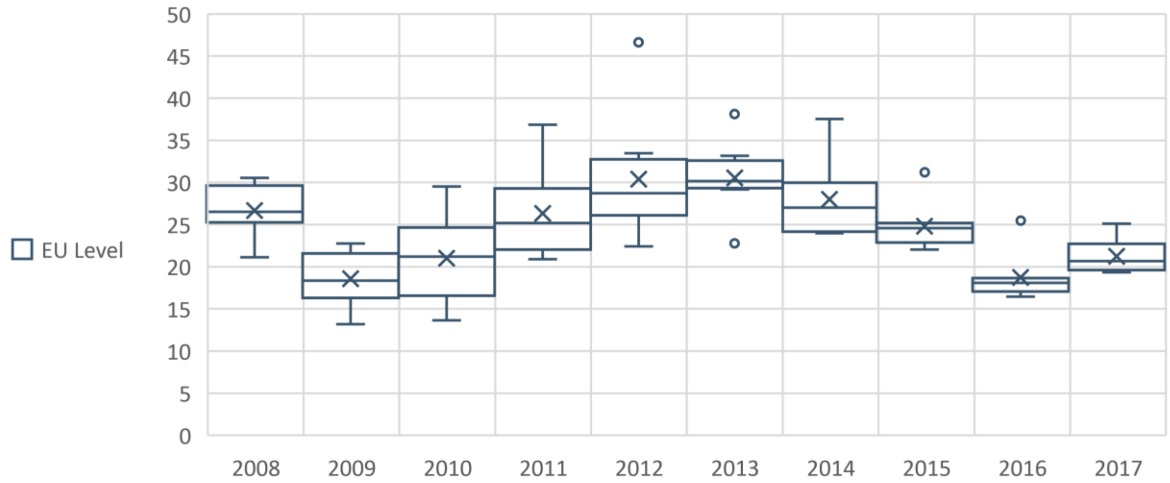
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas prices (€/MWh)	26.7	18.6	46.5	26.3	30.4	30.5	28.0	24.8	18.8	21.2
Natural gas costs (€/tonne)	132.9	84.7	90.1	124.5	144.5	146.6	134.2	119.2	89.8	99.2
Natural gas intensity (MWh/tonne)	5.1	4.8	4.6	5.0	5.0	4.9	5.0	4.9	5.0	5.0

Source: Authors' elaboration

Natural gas prices

In the EU, the average natural gas prices show a volatile trend throughout the 2008 to 2017 period, with the lowest average in 2009 and the highest in 2013 (Figure 183). Prices follow international natural gas price developments. In 2017, the price was €21.2/MWh, while it was €26.7/MWh in 2008. The minimum outlier in 2013 corresponds to the minimum values in all other years. The maximum outliers correspond to a plant that has relatively lower absolute natural gas consumption and natural gas intensity and thus experiences a higher natural gas price. The lower natural gas intensity could be caused by the fact that the plant site externally sources part of its highly natural gas intensive ammonia demand.

Figure 183 Natural gas prices (€/MWh) – Box plots and simple averages



Note: At the EU level the number of observations were 8 in 2008-2015, 7 in 2016 and 6 in 2017. Data for the NWE, SE and CEE regions are not displayed due to confidentiality reasons.
Source: Authors' elaboration

The natural gas prices at EU level and sub-regional level are weighted against natural gas consumption. Table 231 shows that in all cases the EU weighted averages are lower than the simple averages. This suggests that larger plants are able to negotiate more favourable contracts.

Table 231 Natural gas prices (€/MWh) – Simple and weighted averages

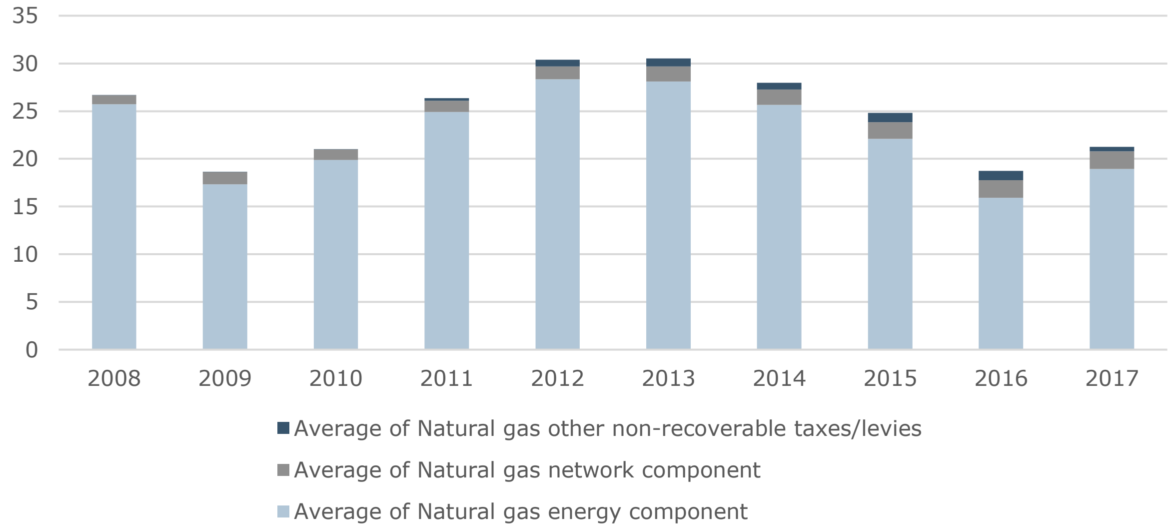
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EU simple average	26.7	18.6	21.0	26.3	30.4	30.5	28.0	24.8	18.8	21.2
EU weighted average	26.1	17.7	20.1	26.0	29.4	29.6	26.6	24.2	17.7	20.3

Note: Weighting factor: purchased natural gas. At the EU level the number of observations were 8 in 2008-2015, 7 in 2016 and 6 in 2017.
Source: Authors' elaboration

<u>Components of the natural gas price</u>[58]

The components of the natural gas price (€/MWh) are shown in Figure 184 and Figure 185. The average of the natural gas energy component represented the largest share of the natural gas price in every year from 2008 to 2017 (€18.9/MWh in 2017), followed by the average of the natural gas network component (€1.8/MWh in 2017) and non-recoverable taxes/levies (€0.5/MWh in 2017). The energy component accounted for around 96% of the total price in 2008, while it accounted for 89% of the total price in 2017. The share of the regulated components increased over the analysed period. The natural gas price development follows international gas prices, which can be observed on international markets.

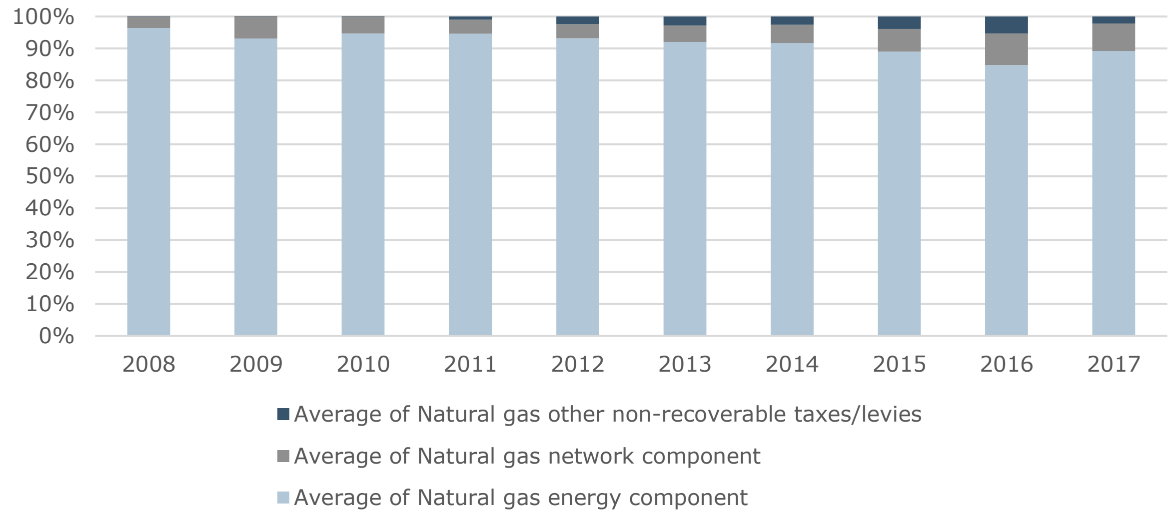
Figure 184 Components of the natural gas price (€/MWh, EU) – Simple averages



Note: At the EU level the number of observations were 8 in 2008-2015, 7 in 2016 and 6 in 2017.
Source: Authors' elaboration

[58] The sum of the natural gas bill components does not necessarily add up to the total natural gas price mentioned before, as there might be plants that did not provide a breakdown of the natural gas bill components while still providing the total natural gas price.

Figure 185 Components of the natural gas price (%, EU) – Simple averages



Note: At the EU level the number of observations were 8 in 2008-2015, 7 in 2016 and 6 in 2017.
Source: Authors' elaboration

The components of the natural gas price are weighted against natural gas consumption. Table 232 shows that the weighted averages are lower than the simple averages, except in 2017, when the weighted average of the other non-recoverable taxes/levies was slightly higher than the simple average. Larger consumers seem to be able to negotiate more favourable deals on the energy component, while at the same time paying less for the network component and other regulatory components (i.e. other non-recoverable taxes/levies).

Table 232 Components of the natural gas price (€/MWh, EU) – Simple and weighted averages

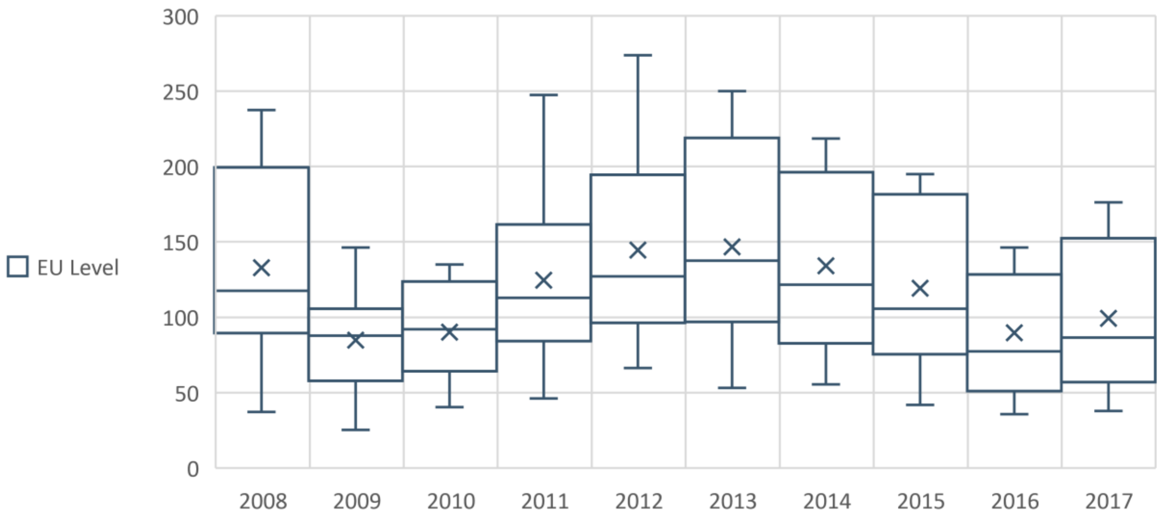
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Energy component simple average	25.7	17.3	19.9	24.9	28.3	28.1	25.7	22.1	15.9	18.9
Energy component weighted average	25.2	16.5	18.9	24.8	28.2	27.6	24.9	21.8	15.6	18.2
Network component simple average	1.0	1.3	1.1	1.2	1.4	1.6	1.6	1.7	1.8	1.8
Network component weighted average	0.9	1.2	1.1	1.1	1.1	1.5	1.5	1.5	1.5	1.3
Other non-recoverable taxes/levies simple average	0.0	0.0	0.0	0.3	0.7	0.8	0.7	1.0	1.0	0.5
Other non-recoverable taxes/levies weighted average	0.0	0.0	0.0	0.1	0.1	0.5	0.2	0.9	0.6	0.7

Note: Weighting factor: purchased natural gas. The number of observations were 8 in 2008-2015, 7 in 2016 and 6 in 2017.
Source: Authors' elaboration

Natural gas costs

Figure 186 shows that the average costs of natural gas (in €/tonne) at the EU level follow a similar trend to the natural gas prices. This is in line with the fairly stable natural gas intensity (see below). The costs increased from 2009 to 2013 and decreased from 2013 to 2017. In 2017 the costs were around €99/tonne, with a minimum of €37.9/tonne and a maximum of €176.2/tonne. In 2008, costs were around €132.9/tonne. The minimum values represent a plant with very low gas intensity, whereas the maximum values represent plants with high gas intensity.

Figure 186 Natural gas costs (in €/tonne) – Box plots and simple averages



Note: At the EU level the number of observations were 8 in 2008-2015, 7 in 2016 and 6 in 2017. Data for the NWE, SE and CEE regions are not displayed due to confidentiality reasons.
Source: Authors' elaboration

The natural gas costs (€/tonne) are weighted against production output. Table 233 shows that the EU weighted averages are lower than the simple averages in half of the cases. From this variation in the comparison it is difficult to conclude anything about the possible impact of economies of scale on the natural gas costs. Overall, it seems that there are limited economies of scale.

Table 233 Natural gas costs (€/tonne) – Simple and weighted averages

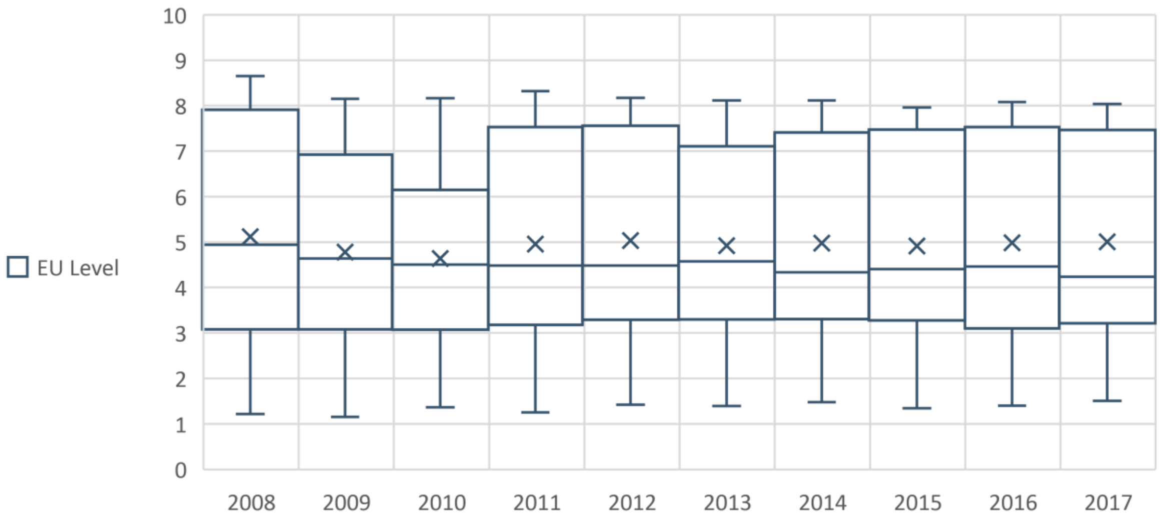
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EU simple average	132.9	84.7	90.1	124.5	144.5	146.6	134.2	119.2	89.8	99.2
EU weighted average	129.2	81.5	88.1	129.4	155.6	147.6	133.9	119.7	91.3	97.2

Note: Weighting factor: production output. At the EU level the number of observations were 8 in 2008-2015, 7 in 2016 and 6 in 2017. Data for the NWE, SE and CEE regions are not displayed due to confidentiality reasons.
Source: Authors' elaboration

Natural gas intensity

The average natural gas intensity (in MWh/tonne) at the EU level 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. Not enough observations were received to be able to calculate natural gas intensity at the NWE, SE and CEE levels.

Figure 187 Natural gas intensity (MWh/tonne) – Box plots and simple averages



Note: At the EU level the number of observations were 8 in 2008-2015, 7 in 2016 and 6 in 2017. Data for the NWE, SE and CEE regions cannot be shown due to confidentiality reasons.
Source: Authors' elaboration

The natural gas intensity is weighted against production output. Table 234 shows that the EU weighted averages are neither continuously lower nor higher than the simple averages. Consequently, there is no indication that larger plants are less natural gas intensive than smaller plants.

Table 234 Natural gas intensity (MWh/tonne) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EU simple average	5.1	4.8	4.6	5.0	5.0	4.9	5.0	4.9	5.0	5.0
EU weighted average	4.9	4.6	4.4	5.0	5.3	5.0	5.0	5.0	5.2	5.1

Note: Weighting factor: production output. At the EU level the number of observations were 8 in 2008-2015, 7 in 2016 and 6 in 2017. Data for the NWE, SE and CEE regions cannot be shown due to confidentiality reasons.
Source: Authors' elaboration

Additional information

All eight plants provided data on the breakdown of their natural gas contract type. Plants could select multiple types of contract, which means in theory that the number of contract types could be higher than the total number of eight. Here, however, this is not the case. Most plants had provider contracts (63%), followed by wholesale contracts (38%).

Table 235 Natural gas contract type

EU	Electricity Contract Type Breakdown	
Contract type	Count	% of plants
Wholesale	3	38%
Provider	5	63%

Source: Authors' elaboration

In terms of natural gas contract duration, interviewees did not report any contracts with a duration of more than five years. Most of the plants (88%) reported contracts of up to five years, while one plant had a contract of indeterminate duration, which is renewed each year.

Table 236 Natural gas contract length

EU	Electricity Contract Length Breakdown	
Contract type	Count	% of plants
Indeterminate duration	1	13%
Up to 5 years	7	88%
More than 5 years	0	0%

Source: Authors' elaboration

Out of the eight plants, one participated in a flexibility/interruptibility scheme for natural gas.

Participating companies did not report on any planned outages. One to two other planned outages were reported, all from one company (see table below), but no duration was provided. The same company also reported many unplanned outages (in addition to two other companies). When a duration was provided, average duration in 2017 was 543 minutes. No plant self-produced any gas.

Table 237 Natural gas outages

EU	Planned outages		Other planned outages		Unplanned outages	
Year	Total number	Average duration	Total number	Average duration	Total number	Average duration
2015	NR	NR	1	NR	6	NR
2016	NR	NR	2	NR	11	NR
2017	NR	NR	2	NR	12	543

Note: Planned outages are linked to interruptibility schemes; other planned outages are not linked to interruptibility schemes, but notified in advance by the energy supplier; unplanned outages are not notified.
Source: Authors' elaboration

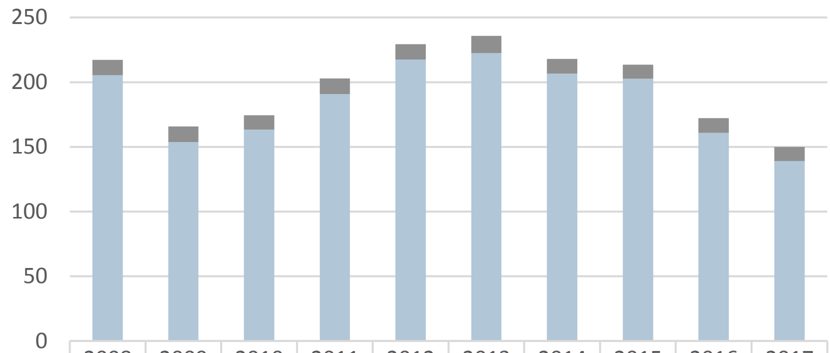
8.4 Competitiveness

Electricity

The average of other production costs per tonne of product decreased by 32% from €205.3/tonne in 2008 to €139.2/tonne in 2017 (see Figure 188). The average costs for electricity per tonne of product also decreased in the same period by 10.8%. Electricity costs per tonne make up around 5.5–7.1% of the total production costs per tonne.[59]

[59] It is important to note that the confidential Production Cost Survey conducted by Fertilizers Europe shows a higher share of electricity costs in production costs. The reason for this may be that this survey focuses on ammonia

Figure 188 Electricity costs as a share of production costs (€/tonne, EU) – Simple averages



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Average of Electricity cost €/tonne	12.0	12.1	11.1	12.3	11.8	13.4	11.3	11.0	11.4	10.7
Average of other Production costs €/tonne	205.3	153.5	163.4	190.6	217.6	222.3	206.7	202.5	160.9	139.2

Note: For electricity costs there were 8 observations in 2008 to 2015, 7 observations in 2016 and 6 observations in 2017. For other production costs there were 7 observations from 2008 to 2015 and 6 observations in 2016 and 2017.
Source: Authors' elaboration

The electricity costs and production costs are weighted against production output. Table 238 shows that all weighted averages for both indicators are higher than the simple averages. This would indicate that larger plants have higher electricity costs per output of production.

Table 238 Electricity costs vs. production costs (€/tonne) – Simple and weighted averages

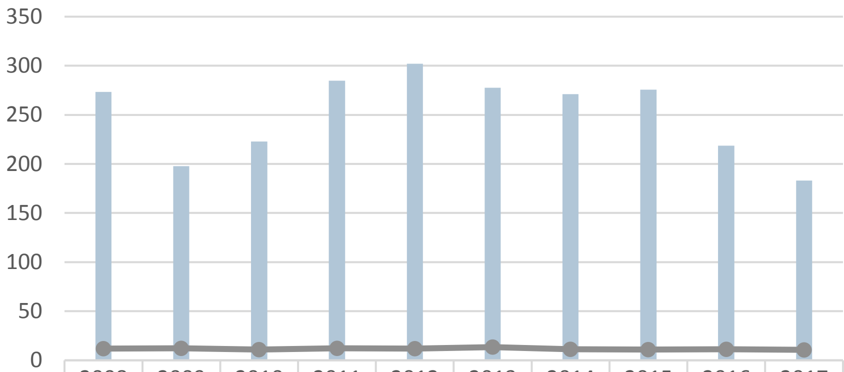
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity costs simple average (€/tonne)	12.0	12.1	11.1	12.3	11.8	13.4	11.3	11.0	11.4	10.7
Electricity costs weighted average (€/tonne)	13.1	12.8	12.1	13.5	12.3	15.0	12.2	11.5	12.2	11.4
Production costs simple average (€/tonne)	217.2	165.7	174.5	203.0	229.4	235.8	217.9	213.5	172.3	149.9
Production costs weighted average (€/tonne)	218.5	166.7	177.8	213.8	243.2	239.7	218.7	215.2	174.5	150.0
Electricity costs as a share of production costs simple averages (%)	5.5%	7.3%	6.4%	6.1%	5.1%	5.7%	5.2%	5.1%	6.6%	7.1%
Electricity costs as a share of production costs weighted averages (%)	6.0%	7.7%	6.8%	6.3%	5.1%	6.2%	5.6%	5.4%	7.0%	7.6%

production only and that it also excludes CAPEX. Source: AC-Fiduciaire, 2017. Fertilizers Europe Production Cost Survey, Zurich: AC-Fiduciaire.

Note: Weighting factor: production output. For electricity costs there were 8 observations in 2008 to 2015, 7 observations in 2016 and 6 observations in 2017. For other production costs there were 7 observations from 2008 to 2015 and 6 observations in 2016 and 2017.
Source: Authors' elaboration

The average turnover per unit of production decreased 33% during the period 2008 to 2017 (see Figure 189). This decrease in turnover per unit of product is higher than the decrease in electricity costs per unit of production, which underwent a 10.7% decrease in the same period. The share of electricity costs in relation to turnover went up from about 4.4% in 2008 to 5.8% in 2017.

Figure 189 Electricity costs versus turnover (€/tonne, EU) – Simple averages



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Average of Turnover €/tonne	273.3	197.6	222.8	284.7	302.0	277.5	271.1	275.6	218.8	183.2
Average of Electricity cost €/tonne	12.0	12.1	11.1	12.3	11.8	13.4	11.3	11.0	11.4	10.7

Note: For electricity costs there were 8 observations in 2008 to 2015, 7 observations in 2016 and 6 observations in 2017. For turnover per tonne, there were 7 observations from 2008 to 2015 and 6 observations in 2016 and 2017.
Source: Authors' elaboration

The electricity costs and turnover are weighted against production output. Table 239 shows that all weighted averages for both indicators are higher than the simple averages. This would indicate that large plants have higher electricity costs per tonne of product, but also higher turnover per tonne of product. The trend between the two indicators is also very similar.

Table 239 Electricity costs vs. turnover (€/tonne) – Simple and weighted averages

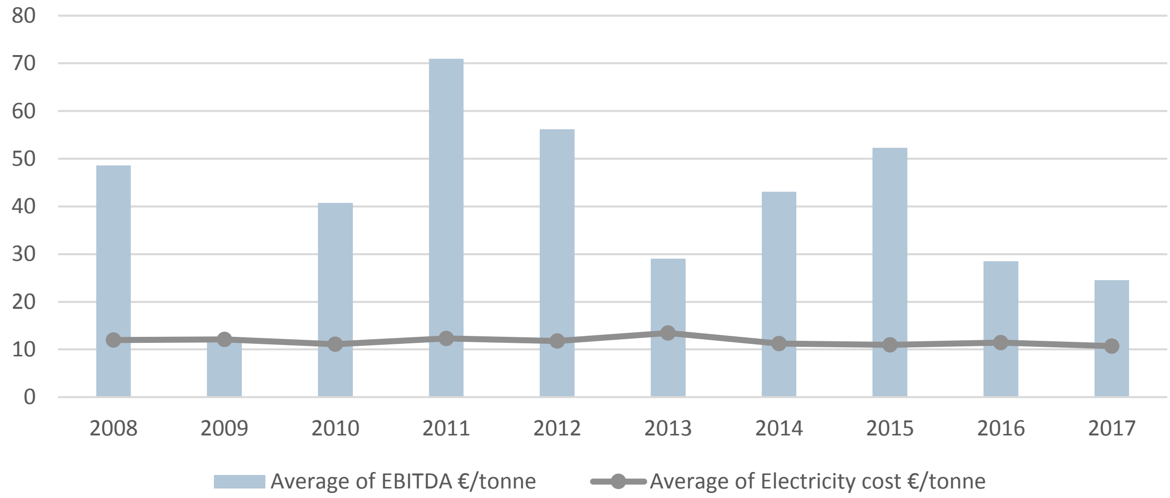
Indicator	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*
Electricity costs simple average (€/tonne)	12.0	12.1	11.1	12.3	11.8	13.4	11.3	11.0	11.4	10.7
Electricity costs weighted average (€/tonne)	13.1	12.8	12.1	13.5	12.3	15.0	12.2	11.5	12.2	11.4
Turnover simple average (€/tonne)	273.3	197.6	222.8	284.7	302.0	277.5	271.1	275.6	218.8	183.2
Turnover weighted average (€/tonne)	298.7	205.8	230.1	297.9	314.8	289.3	276.4	283.5	226.5	190.8
Electricity costs as a share of	4.4%	6.1%	5.0%	4.3%	3.9%	4.8%	4.2%	4.0%	5.2%	5.8%

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
turnover simple averages (%)										
Electricity costs as a share of turnover weighted averages (%)	4.4%	6.2%	5.2%	4.5%	3.9%	5.2%	4.4%	4.1%	5.4%	6.0%

Note: Weighting factor: production output. For electricity costs there were 8 observations in 2008 to 2015, 7 observations in 2016 and 6 observations in 2017. For turnover per tonne, there were 7 observations from 2008 to 2015 and 6 observations in 2016 and 2017.
Source: Authors' elaboration

In the case of EBITDA per tonne, it underwent a similar volatile trend to EBIT per tonne (see Figure 190). On average, EBITDA per tonne decreased almost 50% from €48.6 in 2008 to €24.5/tonne in 2017.

Figure 190 Electricity costs versus EBITDA (€/tonne, EU) – Simple averages



Note: For electricity costs there were 8 observations in 2008 to 2015, 7 observations in 2016 and 6 observations in 2017. For average of EBITA per tonne, there were 7 observations from 2008 to 2015 and 6 observations in 2016 and 2017.
Source: Authors' elaboration

The electricity costs and EBITDA are weighted against production output. Table 240 shows that all weighted averages for electricity costs are higher than the simple averages, while for EBITDA the weighted average does not show a clear trend.

Table 240 Electricity costs vs. EBITDA (€/tonne) – Simple and weighted averages

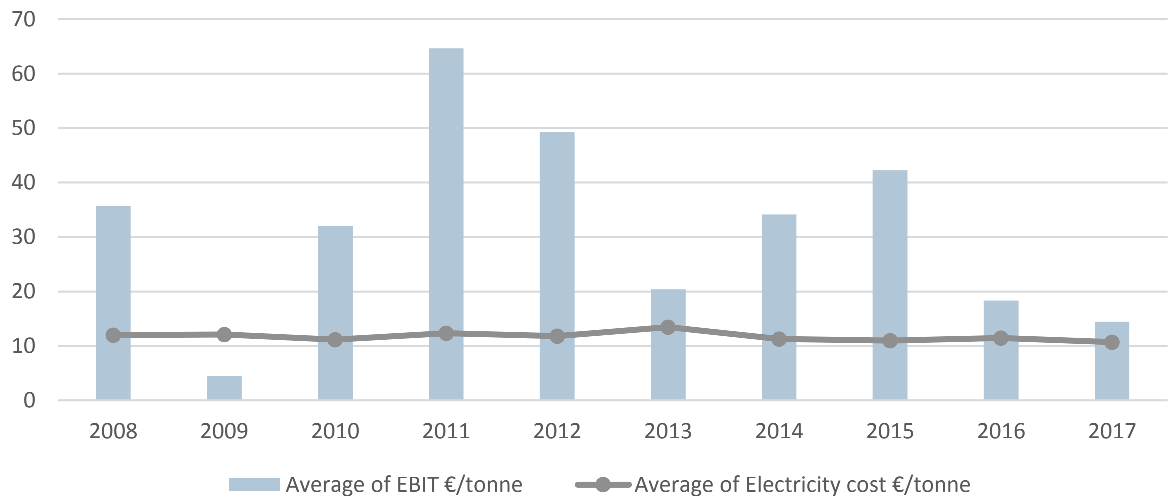
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity costs simple average (€/tonne)	12.0	12.1	11.1	12.3	11.8	13.4	11.3	11.0	11.4	10.7
Electricity costs weighted	13.1	12.8	12.1	13.5	12.3	15.0	12.2	11.5	12.2	11.4

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
average (€/tonne)										
EBITDA simple average (€/tonne)	48.6	12.5	40.7	71.0	56.2	29.0	43.1	52.3	28.5	24.5
EBITDA weighted average (€/tonne)	60.7	14.4	37.8	66.4	49.5	31.0	42.0	51.1	28.6	25.8
Electricity costs as a share of EBITDA simple averages (%)	24.6%	97.3%	27.3%	17.4%	21.0%	46.3%	26.1%	21.0%	40.1%	43.6%
Electricity costs as a share of EBITDA weighted averages (%)	21.5%	88.4%	31.9%	20.3%	24.8%	48.3%	28.9%	22.6%	42.7%	44.3%

Note: Weighting factor: production output. For electricity costs there were 8 observations in 2008 to 2015, 7 observations in 2016 and 6 observations in 2017. For average of EBITA per tonne, there were 7 observations from 2008 to 2015 and 6 observations in 2016 and 2017.
Source: Authors' elaboration

Figure 191 shows a 10.5% decrease in average electricity costs from 2008 to 2017. Furthermore, it shows that EBIT per unit of production was volatile throughout the same period, decreasing from 2008 to 2009, skyrocketing from 2009 to 2011 and dropping substantially again from 2011 to 2013. It underwent an increase from 2013 to 2015 and again a drop from 2015 to 2017. On average, EBIT per tonne decreased 59.6% from 2008 (€35.7/tonne) to 2010 (€14.4/tonne). For several years, the fluctuations in average electricity costs per unit of product and EBIT per unit of product seem to follow each other (electricity costs per unit of product decreases, EBIT per unit of product increases). But this does not hold for the period 2010-2012. Also, a strong increase is not reflected by a similar strong decrease. Thus, based on the current sample, it is difficult to see a clear link between the two.

Figure 191 Electricity costs versus EBIT (€/tonne, EU) – Simple averages



Note: For electricity costs there were 8 observations in 2008 to 2015, 7 observations in 2016 and 6 observations in 2017. For average of EBIT per tonne, there were 7 observations from 2008 to 2015 and 6 observations in 2016 and 2017.
Source: Authors' elaboration

The electricity costs and EBIT are weighted against production output. Table 241 shows that all weighted averages for electricity costs are higher than the simple averages. For EBIT, this does not always hold true.

Table 241 Electricity costs vs. EBIT (€/tonne) – Simple and weighted averages

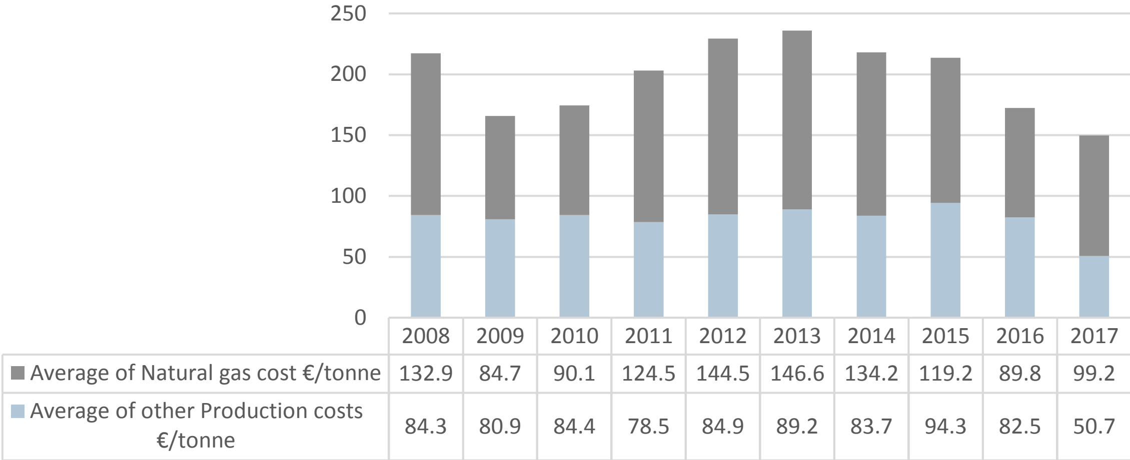
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity costs simple average (€/tonne)	12.0	12.1	11.1	12.3	11.8	13.4	11.3	11.0	11.4	10.7
Electricity costs weighted average (€/tonne)	13.1	12.8	12.1	13.5	12.3	15.0	12.2	11.5	12.2	11.4
EBIT simple average (€/tonne)	35.7	4.5	32.0	64.6	49.3	20.4	34.1	42.3	18.3	14.4
EBIT weighted average (€/tonne)	45.7	5.7	28.9	60.2	42.6	21.8	32.6	40.6	17.4	15.1

Note: Weighting factor: production output. For electricity costs there were 8 observations in 2008 to 2015, 7 observations in 2016 and 6 observations in 2017. For average of EBIT per tonne, there were 7 observations from 2008 to 2015 and 6 observations in 2016 and 2017.
Source: Authors' elaboration

Natural gas

From Figure 192, we see that costs for natural gas use were higher than the average of other production costs in every year from 2008 to 2017, ranging from 51.1% to 66.2% of the production costs[60]. Natural gas costs per tonne decreased by 25% from 2008 to 2017, while production costs per tonne decreased by around 31%.

Figure 192 Natural gas costs as a share of production costs (€/tonne, EU) – Simple averages



Note: For natural gas costs there were 8 observations in 2008 to 2015, 7 observations in 2016 and 6 observations in 2017. For other production, there were 7 observations from 2008 to 2015 and 6 observations in 2016 and 2017.
Source: Authors' elaboration

The natural gas costs and production costs are weighted against production output. Table 242 shows that weighted averages for natural gas costs are neither always higher nor lower than the simple averages. For production costs the weighted average is higher than the simple averages, in all cases.

Table 242 Natural gas costs vs. production costs (€/tonne) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas costs simple average (€/tonne)	132.9	84.7	90.1	124.5	144.5	146.6	134.2	119.2	89.8	99.2
Natural gas costs weighted average (€/tonne)	129.2	81.5	88.1	129.4	155.6	147.6	133.9	119.7	91.3	97.2
Production costs simple average (€/tonne)	217.2	165.7	174.5	203.0	229.4	235.8	217.9	213.5	172.3	149.9
Production costs weighted average (€/tonne)	218.5	166.7	177.8	213.8	243.2	239.7	218.7	215.2	174.5	150.0
Natural gas costs as a share of production costs	61.2 %	51.1%	51.7%	61.3%	63.0%	62.2%	61.6%	55.8%	52.1%	66.2%

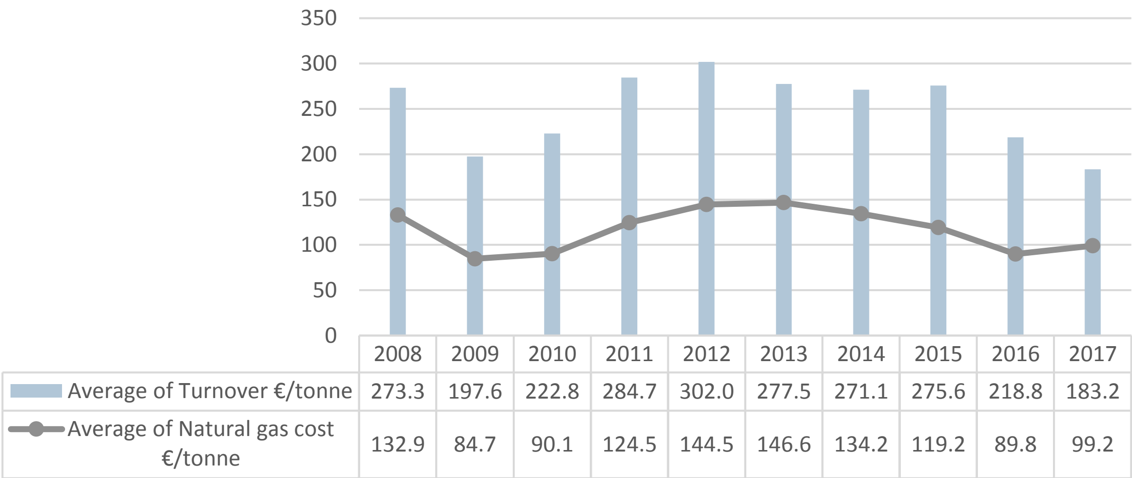
[60] It is important to note that the confidential Production Cost Survey conducted by Fertilizers Europe shows a higher share of natural gas costs in production costs. The reason for this may be that this survey focuses on ammonia production only and that it also excludes CAPEX. Source: AC-Fiduciaire, 2017. Fertilizers Europe Production Cost Survey, Zurich: AC-Fiduciaire.

Indicator	***2008***	***2009***	***2010***	***2011***	***2012***	***2013***	***2014***	***2015***	***2016***	***2017***
simple averages (%)										
Natural gas costs as a share of production costs weighted averages (%)	59.1 %	48.9%	49.6%	60.5%	64.0%	61.6%	61.2%	55.6%	52.3%	64.8%

Note: Weighting factor: production output. For natural gas costs there were 8 observations in 2008 to 2015, 7 observations in 2016 and 6 observations in 2017. For other production, there were 7 observations from 2008 to 2015 and 6 observations in 2016 and 2017.
Source: Authors' elaboration

The average turnover per unit of production decreased 33%, from €132.9/tonne in 2008 to €183.2/tonne in 2017 (see Figure 193). The natural gas costs per unit of production decreased 25.4% from €132.9/tonne in 2008 to €99.2/tonne in 2017. Again, the turnover per unit of production follows the fluctuations in costs closely. Natural gas costs ranged between 40.5% (2010) and 54.1% (2017) of the average sectoral turnover.

Figure 193 Natural gas costs versus turnover (€/tonne, EU) – Simple averages



Note: For natural gas costs there were 8 observations in 2008 to 2015, 7 observations in 2016 and 6 observations in 2017. For turnover per tonne, there were 7 observations from 2008 to 2015 and 6 observations in 2016 and 2017.
Source: Authors' elaboration

The natural gas costs and turnover are weighted against production output. Table 243 shows that for the first three years and 2014, the weighted averages for natural gas costs are lower than the simple averages. For turnover the weighted average is higher than the simple averages, in all cases. A reason could be that larger plants face higher costs and therefore charge higher prices.

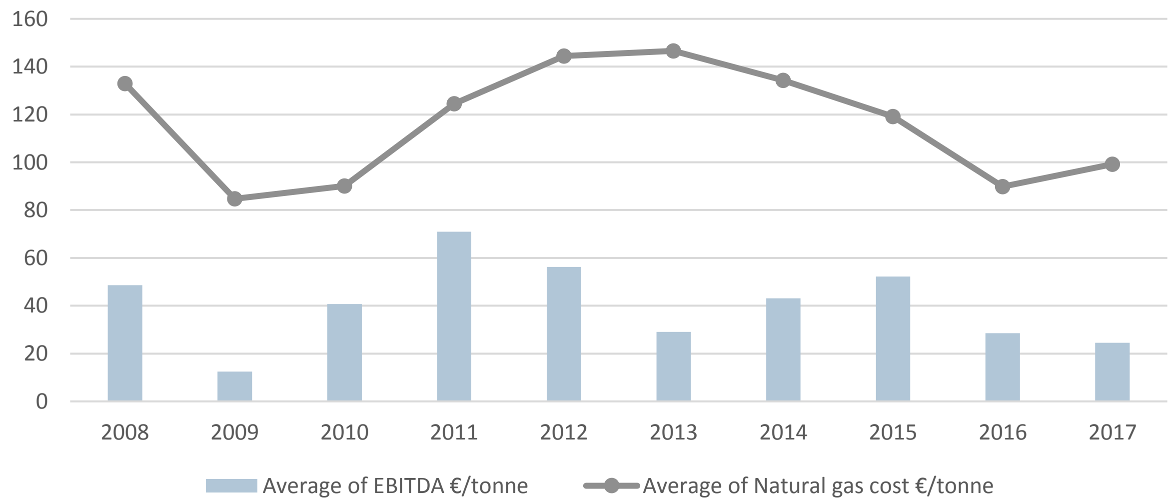
Table 243 Natural gas costs vs. turnover (€/tonne) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas costs simple average (€/tonne)	132.9	84.7	90.1	124.5	144.5	146.6	134.2	119.2	89.8	99.2
Natural gas costs weighted average (€/tonne)	129.2	81.5	88.1	129.4	155.6	147.6	133.9	119.7	91.3	97.2
Turnover simple average (€/tonne)	273.3	197.6	222.8	284.7	302.0	277.5	271.1	275.6	218.8	183.2
Turnover weighted average (€/tonne)	298.7	205.8	230.1	297.9	314.8	289.3	276.4	283.5	226.5	190.8
Natural gas costs as a share of turnover simple averages (%)	48.6%	42.9%	40.5%	43.7%	47.8%	52.8%	49.5%	43.3%	41.0%	54.1%
Natural gas costs as a share of turnover weighted averages (%)	43.2%	39.6%	38.3%	43.4%	49.4%	51.0%	48.5%	42.2%	40.3%	51.0%

Note: Weighting factor: production output. For natural gas costs there were 8 observations in 2008 to 2015, 7 observations in 2016 and 6 observations in 2017. For turnover per tonne, there were 7 observations from 2008 to 2015 and 6 observations in 2016 and 2017.
Source: Authors' elaboration

In the case of EBITDA per tonne, it underwent a 50% decrease from 2008 to 2017. The value, however, fluctuated year by year. In 2017, it was €24.5/tonne.

Figure 194 Natural gas costs versus EBITDA (€/tonne, EU) – Simple averages



Note: For natural gas costs there were 8 observations in 2008 to 2015, 7 observations in 2016 and 6 observations in 2017. For EBITDA per tonne, there were 7 observations from 2008 to 2015 and 6 observations in 2016 and 2017.

The natural gas costs and EBITDA are weighted against production output. Table 244 shows that for half of the years, the weighted averages for both indicators are lower than the simple averages.

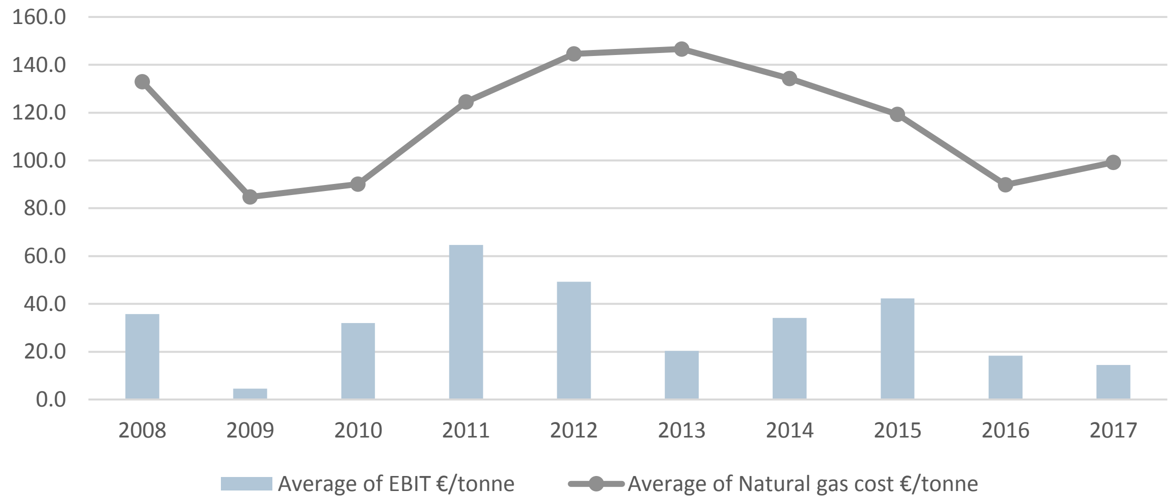
Table 244 Natural gas costs vs. EBITDA (€/tonne) – Simple and weighted averages

Indicator	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*
Natural gas costs simple average (€/tonne)	132.9	84.7	90.1	124.5	144.5	146.6	134.2	119.2	89.8	99.2
Natural gas costs weighted average (€/tonne)	129.2	81.5	88.1	129.4	155.6	147.6	133.9	119.7	91.3	97.2
EBITDA simple average (€/tonne)	48.6	12.5	40.7	71.0	56.2	29.0	43.1	52.3	28.5	24.5
EBITDA weighted average (€/tonne)	60.7	14.4	37.8	66.4	49.5	31.0	42.0	51.1	28.6	25.8

Note: Weighting factor: production output. For natural gas costs there were 8 observations in 2008 to 2015, 7 observations in 2016 and 6 observations in 2017. For EBITDA per tonne, there were 7 observations from 2008 to 2015 and 6 observations in 2016 and 2017.
Source: Authors' elaboration

Figure 195 shows a 25.4% decrease in average natural gas costs from 2008 to 2017. Furthermore, it shows that EBIT per unit of production decreased 59.7% from 2015 to 2017. Thus, although natural gas costs decreased, and natural gas costs are an important part of the costs, plants still faced different challenges that resulted in a strong decrease of EBIT per unit of production.

Figure 195 Natural gas costs versus EBIT (€/tonne, EU) – Simple averages



Note: For natural gas costs there were 8 observations in 2008 to 2015, 7 observations in 2016 and 6 observations in 2017. For EBIT per tonne, there were 7 observations from 2008 to 2015 and 6 observations in 2016 and 2017.

The natural gas costs and EBIT are weighted against production output. Table 245 shows that half of the weighted averages for natural gas costs are lower than the simple averages. For EBIT, the weighted average is higher than the simple averages, except in 2008, 2009, 2013 and 2017.

Table 245 Natural gas costs vs. EBIT (€/tonne) – Simple and weighted averages

Indicator	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*
Natural gas costs simple average (€/tonne)	132.9	84.7	90.1	124.5	144.5	146.6	134.2	119.2	89.8	99.2
Natural gas costs weighted average (€/tonne)	129.2	81.5	88.1	129.4	155.6	147.6	133.9	119.7	91.3	97.2
EBIT simple average (€/tonne)	35.7	4.5	32.0	64.6	49.3	20.4	34.1	42.3	18.3	14.4
EBIT weighted average (€/tonne)	45.7	5.7	28.9	60.2	42.6	21.8	32.6	40.6	17.4	15.1

Note: Weighting factor: production output. For natural gas costs there were 8 observations in 2008 to 2015, 7 observations in 2016 and 6 observations in 2017. For EBIT per tonne, there were 7 observations from 2008 to 2015 and 6 observations in 2016 and 2017.
Source: Authors' elaboration

International competitiveness

This Section compares energy prices and costs borne by EU nitrogen fertiliser producers with those borne by producers based in third countries. The Section relies on primary data for the EU (collected at the plant level and presented before) and international data acquired from the consultancy CRU[61]. The Research Team relies on such third-party data as none of the participating nitrogen fertiliser producers was able to provide primary international data on energy prices and costs from their facilities outside the EU. In terms of third countries, Algeria, Egypt and Russia were selected as these are the main countries exporting to the EU. The focus is on the year 2016 as data from CRU was only purchased for this specific year.

The following Section on 'Energy prices' presents average electricity and natural gas prices borne by nitrogen fertiliser producers in the EU with those in Algeria, Egypt and Russia. As the international data from CRU is based on weighted averages, we also use weighted average values for the EU to allow for a meaningful and consistent comparison between EU and international data. The Section on 'International Competitiveness', in contrast, compares key performance indicators of EU nitrogen fertiliser producers with those of the international counterparts above. In line with the methodology used by CRU, this Section also presents weighted averages in the figures.

It is important to note that international data from CRU refers to urea production plants while the EU level data refers to nitrogen fertiliser plants in general, meaning that outputs such as urea but also, for example, ammonium nitrate are produced at these plant sites.

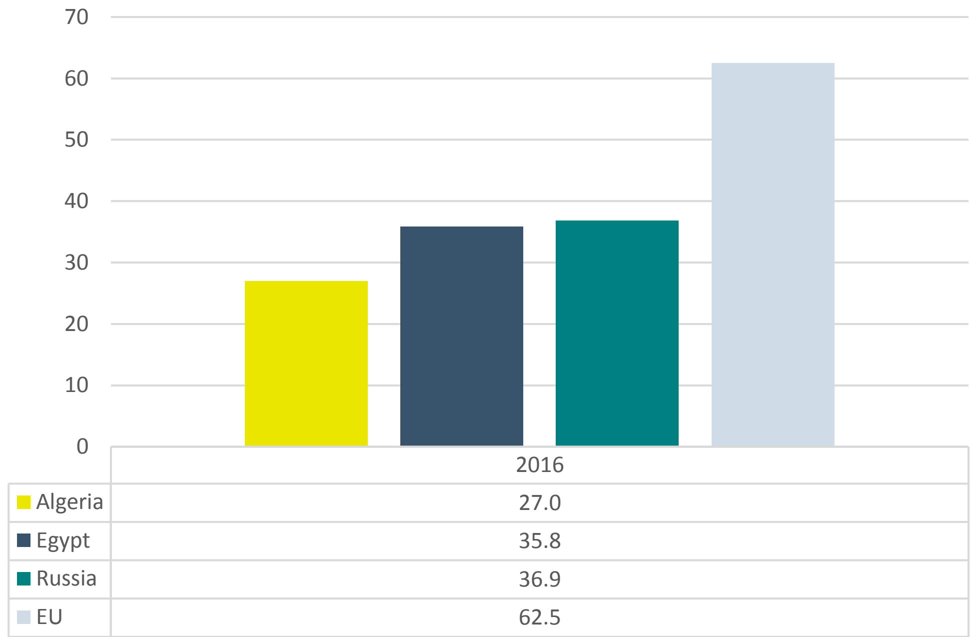
[61] CRU specialises in mining, metal and fertiliser commodities, delivering global business intelligence through analysis, prices, consulting and events: https://www.crugroup.com/

International energy prices

Figure 196 compares electricity prices borne by nitrogen fertiliser producers in the EU with those in Algeria, Egypt and Russia for the year 2016. On average, EU producers with €62.5/MWh seem to face substantially higher electricity prices than all other counterparts. The lowest price is observed in Algeria with €27/MWh. In Egypt and Russia, prices are fairly similar, at €35.8/MWh and €36.9/MWh respectively. Overall, this means that the EU price is around double the electricity price in competing countries.

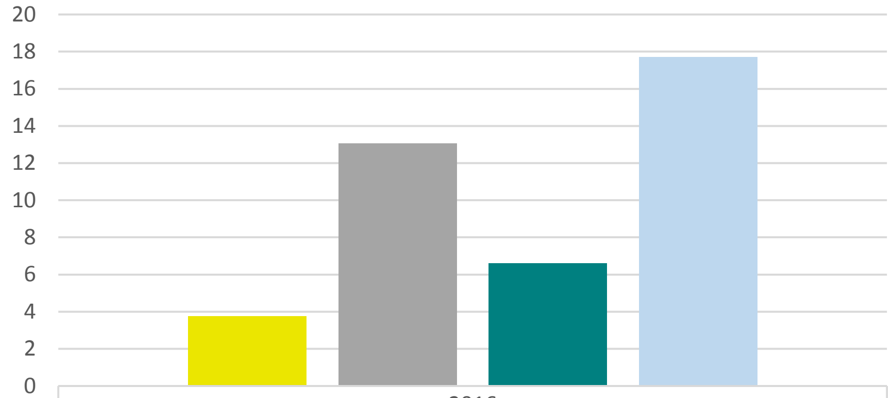
Figure 197 compares natural gas prices borne by nitrogen fertiliser producers in the EU with the same counterparts as above for the year 2016. On average, EU producers with €17.7/MWh seem to face substantially higher natural gas prices than all other counterparts. As with electricity, the lowest natural gas price is observed in Algeria with €3.7/MWh. The price in Russia is somewhat higher than that in Algeria but is still low at €6.6/MWh. The price in Egypt is €13.1/MWh and thus still around 26% lower than in the EU. Overall, this means that the EU faces higher natural gas prices than the assessed competing countries.

Figure 196 Electricity prices (€/MWh, 2016) – Weighted averages



Note: weighting factor: purchased electricity; data for the EU rely on primary data collected at the plant level as part of this study (7 observations in 2016); international data are retrieved from CRU.
Source: Authors' elaboration

Figure 197 Natural gas prices (€/MWh, 2016) – Weighted averages



	2016
Algeria	3.7
Egypt	13.1
Russia	6.6
EU	17.7

Note: weighting factor: purchased natural gas; data for the EU rely on primary data collected at the plant level as part of this study (7 observations in 2016); international data are retrieved from CRU.
Source: Authors' elaboration

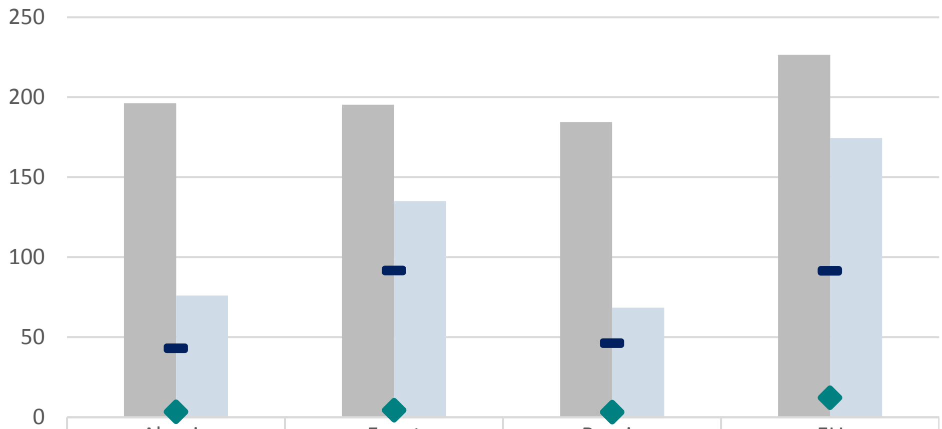
International competitiveness

Figure 198 compares electricity and natural gas costs as well as turnover and production costs borne by nitrogen fertiliser producers in the EU with those in Algeria, Egypt and Russia for the year 2016.

On average, EU producers with 226.5 €/tonne seem to face the highest turnover per tonne of output followed by Algeria (196.2 €/tonne) and Egypt (195.3 €/tonne). Russian plants seem to have a lower level of turnover with only 184.5 €/tonne. In general, the difference in turnover between the EU and these countries is relatively small. When comparing the production costs, a more substantial difference can be observed. While the EU and Egypt face higher production costs, i.e. 174.5 and 135.1 €/tonne respectively, Algeria (76.1 €/tonne) and Russia (68.4 €/tonne) seem to have much lower production costs. This might be induced by the much lower natural gas prices in Russia and Algeria in comparison to the EU and Egypt, which was shown above. Overall, the EU faces the highest turnover but also the highest production costs per tonne of output.

The natural gas costs in Figure 198 confirm our assumption that the natural gas prices seem to be responsible for the higher production costs in the EU in comparison to Algeria and Russia. Egypt faces the highest natural gas costs per tonne with 91.6 €/tonne, very closely followed by the EU (91.3 €/tonne). As natural gas prices are higher in the EU than in Egypt, this could mean that EU plants are much less natural gas intensive per tonne of output than their counterparts in Egypt. Algeria faces the lowest natural gas costs with 43.0 €/tonne, being more than 50% lower than in the EU. Electricity costs per tonne of output in the EU with 12.2 €/tonne are by factor 3 to 4 higher than the costs of their counterparts. Russia faces the lowest electricity costs with 3.1 €/tonne.

Figure 198 Electricity and natural gas costs vs production costs and turnover (€/tonne, 2016) – Weighted averages

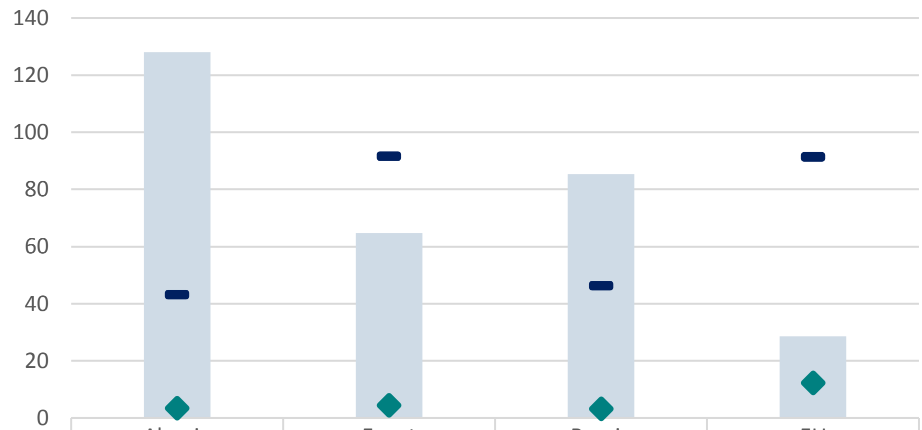


	Algeria	Egypt	Russia	EU
Turnover (€/tonne)	196.2	195.3	184.5	226.5
Production costs (€/tonne)	76.1	135.1	68.4	174.5
Natural gas costs (€/tonne)	43.0	91.6	46.2	91.3
Electricity costs (€/tonne)	3.4	4.4	3.1	12.2

Note: weighting factor: production output; data for the EU relies on primary data collected at the plant level as part of this study (7 observations in 2016); international data is retrieved from CRU.
Source: Authors' elaboration

Figure 199 compares electricity, natural gas costs and EBITDA borne by nitrogen fertiliser producers in the EU with those in Algeria, Egypt and Russia for the year 2016. The comparison of EBITDA per tonne of output between countries shows that Algeria faces the highest EBITDA with 128.0 €/tonne in 2016 followed by Russia with 85.3 €/tonne. The EU ranks lowest with 28.6 €/tonne. In Egypt and the EU, natural gas costs per tonne are higher than the EBITDA per tonne.

Figure 199 Electricity and natural gas costs vs EBITDA (€/tonne, 2016) – Weighted averages



	Algeria	Egypt	Russia	EU
EBITDA (€/tonne)	128.0	64.7	85.3	28.6
Natural gas costs (€/tonne)	43.0	91.6	46.2	91.3
Electricity costs (€/tonne)	3.4	4.4	3.1	12.2

Note: weighting factor: production output; data for the EU relies on primary data collected at the plant level as part of this study (7 observations in 2016); international data is retrieved from CRU.
Source: Authors' elaboration

9 Refineries

Box 16 Highlights - Refineries

In the refinery sector, electricity costs represented around 1% of total production costs (simple average) between 2008 and 2017. Natural gas costs also represented on average around 1% of total production costs (simple average). Other fuel costs (coke, fuel oil and crude oil)[62] made up around 88% of total production costs (86% being attributable to crude oil only) (simple average).

Electricity

- Average **electricity prices** (simple average) at the EU level decreased during the period 2008 to 2017, ranging from €69 to €77/MWh. In 2008, the price was €78/MWh while in 2017 it was €71/MWh. In most years, electricity prices in NWE were higher than in SE. In terms of components of the electricity price, throughout the 2008 to 2017 period the electricity energy component underwent a downward trend (in absolute value), with the highest average in 2008 (€63.5/MWh) and the lowest in 2016 (€42.1/MWh). The electricity component accounted for 79% and 63% of the total electricity price in 2008 and 2017 respectively (€45/MWh in 2017). Large consumers seem to not only pay less for the energy component but also less for the network component and other regulatory components such as RES levies and other non-recoverable taxes/levies.
- Average **electricity costs in €/MWh** (simple average) at the EU level were on a downward trend from 2008 (€92/MWh) to 2017 (€66/MWh), with a significant decrease from 2015 to 2016. The high difference between electricity price and electricity costs in €/MWh between 2008 and 2015 is caused by two plants that had high costs for self-generated electricity. These two plants were not covered in the sample in 2016 and 2017, leading to the observed decrease in electricity costs from 2015 to 2016. For the EU and the NWE region, the weighted average (by electricity consumption) for this indicator was lower than the simple average, confirming better conditions for larger consumers (this does not hold for plants in the SE region). The average **electricity costs (€/tonne)** (simple average) at EU, NWE and SE levels saw a downward trend between 2008 (€6/tonne) and 2017 (€4/tonne). Since the electricity intensity shows a limited decrease, the changes in electricity costs seem to be following the fluctuations in electricity prices and costs in € per MWh. The analysis showed that economies of scale are relevant for the sector.
- The average **electricity intensity** (simple average) at the EU level 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.

Gas

- In the EU and NWE, the average **natural gas prices** (simple average) show a general descending trend, which was notably visible from 2013 to 2016 when prices dropped from €30/MWh to €20/MWh. In 2017, the price was €22/MWh. The average of the natural gas energy component increased (in absolute value) by 7% from 2008 to 2013 but decreased by 33% from 2013 (€29/MWh) to 2017 (€19/MWh in 2017). The energy component made up around 93% and 89% of the total natural gas price in 2008 and 2017 respectively. There is no clear indication that larger consumers pay less for the natural gas energy component and network component than their smaller counterparts. Larger consumers,

[62] Other fuels refer to coke, fuel oil and crude oil. While coke and fuel oil are used as a fuel, only a portion of crude oil (4–8%) is used as a fuel in the transformation and cracking processes of refineries. We nonetheless also cover crude oil in this study as crude oil costs represent the largest part of refineries' production costs and are thus of particular relevance.

however, seem to pay less for the other regulatory component (i.e. non-recoverable taxes/levies).

- The average **natural gas costs in €/tonne** (simple average) at EU level decreased by 52% from 2008 (€11/tonne) to 2017 (€5/tonne). Weighted average (by production output) for natural gas costs in €/tonne is below simple average; this seems to be due to the lower natural gas prices for large consumers as well as economies of scale.
- The average **natural gas intensity** (simple average) at EU level was on a decreasing trend throughout the period 2008 to 2017. In 2008, the average intensity was 0.35 MWh/tonne, while in 2017 it was 0.24 MWh/tonne. **Total gas intensity** (including natural gas and refinery fuel gas consumption) at the EU level also 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.

Other fuels[63]

- The coke price (simple average) increased from 2016 to 2017 (+35% at the EU level and +30% at the NWE level). At the same time, the **coke costs** per tonne of output in €/tonne increased by 20% from 2016 (€2.0/tonne) to 2017 (€2.4/tonne). The **coke intensity** per tonne of output, in contrast, declined slightly from about 0.13 to 0.12 MWh/tonne.
- From 2016 to 2017, the **fuel oil price** (simple average) increased from about €15/MWh in 2016 to €20/MWh in 2017. At the same time, the **fuel oil costs** per tonne of output in €/tonne moved from about €2.2/tonne in 2016 to €2.5/tonne in 2017. The **fuel oil intensity** per tonne of output (in MWh/tonne), in contrast, dropped slightly from 0.14 MWh/tonne in 2016 to 0.11 MWh/tonne in 2017.
- Regarding the **crude oil price** (simple average), the EU average moved from about €24/MWh in 2016 to €29/MWh in 2017. At the same time, the **crude oil costs** per tonne of output in €/tonne moved from about €332/tonne in 2016 to €396/tonne in 2017. The **crude oil intensity** per tonne of output on EU level hardly changed from 2016 to 2017 (13.62 MWh/tonne in 2017).

Competitiveness

- **Electricity costs** per tonne made up less than 1% of the **total production costs** per tonne. This share decreased from 1.6% in 2015 to 0.8% in 2017. While the average costs for electricity per tonne of product decreased by 38% from 2015 to 2017, the average of other production costs per tonne of product increased from €372/tonne in 2015 to €488/tonne in 2017 (i.e. 30%).
- **Natural gas costs** made up around 1% of **the total production costs**. They decreased from 1.6% in 2015 to 1.1% in 2017.
- **Other fuel costs** (coke, fuel oil and crude oil) made up 88% and thus the largest part of the total production costs per tonne (86% being attributable to crude oil only).
- The share of electricity costs in relation to **turnover** decreased from about 0.9% in 2015 to 0.6% in 2017. The share of natural gas cost in relation to turnover remained fairly stable at around 0.9%. Other fuel costs made up between 63% and 75% of total turnover in 2016 and 2017 respectively. The average turnover per unit of production (simple average) decreased by 7%, from €666/tonne in 2015 to €619/tonne in 2017.
- **EBITDA** per tonne (simple average) underwent a 41% decrease from 2015 (€75/tonne) to 2017 (€44/tonne). In the same period, **EBIT** decreased by 36% from €48/tonne in 2015 to €31/tonne in 2017. By looking at trends in costs and margins, it is not possible to draw conclusions about the impact of electricity and

[63] As data on other fuels were calculated in this study for the first time, only data for the years 2016 and 2017 are shown and analysed.

natural gas costs on profitability (more details on the point are provided in Annex B to this Study).

Sample and limitations

- The **sample** includes 13 plants across the EU, representing about **20% of the total refining capacity** in the EU in 2017. About 62% of the sample is composed of plants based in the NWE region, while 31% of the sample is composed of plants in SE. As 8% of plants were based in CEE, the region is slightly under-represented in the sample.
- The sample includes only plants operating in the entire period under observation; therefore, results may **overestimate profitability indicators and underestimate production costs and energy costs**, if one considers that between 2008 and 2017 a number of relatively less efficient plants and companies left the market.
- For some indicators, the number of available observations varies across years; therefore, the trend may be affected by **changes in the sample size**. More details about the number of observations are provided underneath each figure and table.
- Averages for the **CEE region cannot be shown for confidentiality reasons**. However, data provided by CEE plants are included in the EU average.

9.1 Composition of the sample

Sampling strategy

The sampling strategy for the refinery sector considers the following sampling criteria:

- Production technology
- Geographical distribution
- Company ownership/size.

For subsectors (i.e. production technology), the sample focuses on one type of production technology, the so-called mainstream refineries. Small petroleum oil sites performing specialised functions (mostly bitumen and lube oil manufacture), in contrast, are excluded as they are atypical for the refinery sector. For the geographical distribution, we aimed for a representative sample taking into account the refinery sector's geographical distribution in terms of capacity over the three selected regions (SE, CEE and NWE). In this respect, capacity data obtained from FuelsEurope provide an overview of the spread of the nominal capacities over countries and companies.

When it comes to company ownership/size, it is important to note that SME are not relevant among refining facilities such as mainstream refineries. For this reason, different plant sizes are not directly taken into consideration for the sampling. With regards to ownership, the sample ensures the coverage of both global as well as regional players. Against this background and keeping in mind international best practices for collecting data on regulatory costs, the Research Team aimed to have a minimum number of 15 refinery plant sites in the sample, five for each geographical region (Table 246).

Table 246 Minimum number of plants to be surveyed

Geographical regions	Refinery
Southern Europe	5
Central Eastern Europe	5
North-Western Europe	5
Total	**15**

Source: Authors' elaboration

Box 17 Key features of the sector

The European refining sector has been going through a restructuring process, necessitated both by changes in the global economy and the need to address climate and environmental externalities. Several international oil companies are divesting from refining capacity in Europe and are expanding in non-OECD countries, while non-European international companies are emerging as important investors. However, they currently remain relatively minor players. Since 2008, the EU crude processing capacity has been on a decreasing trend. The key dynamics underlying these changes are the changing local market conditions and uncertain future perspectives, especially as a result of reduced demand, overcapacity and product demand shifting to low carbon technologies such as (bio-)diesel and electromobility.

A 'typical plant':

- The average refining plant has an annual capacity of 8.1 million tonnes and has more than 250 employees (non-SME). In our sample, the average produced capacity is around 6.5 million tonnes.
- Most refineries are in NWE or SE, and a typical plant can be found in Germany, Italy, Spain or France.
- In all refineries, the first production process is the distillation of crude oil. Common conversion processes are thermal or catalytic processes.
- The major share of energy consumption is in natural gas and fuel gas. Based on the refineries in the sample, the average natural gas intensity is 0.26 MWh/tonne and the average electricity intensity is 0.07 MWh/tonne.

Snapshot of the sector in figures:

- The total EU refining capacity in 2017 amounted to 656 million tonnes of crude oil.
- There are 81 mainstream refineries in the EU. The largest refinery has an annual capacity of 20.2 million tonnes, whereas the smallest has an annual capacity of only 0.4 million tonnes.
- In 2016, Germany accounted for the highest share of EU refining capacity (14.3%), followed closely by Italy with a share of 13.4%.
- Europe/Eurasia remains the third largest refining region in the world, with a share of 17.3% in 2017.
- Refineries provide work for approximately 120,000 employees and contractors. Indirect employment accounts for an additional 1.2 million jobs, many of which are in highly skilled technical positions, logistics or marketing.
- Imported refined petroleum products from Russia have been steadily increasing since 2012, reaching around 65 million tonnes in 2016.
- The United States is still the most important export country of the EU. This volume has steadily reduced from 33 million tonnes in 2008 to 25 million tonnes in 2016. Imports from the United States also were at around 25 million tonnes in 2016.
- From 2008 to 2016, extra-EU imports of refined petroleum products were always at a similar level to extra-EU exports.

Source: Authors' elaboration

Sample statistics

Overall, 81 refinery plant sites were contacted and asked to participate in the Study. Eventually, 13 out of these, i.e. 16%, responded to the questionnaire; two plants shared electricity and gas bills with the Research Team for validation purposes (see Table 247).

Table 247 Plants participating in the survey

Geographical regions	Plants contacted	Questionnaires collected	Number of plants sharing supporting evidence
CEE	14	1	0
NWE	42	8	2
SE	25	4	0
Total	**81**	**13**	**2**

Source: Authors' elaboration

The coverage of the EU population shows the share of the capacity of surveyed plants in total EU capacity (i.e. total production capacity of the sample divided by the total EU production capacity) in each year. According to data obtained from FuelsEurope, total refining capacity in the EU was around 685 Mt/year in 2017. As the respondents accounted for a capacity of around 130 Mt/year in 2016 and 2017, we covered around 19-20% of total EU capacity in 2016 and 2017 (Table 248). It is important to note that data for the years prior to 2016 are obtained from the sampled data in the 2016 EPC Study, which analysed data from 2008 to 2015 except for 2009 and 2011.

Table 248 Capacity of sampled plants out of total capacity in the EU (%)

Sector	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Refinery	9.4	n.a.	12.8	n.a.	19.8	21.8	22.5	22.4	19.1	19.8

Source: Authors' elaboration on FuelsEurope.

About 62% of the sample is composed of plants based in the NWE region, while 31% of the sample is composed of plants in SE. As 8% of plants were based in CEE, the region is slightly under-represented.

As for mitigation measures, we did the following to increase the response rate:

- We asked for additional support from EU associations (FuelsEurope and Concawe), who helped convince companies to participate.
- We sent out reminders via email to all companies where we had contact details.
- We called companies whenever we had a relevant phone number.
- We specifically approached again the companies that participated in the previous study two years ago, either via email or phone.

9.2 Electricity

The following table summarises the electricity data, including electricity prices and electricity costs in €/MWh, electricity costs in €/tonne and electricity intensity in MWh/tonne. In the table small fluctuations can be seen in electricity prices over the period 2008-2017. In the same period, a significant fall in electricity costs can also be seen. The difference is due to reimbursement and self-generation. Electricity intensity shows a very slight decline.

Table 249 Electricity: summary table (EU) - Simple averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity prices (€/MWh)	77.6	n.a.	69.2	n.a.	75.5	72.4	76.9	73.6	69.0	70.5
Electricity costs (€/MWh)	92.4	n.a.	89.2	n.a.	92.0	92.6	89.2	83.6	62.9	65.9

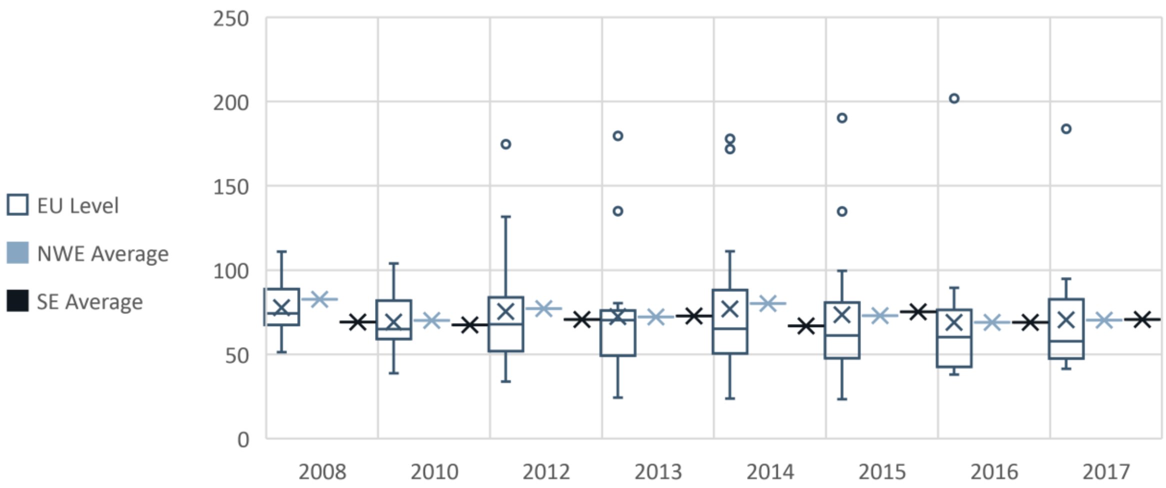
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity costs (€/tonne)	6.2	n.a.	6.7	n.a.	6.9	6.8	7.1	6.1	3.5	3.8
Electricity intensity (MWh/tonne)	0.07	n.a.	0.08	n.a.	0.07	0.07	0.07	0.07	0.06	0.06

Source: Authors' elaboration

Electricity prices

Figure 200 shows that average electricity prices at the EU level decreased from 2008 (€77.6/MWh) to 2017 (€70.5/MWh). Prices ranged from €69.0 to €76.9/MWh. In 2017, the price was €70.5/MWh. In most years, electricity prices in NWE were higher than in SE. In the former the average electricity price ranged from €69.0 to €82.7/MWh and in the latter from €67.0 to €75.3/MWh. In 2017, the electricity price at EU level was on average €70.5/MWh with a minimum of €41.5/MWh and a maximum of €94.8/MWh. However, there are outliers in every year of observation from 2012 to 2017; these are plants either in countries with high electricity prices with *ex post* reimbursements that are not covered under the price of electricity, but under electricity costs (see below), or plants that do not receive any reimbursement or exemption.

Figure 200 Electricity prices (€/MWh) – Box plots and simple averages



Note: At the EU level the number of observations were 8 in 2008, 9 in 2010, 15 in 2012, 16 in 2013, 2014 and 2015 and 13 in 2016 and 2017. Data for the CEE region are not displayed due to confidentiality reasons.
Source: Authors' elaboration

The electricity prices at EU level and sub-regional level are weighted against purchased electricity in MWh. Table 250 shows that the EU and NWE weighted averages are lower than the simple averages. A reason could be that larger plants in this region are able to negotiate more favourable contracts. On the other hand, SE weighted averages are higher than simple averages, except in 2010. Possible reasons could be that the advantage of larger plants in negotiations does not hold here or that in specific countries in the region prices are higher than in others.

Table 250 Electricity prices (€/MWh) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EU simple average	77.6	n.a.	69.2	n.a.	75.5	72.4	76.9	73.6	69.0	70.5
EU weighted average	67.3	n.a.	64.6	n.a.	63.8	63.6	63.3	63.6	59.6	63.7
NWE simple average	82.7	n.a.	70.0	n.a.	77.2	72.2	80.2	73.1	69.0	70.4
NWE weighted average	66.4	n.a.	63.7	n.a.	61.3	60.5	61.6	59.0	56.8	60.4
SE simple average	69.2	n.a.	67.4	n.a.	70.8	72.7	67.0	75.3	69.1	70.7
SE weighted average	70.0	n.a.	67.1	n.a.	71.5	73.5	68.5	78.4	70.6	75.3

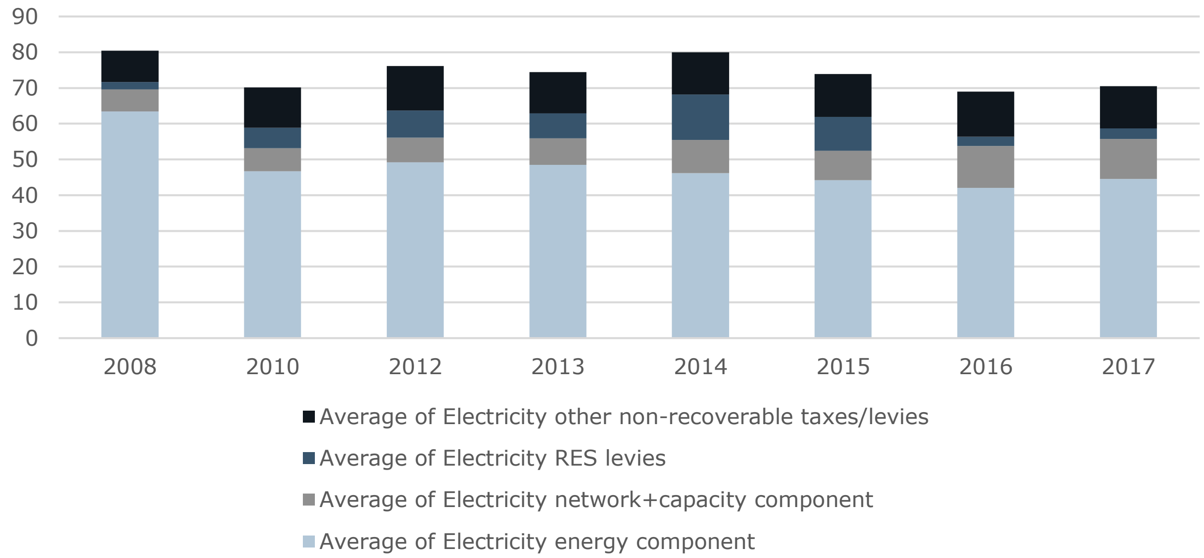
Note: Weighting factor: electricity purchased. At the EU level the number of observations were 8 in 2008, 9 in 2010, 15 in 2012, 16 in 2013, 2014 and 2015 and 13 in 2016 and 2017.
Source: Authors' elaboration

Components of the electricity price[64]

Figure 201 and Figure 202 show the average of the various electricity components at the EU level. Throughout the 2008 to 2017 period the average of the electricity energy component underwent a slightly downward trend, with the highest average in 2008 (€63.5/MWh) and the lowest in 2016 (€42.1/MWh). In 2017, the electricity component was €44.5/MWh. On the contrary, the average of the electricity network and capacity component shows a slightly increasing trend with the highest value in 2016 followed by 2017 (€11.2/MWh in 2017). The electricity component accounted for 79% and 63% of the total electricity price in 2008 and 2017 respectively. The average of the electricity other non-recoverable taxes/levies shows a fairly stable trend (€11.9/MWh in 2017), while the average electricity RES levies show a rather volatile average throughout the period (€2.9/MWh in 2017). The high RES levies from 2012 to 2015 are caused by two sites that were not exempted from the RES levy nor received any reimbursement. Both sites participated in the 2016 EPC Study, but were not covered in the current Assignment.

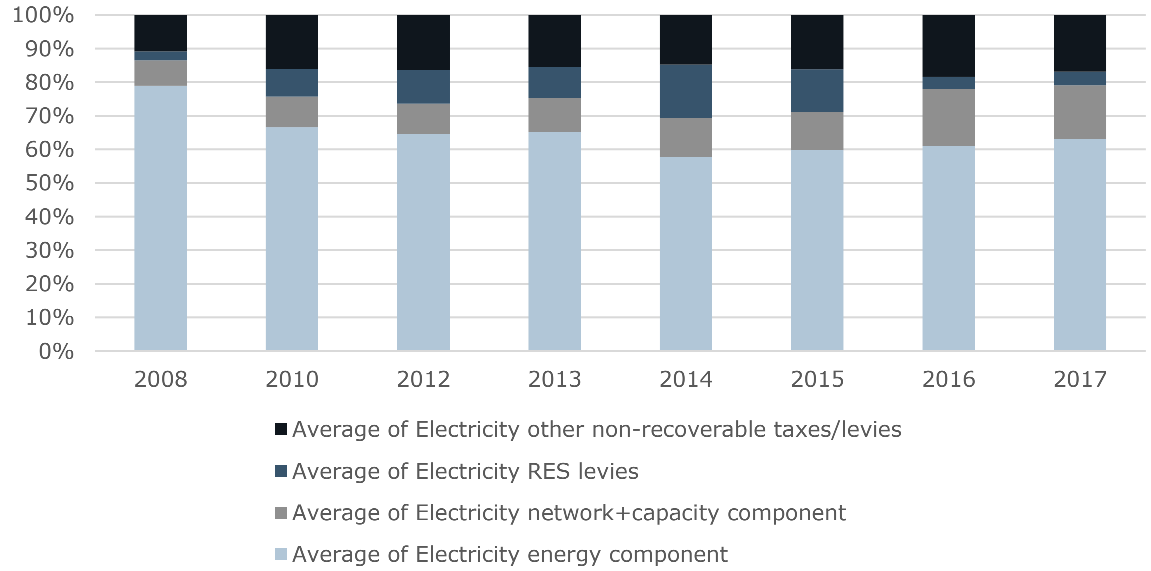
[64] Note that the sum of the electricity bill components does not necessarily add up to the total electricity price mentioned before as there might be plants that did not provide a breakdown of the electricity bill components while still providing the total electricity price.

Figure 201 Components of the electricity price (€/MWh, EU) - Simple averages



Note: At the EU level the number of observations were 7 in 2008, 8 in 2010, 14 in 2012-2015 and 13 in 2016 and 2017.
Source: Authors' elaboration

Figure 202 Components of the electricity price (%, EU) - Simple averages



Note: At the EU level the number of observations were 7 in 2008, 8 in 2010, 14 in 2012-2015 and 13 in 2016 and 2017.
Source: Authors' elaboration

The components of the electricity price at EU level are weighted against purchased electricity in MWh. Table 251 shows that for all indicators the weighted averages are lower than the simple averages, except RES levies in 2010. A possible explanation could be that larger plants are able to negotiate better rates for their energy component, while at the same time paying less for network and other regulatory components (RES and other non-recoverable taxes/levies).

Table 251 Components of the electricity price (€/MWh, EU) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Energy component simple average	63.5	n.a.	46.7	n.a.	49.2	48.5	46.2	44.2	42.1	44.5
Energy component weighted average	56.1	n.a.	44.7	n.a.	46.4	47.2	43.6	42.9	40.1	43.2
Network + capacity component simple average	6.1	n.a.	6.4	n.a.	6.9	7.5	9.3	8.3	11.7	11.2
Network + capacity component weighted average	3.1	n.a.	4.3	n.a.	4.8	5.6	6.5	7.3	9.0	9.9
RES levies simple average	2.1	n.a.	5.7	n.a.	7.6	6.9	12.7	9.5	2.5	2.9
RES levies weighted average	1.6	n.a.	8.8	n.a.	3.7	2.5	5.3	3.7	2.4	2.7
Other non-recoverable taxes/levies simple average	8.8	n.a.	11.3	n.a.	12.5	11.5	11.8	12.0	12.7	11.9
Other non-recoverable taxes/levies weighted average	6.2	n.a.	6.4	n.a.	8.4	7.6	7.5	7.9	8.0	8.0

Note: Weighting factor: electricity purchased. At the EU level the number of observations were 7 in 2008, 8 in 2010, 14 in 2012-2015 and 13 in 2016 and 2017.
Source: Authors' elaboration

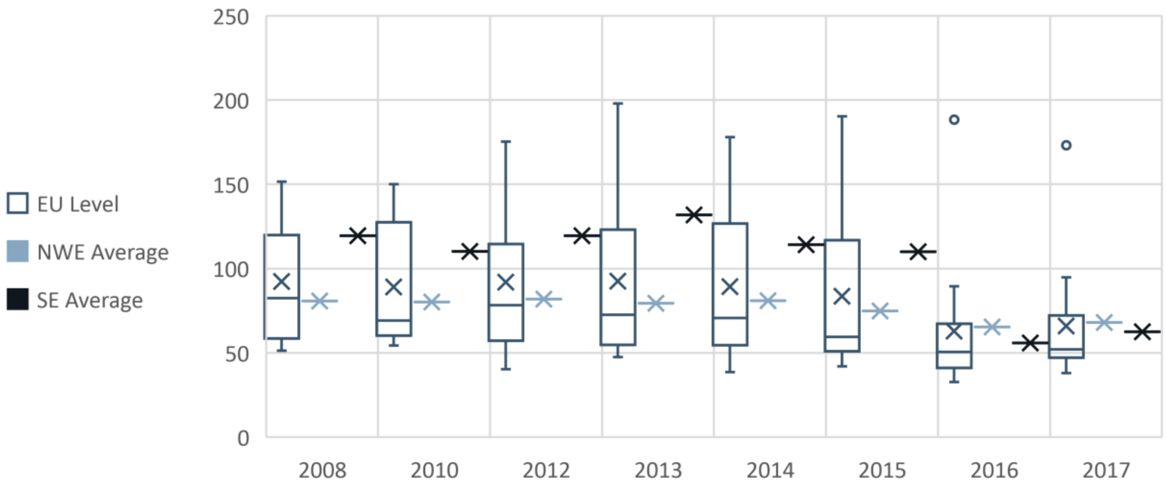
Electricity costs

Average electricity costs in €/MWh at the EU level were on a slightly downward trend from 2008 (€92.4/MWh) to 2017 (€65.9/MWh), with a significant decrease from 2015 to 2016 (see Figure 203).[65] This significant decrease is particularly seen in the SE region, where the average electricity cost plummeted from €110.0/MWh to €55.8/MWh. The NWE region also underwent a downward trend in electricity costs, though not as prominent as in the SE region. In 2016 and 2017, the average electricity costs at EU, NWE and SE level were relatively similar at €65.9/MWh (EU), €68.0/MWh (NWE) and €62.6/MWh (SE). At the EU level the minimum cost was €38.1/MWh and the maximum cost was €94.8/MWh. One outlier is present

[65] Electricity prices in €/MWh are defined as follows: Total price paid to purchase electricity/Total electricity purchased. Electricity costs in €/MWh are defined 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).

in 2016 and 2017. This is a plant that faces high electricity prices. The maximum values before 2016 are either the same plant or two plants that have high electricity self-generation costs. Note that in 2017, two plants received some form of reimbursement. The high difference between electricity price and electricity costs in €/MWh between 2008 and 2015 is caused by two plants that had high costs for self-generated electricity. The two plants were not covered in the sample in 2016 and 2017.

Figure 203 Electricity costs (€/MWh) – Box plots and simple averages



Note: At the EU level the number of observations were 10 in 2008 and 2010, 15 in 2012, 16 in 2013-2015 and 13 in 2016 and 2017. Data for the CEE region are not displayed due to confidentiality reasons.
Source: Authors' elaboration

The electricity costs in €/MWh at EU level and sub-regional level are weighted against electricity consumption. The EU and NWE weighted averages are significantly lower than the simple averages. This is a similar trend as was seen for the electricity prices and could indicate that large plants are able to negotiate more favourable contracts and pay less for network and other regulatory components (RES and other non-recoverable taxes/levies). This does not hold for SE weighted averages, where in most cases weighted average is higher than the simple average.

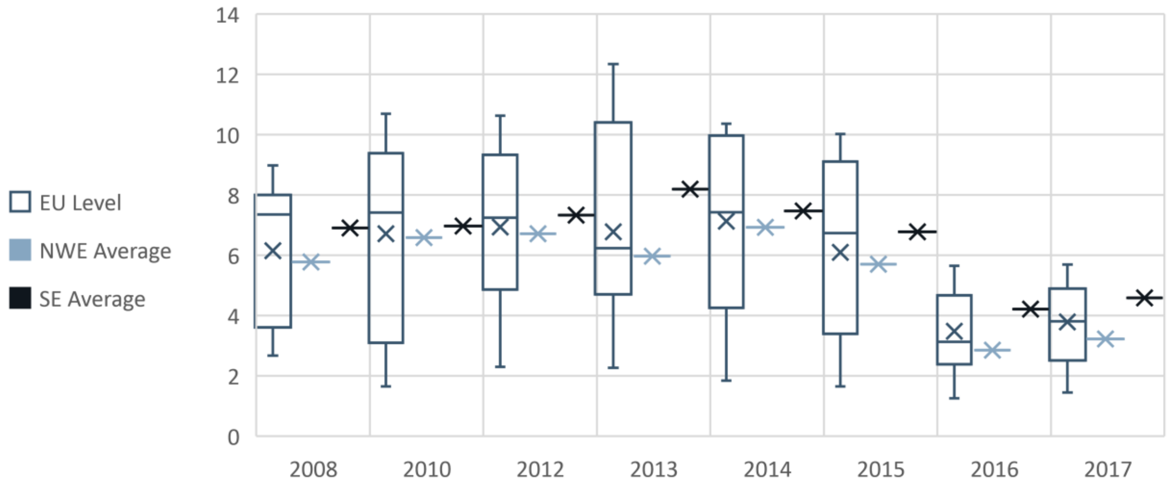
Table 252 Electricity costs (€/MWh) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EU simple average	92.4	n.a.	89.2	n.a.	92.0	92.6	89.2	83.6	62.9	65.9
EU weighted average	79.1	n.a.	79.0	n.a.	84.6	87.0	80.3	73.2	51.6	56.0
NWE simple average	80.7	n.a.	80.2	n.a.	82.0	79.5	80.9	74.8	65.5	68.0
NWE weighted average	70.2	n.a.	71.4	n.a.	72.5	73.0	69.6	61.9	49.2	53.5
SE simple average	119.6	n.a.	110.1	n.a.	119.5	131.8	114.1	110.0	55.8	62.6
SE weighted average	119.2	n.a.	106.9	n.a.	128.4	141.2	121.0	118.9	55.1	60.7

Note: Weighting factor: total electricity consumption. At the EU level the number of observations were 10 in 2008 and 2010, 15 in 2012, 16 in 2013-2015 and 13 in 2016 and 2017.
Source: Authors' elaboration

Figure 204 shows that the average electricity costs (€/tonne) at EU, NWE and SE levels saw a fairly stable trend in the 2008-2015 period. However, the average cost dropped substantially from 2014 to 2017. In 2017, costs were at €3.8/tonne. Since electricity intensity (see next section) shows a limited decrease, the changes in electricity costs seem to follow the fluctuations in electricity prices and costs in € per MWh. The observations showed high ranges between minimum and maximum electricity costs, especially from 2008 and 2017, with the highest range in 2013, when the minimum was €2.3/tonne and the maximum €12.3/tonne.

Figure 204 Electricity costs (€/tonne) – Box plots and simple averages



Note: At the EU level the number of observations were 9 in 2008 and 2010, 11 in 2012-2015 and 13 in 2016 and 2017. Data for the CEE region are not displayed due to confidentiality reasons.
Source: Authors' elaboration

The electricity costs (€/tonne) are weighted against production output. Table 253 shows that the EU and NWE weighted averages are lower than the simple averages (note: this does not always hold for SE). The clear EU trend between simple and weighted averages indicates that economies of scale are relevant for the sector.

Table 253 Electricity costs (€/tonne) – Simple and weighted averages

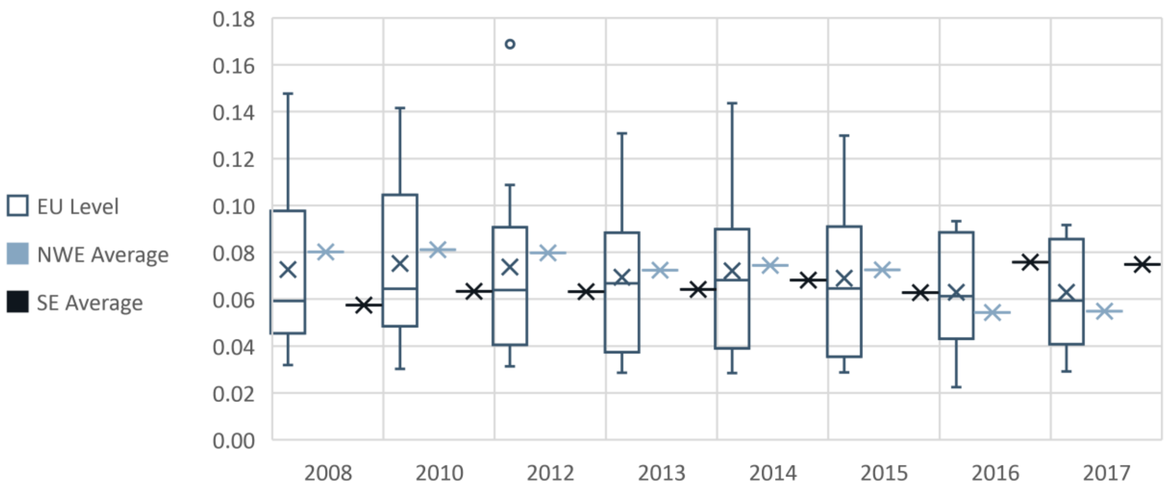
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EU simple average	6.2	n.a.	6.7	n.a.	6.9	6.8	7.1	6.1	3.5	3.8
EU weighted average	5.7	n.a.	5.8	n.a.	6.7	6.5	6.5	5.8	3.2	3.6
NWE simple average	5.8	n.a.	6.6	n.a.	6.7	6.0	6.9	5.7	2.8	3.2
NWE weighted average	5.2	n.a.	5.4	n.a.	6.0	5.3	5.8	5.0	2.8	3.1
SE simple average	6.9	n.a.	7.0	n.a.	7.3	8.2	7.5	6.8	4.2	4.6
SE weighted average	6.9	n.a.	6.8	n.a.	7.9	8.9	8.0	7.4	4.2	4.6

Note: Weighting factor: production output. At the EU level the number of observations were 9 in 2008 and 2010, 11 in 2012-2015 and 13 in 2016 and 2017.
Source: Authors' elaboration

Electricity intensity

Figure 205 shows that the average electricity intensity at the EU level ranged from 0.06 to 0.08 MWh/tonne, decreasing slightly from 2008 (0.07 MWh/tonne) to 2017 (0.06 MWh/tonne). Overall, efficiency thus increased slightly. The NWE region underwent a slightly downward trend, especially noticeable between 2015 (0.07 MWh/tonne) and 2017 (0.05 MWh/tonne). By contrast, the SE region underwent a slight upward trend, particularly visible from 2015 (0.06 MWh/tonne) to 2016 (0.08 MWh/tonne). In 2017, the electricity intensity for the EU was 0.06 MWh/tonne. The outlier in 2012 is caused by the same plant as was responsible for the maximum values in 2008, 2010, 2013, 2014 and 2015.

Figure 205 Electricity intensity (MWh/tonne) – Box plots and simple averages



Note: At the EU level the number of observations were 9 in 2008 and 2010, 11 in 2012-2015 and 13 in 2016 and 2017. Data for the CEE region are not displayed due to confidentiality reasons.
Source: Authors' elaboration

The electricity intensity averages are weighted against product output. Table 254 shows that the EU, SE and NWE weighted averages are almost the same as the simple averages. This may be an indication that there is limited effect from economies of scale on electricity intensity in the sector.

Table 254 Electricity intensity (MWh/tonne) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EU simple average	0.07	n.a.	0.08	n.a.	0.07	0.07	0.07	0.07	0.06	0.06
EU weighted average	0.07	n.a.	0.07	n.a.	0.07	0.07	0.07	0.07	0.06	0.06
NWE simple average	0.08	n.a.	0.08	n.a.	0.08	0.07	0.07	0.07	0.05	0.05
NWE weighted average	0.08	n.a.	0.08	n.a.	0.08	0.07	0.07	0.07	0.06	0.06
SE simple average	0.06	n.a.	0.06	n.a.	0.06	0.06	0.07	0.06	0.08	0.07
SE weighted average	0.06	n.a.	0.06	n.a.	0.06	0.06	0.07	0.06	0.08	0.08

Note: Weighting factor: production output. At the EU level the number of observations were 9 in 2008 and 2010, 11 in 2012-2015 and 13 in 2016 and 2017.
Source: Authors' elaboration

Additional information

In this section we focus on the analysis of the years 2015, 2016 and 2017, given that this additional information was not asked for in years prior to 2015 (the 2016 EPC Study). In total, 13 plants provided data on the breakdown of their electricity contract type. Plants could select multiple types of contract, which means that the number of contracts is higher than the total number of 13 plants. Most of the plants have wholesale contracts, followed by provider contracts.

Table 255 Electricity contract type

EU	Electricity Contract Type Breakdown	
Contract type	Count	% of plants
PPA	1	8%
Wholesale	11	85%
Provider	5	38%

Note: At EU level the number of observations was 13.
Source: Authors' elaboration

The duration of electricity contracts was provided by 13 plants. None reported any contracts of an indeterminate duration. 77% (in total 10) reported contracts of up to five years. 23% (three contracts) reported contracts with a duration of over five years.

Out of the 13 plants, two participated in a flexibility scheme for electricity (both NWE). The average number of outages and the average duration (in minutes) of these outages are divided into three types, namely planned outages, other planned outages and unplanned outages. The unplanned outages were spread over the three geographical regions.

Table 256 Electricity outages

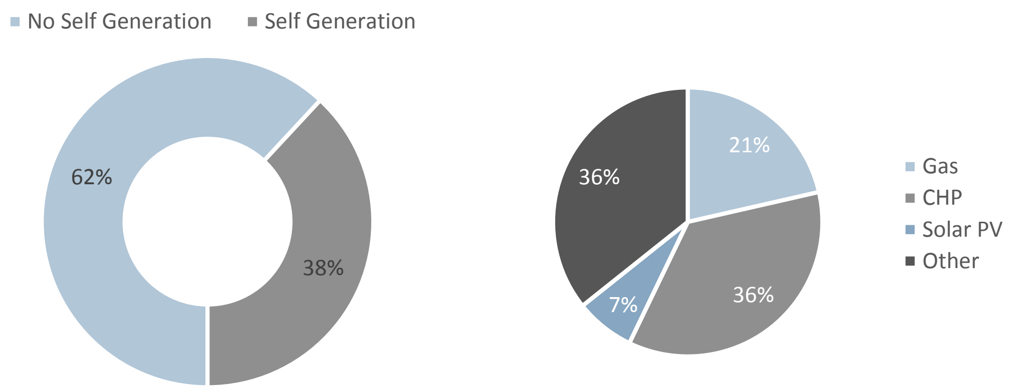
EU	Planned outages		Other planned outages		Unplanned outages	
Year	Total number	Average duration	Total number	Average duration	Total number	Average duration
2015	NR	NR	0	0	9	2
2016	NR	NR	1	720	9	5
2017	NR	NR	0	0	7	1

Note: Planned outages are linked to flexibility schemes; other planned outages are not linked to flexibility schemes, but notified in advance by the energy supplier; unplanned outages are not notified.

Source: Authors' elaboration

About 40% of sampled plants used self-generated electricity. Most of this self-generated electricity came from CHP (36%), gas (21%) and other sources (29%, for example solar PV). Four plants sold self-generated electricity on the market, this is a percentage of 31%.

Figure 206 Self-generation & self-generation type



Source: Authors' elaboration

9.3 Natural gas

The following table summarises the natural gas data, including prices in €/MWh, costs in €/tonne and intensity in MWh/tonne. As can be seen, natural gas prices and costs, after a dip in 2010, slightly increased and then decreased from 2014 onwards. Also, natural gas intensity as well as total gas intensity (which includes the consumption of self-produced gases, i.e. refinery fuel gases) follows the same trend, with in particular a decrease from 2014 onwards. This could indicate more efficient use of natural gas in the plants.

Table 257 Natural gas: summary table (EU) - Simple averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas prices (€/MWh)	28.6	n.a.	23.4	n.a.	28.6	30.1	26.4	23.8	20.3	21.6
Natural gas costs (€/tonne)	10.7	n.a.	9.3	n.a.	11.7	12.0	8.2	5.9	4.6	5.1
Total gas costs (€/tonne)	13.1	n.a.	13.7	n.a.	19.6	18.5	14.3	10.5	11.9	14.1

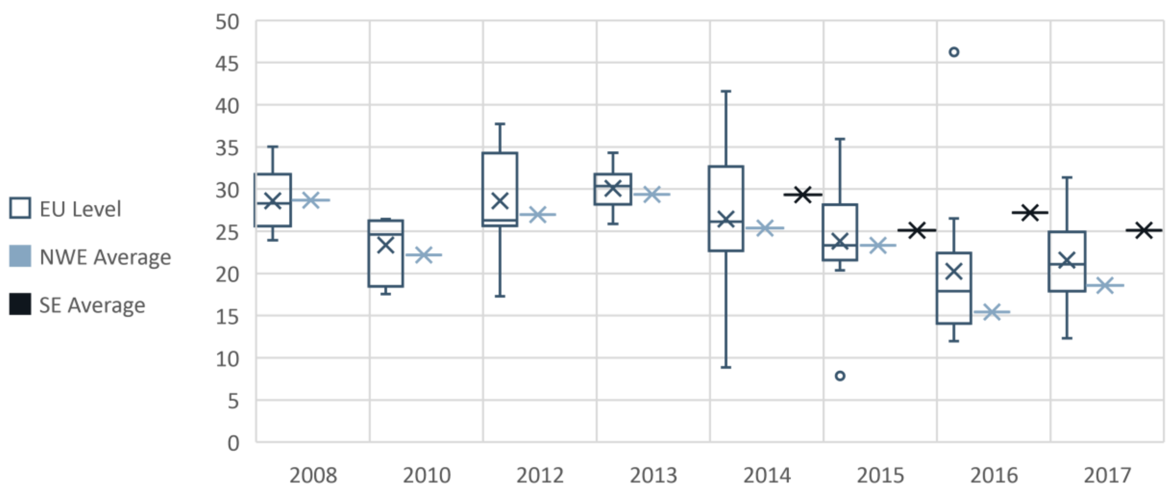
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas intensity (MWh/tonne)	0.35	n.a.	0.34	n.a.	0.36	0.38	0.31	0.26	0.24	0.24
Total gas intensity (MWh/tonne)	0.77	n.a.	0.83	n.a.	0.89	0.88	0.91	0.86	0.69	0.68

At the EU level the number of observations was 5 in 2008, 7 in 2010, 11 in 2012, 12 in 2013, 2016 and 2017 and 15 in 2014 and 2015.
Source: Authors' elaboration

Natural gas prices

In the EU, the average natural gas prices show a general decreasing trend, which is notably visible from 2013 to 2016, when prices dropped from €30.0/MWh to €20.3/MWh (Figure 207). In 2017, the value was €21.6/MWh. This clear fall in prices was also seen at the NWE level, where natural gas prices plunged from €29.4/MWh in 2013 to €15.4/MWh in 2016. At the SE level, it is difficult to draw conclusions given that the number of data points throughout the 2008 to 2017 period is small. The outlier shown in 2016 is a plant that self-generates most of the gas that it consumes. The outlier for 2015 is the same plant as bottom range 2014 and provided only data for these two years. For all years where SE natural gas prices could be shown, the natural gas price is above the NWE natural gas price.

Figure 207 Natural gas prices (€/MWh) – Box plots and simple averages



Note: At the EU level the number of observations was 5 in 2008, 7 in 2010, 11 in 2012, 12 in 2013, 2016 and 2017 and 15 in 2014 and 2015. Data for the SE region in 2008 to 2013 and the CEE region are not displayed due to confidentiality reasons.
Source: Authors' elaboration

The natural gas prices at EU level and sub-regional level are weighted against purchased natural gas. Table 258 shows that the EU and NWE weighted averages are lower than the simple averages, except in 2014 and 2015. Similar to electricity prices, this could indicate that larger plants in the NWE are able to negotiate more favourable contracts. SE weighted averages are mostly higher than simple averages.

Table 258 Natural gas prices (€/MWh) – Simple and weighted averages

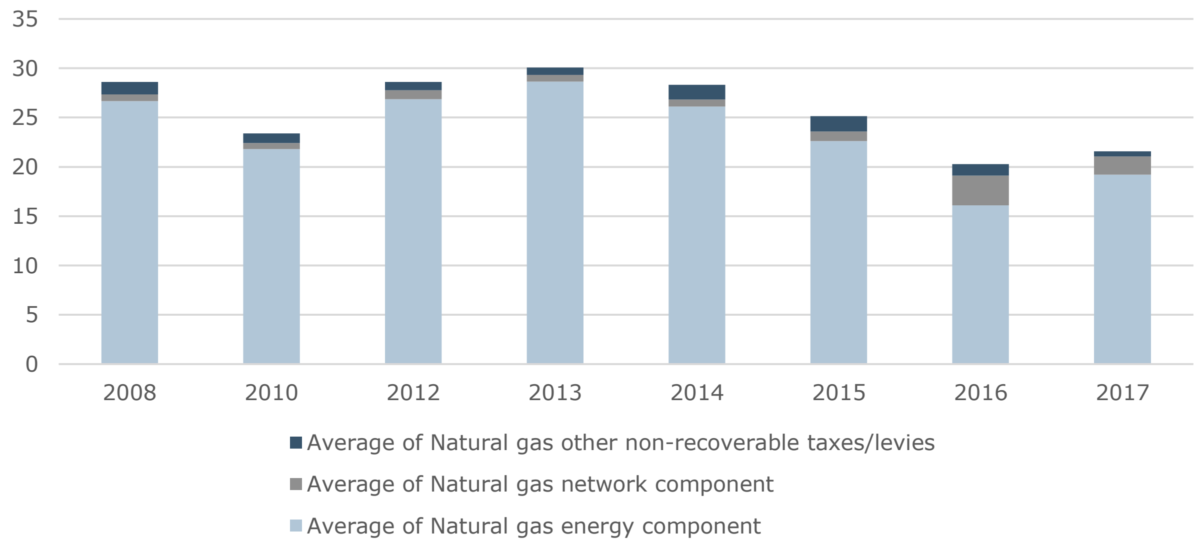
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EU simple average	28.6	n.a.	23.4	n.a.	28.6	30.1	26.4	23.8	20.3	21.6
EU weighted average	26.4	n.a.	21.9	n.a.	26.4	30.1	25.9	23.4	17.8	20.5
NWE simple average	28.7	n.a.	22.2	n.a.	27.0	29.4	25.4	23.3	15.4	18.6
NWE weighted average	26.0	n.a.	20.9	n.a.	24.8	29.3	25.6	23.6	15.0	17.7
SE simple average	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	29.3	25.1	27.2	25.1
SE weighted average	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	26.7	22.4	20.9	23.1

Note: Weighting factor: natural gas purchased. At the EU level the number of observations was 5 in 2008, 7 in 2010, 11 in 2012, 12 in 2013, 2016 and 2017 and 15 in 2014 and 2015.
Source: Authors' elaboration

Components of the natural gas price[66]

The components of the natural gas price (€/MWh) are shown in Figure 208 and Figure 209. The average of the natural gas energy component increased 7% from 2008 to 2013 but decreased 33% from 2013 (€28.6/MWh) to 2017 (€19.2/MWh in 2017). The energy component made up around 93% and 89% of the total natural gas price in 2008 and 2017 respectively. The average of the natural gas network component was moderately stable until 2015 (€0.6-0.9/MWh), while in 2016 it increased to €3/MWh. This outlier is caused by the fact that one plant had very low natural gas consumption in that respective year (due to a very high share of self-generation), meaning that network costs became relatively and absolutely more important. The average of the other non-recoverable taxes/levies component shows a general declining trend throughout the period from 2008 (€1.3/MWh) to 2017 (€0.5 /MWh in 2017), equivalent to 62%.

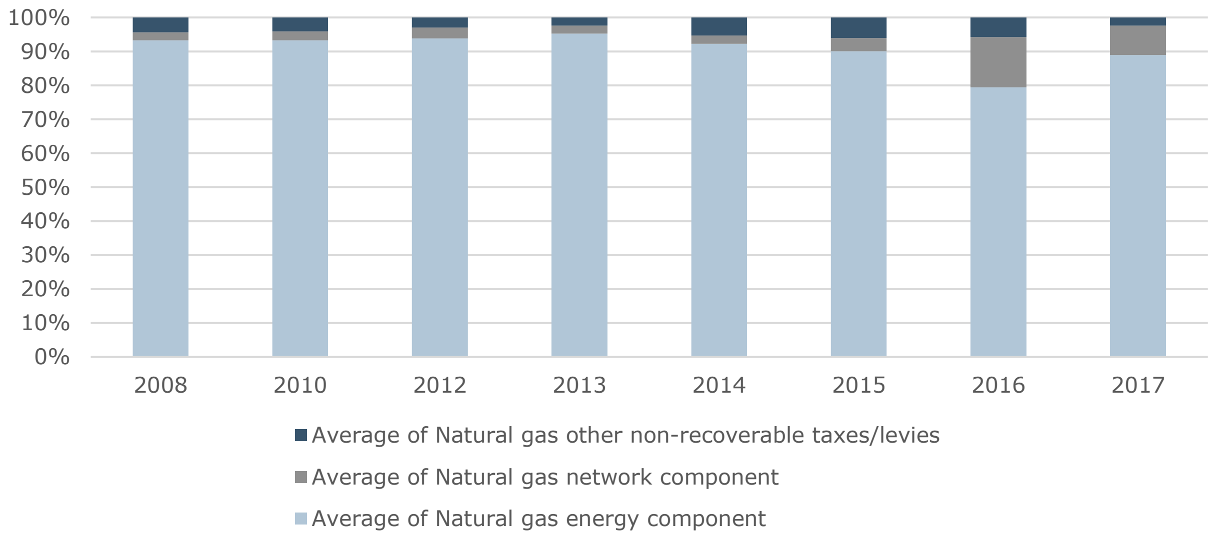
Figure 208 Components of the natural gas price (€/MWh, EU) – Simple averages



Note: The observations at EU level were 5 in 2008, 7 in 2010, 11 in 2012-2013, 13 in 2014-2015 and 12 in 2016-2017.
Source: Authors' elaboration

[66] Note that the sum of the natural gas bill components does not necessarily add up to the total natural gas price mentioned before as there might be plants that did not provide a breakdown of the natural gas bill components while still providing the total natural gas price.

Figure 209 Components of the natural gas price (%, EU) – Simple averages



Note: The observations at EU level were 5 in 2008, 7 in 2010, 11 in 2012-2013, 13 in 2014-2015 and 12 in 2016-2017.
Source: Authors' elaboration

The components of the natural gas price are weighted against natural gas consumption. Table 259 shows that the weighted averages of the energy component are lower than the simple averages, except in 2013, 2014 and 2015. The weighted averages of the network component are also not always lower than the simple averages. Other non-recoverable taxes/levies, in contrast, are for all years lower than the simple average. This indicates that larger plants do not necessarily negotiate better rates for their energy component, nor do they pay less for the network component. Larger consumers, however, seem to pay less for their other regulatory component (i.e. non-recoverable taxes/levies) than their smaller counterparts.

Table 259 Components of the natural gas price (€/MWh, EU) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Energy component simple average	26.7	n.a.	21.8	n.a.	26.9	28.6	26.1	22.6	16.1	19.2
Energy component weighted average	23.8	n.a.	20.3	n.a.	25.1	28.9	26.3	23.3	15.6	18.6
Network component simple average	0.7	n.a.	0.6	n.a.	0.9	0.7	0.7	1.0	3.0	1.9
Network component weighted average	1.4	n.a.	0.9	n.a.	0.8	0.7	0.8	0.7	1.3	1.3
Other non-recoverable taxes/levie	1.3	n.a.	1.0	n.a.	0.8	0.7	1.5	1.5	1.2	0.5

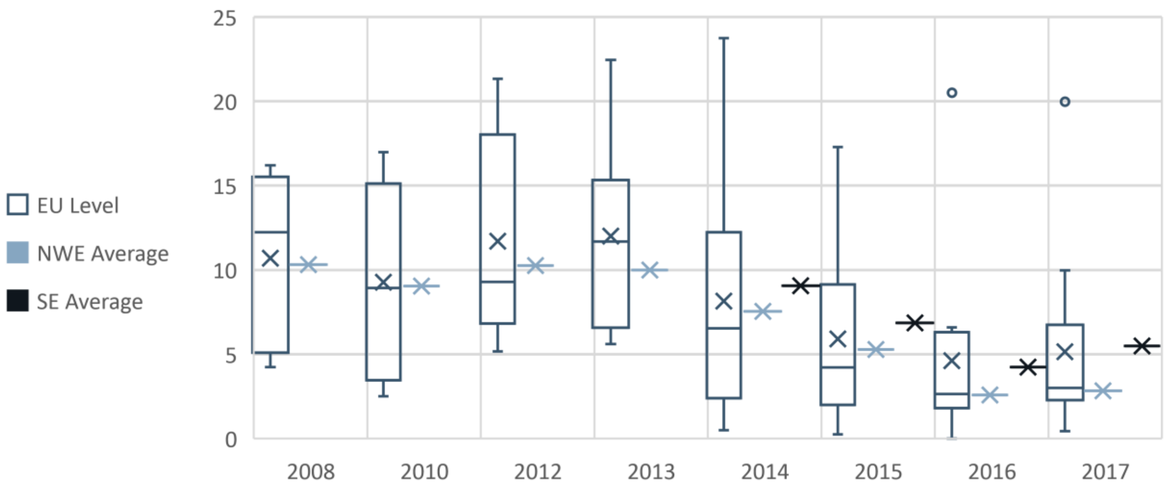
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
s simple average										
Other non-recoverable taxes/levies weighted average	1.1	n.a.	0.7	n.a.	0.5	0.5	0.5	0.6	0.8	0.6

Note: Weighting factor: natural gas purchased. The observations at EU level were 5 in 2008, 7 in 2010, 11 in 2012-2013, 13 in 2014-2015 and 12 in 2016-2017.
Source: Authors' elaboration

Natural gas costs

Figure 210 shows that the average costs of natural gas (in €/tonne) at the EU level decreased by 52%. In 2017 the cost was around €5/tonne, with a minimum of €0.4/tonne and a maximum of €10/tonne. There are two statistical outliers, one in 2016 and one in 2017. These are due to a plant with low natural gas consumption as most gas used is self-generated at low costs. The trend of the average NWE costs is similar to the trend at EU level. However, average NWE costs were at the lower end of EU prices in 2016 and 2017. In 2017, NWE average costs were €2.8/tonne. There are too few data points to determine a trend in the SE region during the 2008 to 2017 period; however, it is evident that the costs in the SE region declined from 2014-2017, with an average cost of €5.5/tonne in 2017.

Figure 210 Natural gas costs (in €/tonne) – Box plots and simple averages



Note: At the EU level the number of observations was 5 in 2008, 6 in 2010, 7 in 2012-2013, 10 in 2014-2015 and 12 in 2016-2017. Data for the SE region in 2008 to 2103 and the CEE region are not displayed due to confidentiality reasons.
Source: Authors' elaboration

The natural gas costs (€/tonne) are weighted against production output. Table 260 shows that the EU and NWE weighted averages are lower than the simple averages. This seems to be due to the lower natural gas prices for large consumers as well as economies of scale. The weighted averages of SE in 2014 and 2015, in contrast, are higher than the simple average.

Table 260 Natural gas costs (€/tonne) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EU simple average	10.7	n.a.	9.3	n.a.	11.7	12.0	8.2	5.9	4.6	5.1

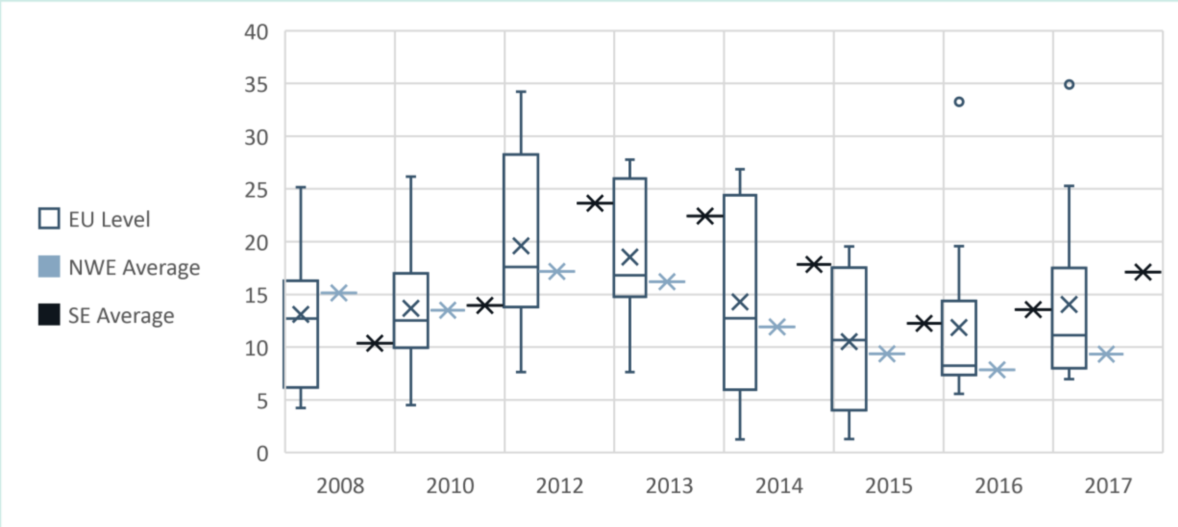
EU weighted average	10.5	n.a.	8.7	n.a.	11.7	11.6	7.8	5.6	3.1	3.7
NWE simple average	10.3	n.a.	9.0	n.a.	10.3	10.0	7.6	5.3	2.6	2.8
NWE weighted average	10.2	n.a.	8.0	n.a.	9.8	9.3	7.0	4.7	2.3	2.6
SE simple average	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	9.1	6.9	4.2	5.5
SE weighted average	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	9.2	7.1	3.8	5.1

Note: Weighting factor: production output. At the EU level the number of observations was 5 in 2008, 6 in 2010, 7 in 2012-2013, 10 in 2014-2015 and 12 in 2016-2017.
Source: Authors' elaboration

Box 18 Total gas costs (in €/tonne) – Box plots and simple averages

Figure 211 indicates that the average total gas costs (in €/tonne) at the EU level was rather volatile throughout the 2008 to 2017 period, ranging from €10.5 to €19.6/tonne. In 2016 and 2017 the total costs were €11.9 and €14.0 in €/tonne respectively. Statistical outliers in 2016 and 2017 are present, which correspond to a small plant with very high natural gas intensity, medium natural gas price and low self-produced gas share.

Figure 211 Total gas costs (in €/tonne) – Box plots and simple averages



Note: At the EU level the number of observations was 7 in 2008-2010, 8 in 2012-2013, 10 in 2014-2015 and 12 in 2016-2017. Data for the CEE region are not displayed due to confidentiality reasons.

The total natural gas cost is weighted against production output. The EU weighted averages are higher than the simple averages, except in 2014, 2015, 2016 and 2017. NWE weighted averages are higher than simple averages in all cases, while SE simple averages are higher than weighted averages in all cases.

Figure 212 Total gas costs (€/tonne) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EU simple average	13.1	n.a.	13.7	n.a.	19.6	18.5	14.3	10.5	11.9	14.1
EU weighted average	14.9	n.a.	14.1	n.a.	20.0	18.9	13.9	10.3	10.0	12.1

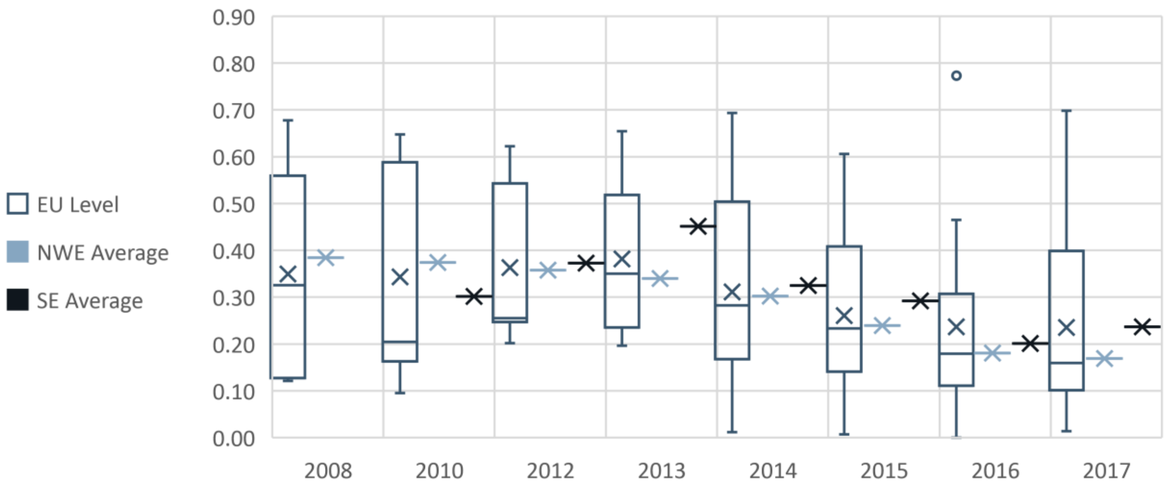
NWE simple average	15.1	n.a.	13.5	n.a.	17.2	16.2	11.9	9.4	7.8	9.3
NWE weighted average	17.4	n.a.	14.2	n.a.	18.8	17.7	12.7	9.9	8.1	9.6
SE simple average	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	17.9	12.3	13.6	17.1
SE weighted average	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	15.9	11.1	12.9	16.5

Note: Weighting factor: production output. At the EU level the number of observations was 7 in 2008-2010, 8 in 2012-2013, 10 in 2014-2015 and 12 in 2016-2017.
Source: Authors' elaboration

Natural gas intensity

Figure 213 indicates that average natural gas intensity at the EU level was on a decreasing trend throughout the period 2008 to 2017, with wide ranges in most years. In 2008, the average intensity was 0.35 MWh/tonne while in 2017, it was 0.24 MWh/tonne. At the NWE level, the natural gas intensity decreased during the 2008 to 2017 period from 0.38 MWh/tonne to 0.17 MWh/tonne. At the SE level, the natural gas intensity increased from 2010 to 2013, but decreased in the following four years. The natural gas intensity in NWE is on average mostly lower than the natural gas intensity in SE (2010 is an exception). The statistical outlier in 2016 corresponds to a small plant with a very high natural gas intensity and limited self-production of gas; and the low minimum values from 2014 to 2017 correspond to a plant with low natural gas consumption as most gas used is self-generated.

Figure 213 Natural gas intensity (MWh/tonne) – Box plots and simple averages



Note: At the EU level the number of observations was 6 in 2008, 7 in 2010, 8 in 2012-2013, 10 in 2014-2015 and 12 in 2016-2017. Data for the SE region in 2008 and for the CEE region are not displayed due to confidentiality reasons.
Source: Authors' elaboration

The natural gas intensity is weighted against production output. Table 261 shows that the EU weighted averages are lower than the simple averages, except in 2008, 2010 and 2012. The NWE weighted averages are always lower except for in 2008. The SE weighted averages are higher in 2014 and 2015, but lower in 2016 and 2017.

Table 261 Natural gas intensity (MWh/tonne) – Simple and weighted averages

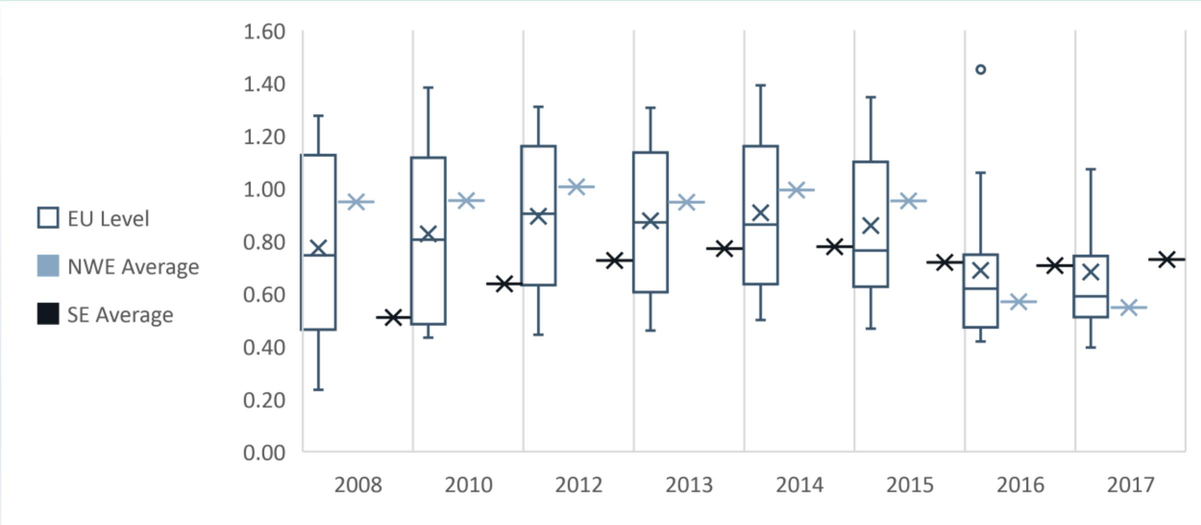
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EU simple average	0.35	n.a.	0.34	n.a.	0.36	0.38	0.31	0.26	0.24	0.24
EU weighted average	0.40	n.a.	0.36	n.a.	0.38	0.37	0.30	0.25	0.18	0.18
NWE simple average	0.38	n.a.	0.37	n.a.	0.36	0.34	0.30	0.24	0.18	0.17
NWE weighted average	0.39	n.a.	0.35	n.a.	0.34	0.32	0.27	0.21	0.16	0.15
SE simple average	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	0.33	0.29	0.20	0.24
SE weighted average	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	0.34	0.32	0.18	0.22

Note: Weighting factor: production output. At the EU level the number of observations was 6 in 2008, 7 in 2010, 8 in 2012-2013, 10 in 2014-2015 and 12 in 2016-2017.
Source: Authors' elaboration

Box 19 Total gas intensity (in MWh/tonne)

Figure 214 indicates that the total gas intensity at the EU level remained fairly stable throughout the period from 2008 to 2017, with a slight change of total gas intensity from 0.77 MWh/tonne in 2008 to 0.68 MWh/tonne in 2017. At the NWE level, the total gas intensity was higher than the EU level average until 2015, dropping from 0.95 MWh/tonne in 2015 to 0.55 MWh/tonne in 2017. On the other hand, the SE region had a noticeable increase in total gas intensity from 2008 to 2017.

Figure 214 Total gas intensity (MWh/tonne) – Box plots and simple averages



Note: At the EU level the number of observations was 10 in 2008, 2010 and 2012-2015 and 12 in 2016 and 2017. Data for the CEE region are not displayed due to confidentiality reasons.
Source: Authors' elaboration

The total natural gas intensity is weighted against production output. Table 262 shows that the EU weighted averages are lower than the simple averages, except in 2008 and 2010. NWE weighted averages are also lower, except in 2016 and 2017. SE weighted averages are lower than simple averages, except in 2015.

Table 262 Total gas intensity (MWh/tonne) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EU simple average	0.77	n.a.	0.83	n.a.	0.89	0.88	0.91	0.86	0.69	0.68
EU weighted average	0.90	n.a.	0.86	n.a.	0.86	0.83	0.85	0.82	0.63	0.62
NWE simple average	0.95	n.a.	0.95	n.a.	1.00	0.95	0.99	0.95	0.57	0.55
NWE weighted average	0.91	n.a.	0.87	n.a.	0.84	0.78	0.89	0.86	0.59	0.56
SE simple average	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	0.78	0.72	0.71	0.73
SE weighted average	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	0.78	0.74	0.68	0.70

Note: Weighting factor: production output. At the EU level the number of observations was 10 in 2008, 2010 and 2012-2015 and 12 in 2016 and 2017.
Source: Authors' elaboration

Additional information

In total, 13 plants provided data about the breakdown of their natural gas contract type. Plants could select multiple types of contract, which means that the number of contracts is higher than the total number of 13. Most plants (85%) have a provider contract type, followed by wholesale contracts (38%).

Table 263 Natural gas contract type

EU	Electricity Contract Type Breakdown	
Contract type	Count	% of plants
Wholesale	5	38%
Provider	11	85%

Source: Authors' elaboration

In terms of natural gas contract duration, interviewees did not report any contracts of an indeterminate duration. 85% (in total 11) reported contracts of up to five years, and 8% (one contract) reported contracts with a duration of more than five years. Those with a duration of more than five years reported that they have problems in renewing these contracts as suppliers now hesitate to provide long-term contracts. According to participants, one reason for this is that energy markets are undergoing regulatory and legislative reforms. Out of the 13 plants, two participated in a flexibility/interruptibility scheme for natural gas (NWE).

Participating companies did not report on any outages. Furthermore, all plants reported they produced gas themselves and one plant reported that they sell at least part of their self-produced gas.

9.4 Other fuel[67]

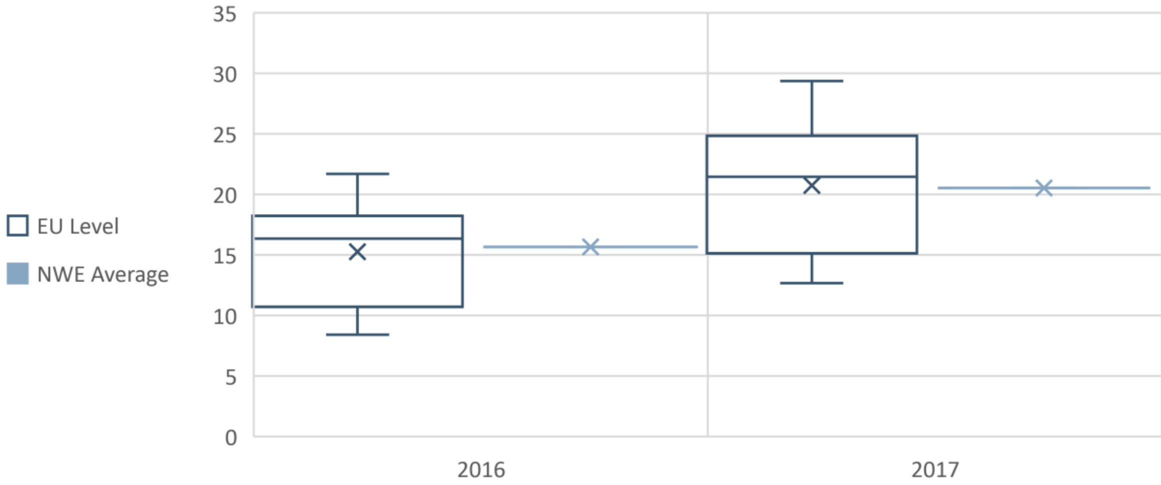
Other fuel prices (coke)

At the EU and NWE levels, the price of solid fuel (coke) increased from 2016 to 2017; 35% at the EU level (30% at the NWE level). In 2017, the price was €20.7/MWh. There are no

[67] Other fuels in this chapter refer to coke, fuel oil and crude oil. While coke and fuel oil are used as a fuel, only a portion of crude oil (4–8%) is used as a fuel in the transformation and cracking processes of refineries. We nonetheless also cover crude oil in this chapter as crude oil costs represent the largest part of refineries' production costs and are thus of particular relevance.

data available for the previous years. Observations from the SE and CEE regions were not sufficient to provide an indication of coke prices.

Figure 215 Coke price (€/MWh) – Box plots and simple averages



Note: There were 8 observations in 2016 and in 2017 for the EU level; and 5 observations in 2016 and in 2017 for the NWE level. The number of observations in each year was 1 for the CEE region and 2 for the SE region, and therefore data for the SE and CEE regions are not displayed separately.
Source: Authors' elaboration

The coke price is weighted against coke consumption in MWh. Table 264 shows that the EU weighted average is lower than the simple average in both 2016 and 2017.

Table 264 Coke price (€/MWh) – Simple and weighted averages

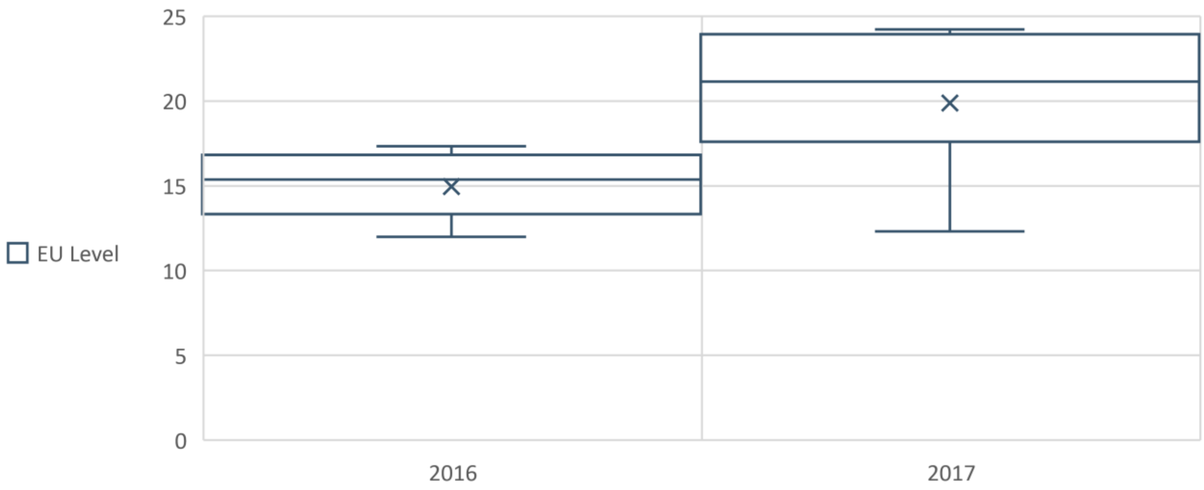
Indicator	2016	2017
EU simple average	15.3	20.7
EU weighted average	14.6	19.3

Note: Weighting factor: solid fuel (coke) consumption. At the EU level there were 8 observations for 2016 and 2017.
Source: Authors' elaboration

Other fuel prices (fuel oil)

Regarding the price of fuel oil, the EU average increased from about €14.9/MWh in 2016 to €19.9/MWh in 2017 (see Figure 216). The NWE, SE and CEE regions did not provide enough independent observations to allow for an estimation of a regional average.

Figure 216 Fuel oil price (€/MWh) – Simple averages



Note: There were 7 observations in 2016 and 2017 for the EU level. No regions are shown as there were not enough independent observations per region in each year.
Source: Authors' elaboration

The fuel oil price is weighted against fuel oil consumption. Table 265 shows that the EU weighted average is higher than the simple average in both 2016 and 2017. This is caused by one plant consuming a large amount of fuel oil while also having relatively high fuel oil prices.

Table 265 Fuel oil price (€/MWh) – Simple and weighted averages

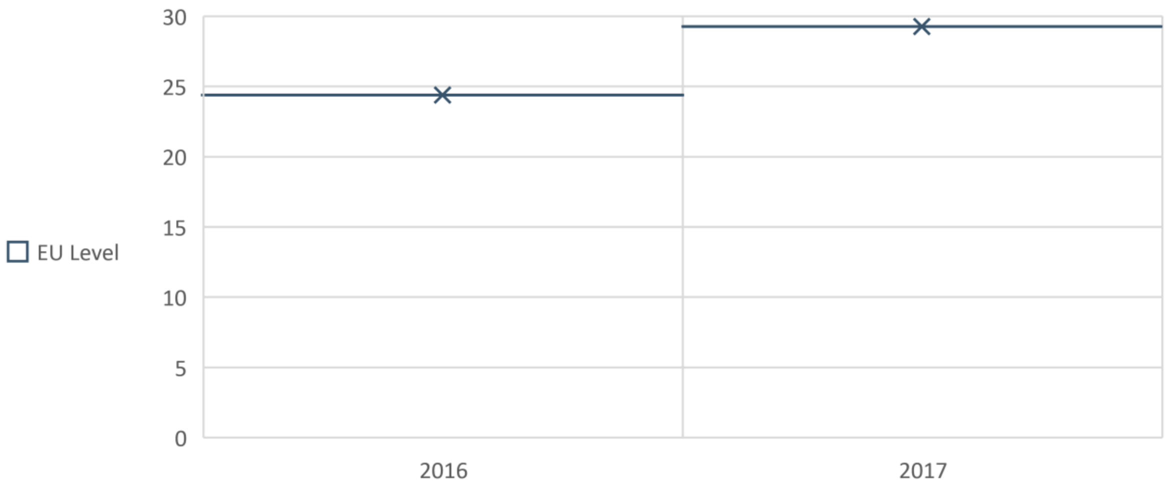
Indicator	2016	2017
EU simple average	14.9	19.9
EU weighted average	16.4	22.9

Note: Weighting factor: fuel oil consumption. There were 7 observations in 2016 and 2017 for the EU level.
Source: Authors' elaboration

Other fuel prices (crude oil)

Regarding the price of crude oil, the EU average moved from about €24.4/MWh in 2016 to €29.3/MWh in 2017. The NWE, SE and CEE regions did not provide enough observations to allow for an estimation of a regional average. In the figure below no box plots are shown because of confidentiality reasons (there were only three observations).

Figure 217 Crude oil price (€/MWh) – Simple averages



Note: There were 3 observations in 2016 and 2017 for the EU level. For NWE, SE and CEE regions, there was only 1 observation per region in each year.
Source: Authors' elaboration

The crude oil price is weighted against crude oil consumption. Table 266 shows that the EU weighted average is lower than the simple average in both 2016 and 2017.

Table 266 Crude oil price (€/MWh) – Simple and weighted averages

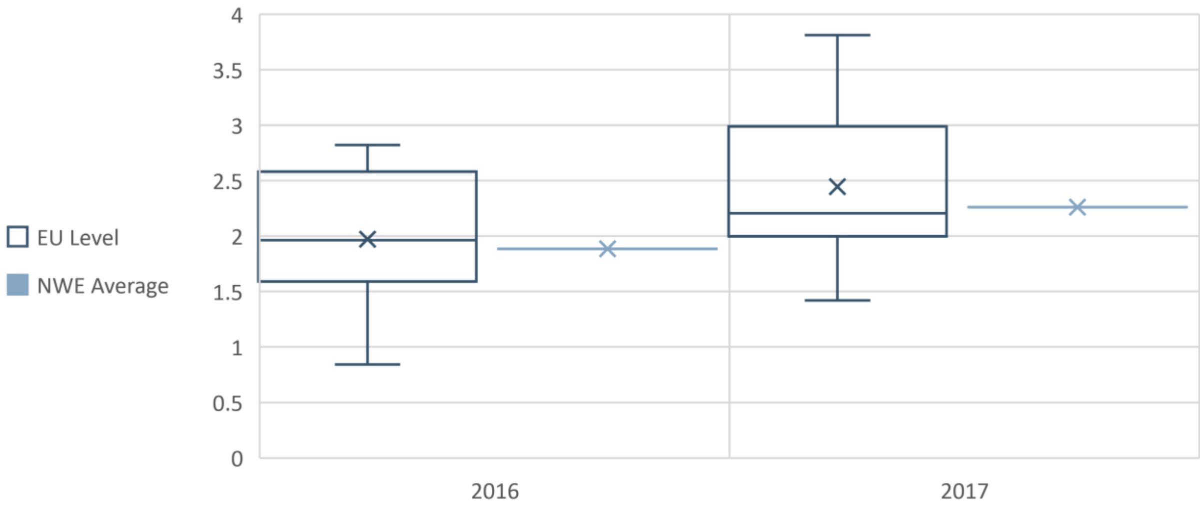
Indicator	2016	2017
EU simple average	24.4	29.3
EU weighted average	23.9	28.9

Note: Weighting factor: crude oil consumption. There were 3 observations in 2016 and 2017 for the EU level.
Source: Authors' elaboration

Other fuel costs (coke)

At the EU and NWE levels, the costs of solid fuel (coke) in €/tonne increased significantly from 2016 to 2017. In the EU, prices increased by around 20% (in NWE they also increased by 20%). There is no data available for the previous years. The number of observations from the SE and CEE regions were not sufficient to provide an indication of coke prices for those regions.

Figure 218 Coke costs (€/tonne) – Box plots and simple averages



Note: There were 8 observations in 2016 and in 2017 for the EU level; and 5 observations in 2016 and in 2017 for the NWE level. The number of observations in each year was 1 for the CEE region and 2 for the SE region, and therefore data for the SE and CEE regions are not displayed separately.
Source: Authors' elaboration

The coke price is weighted against production output. Table 267 shows that the EU weighted average is at an identical level to the simple average in both 2016 and 2017.

Table 267 Coke costs (€/tonne) – Simple and weighted averages

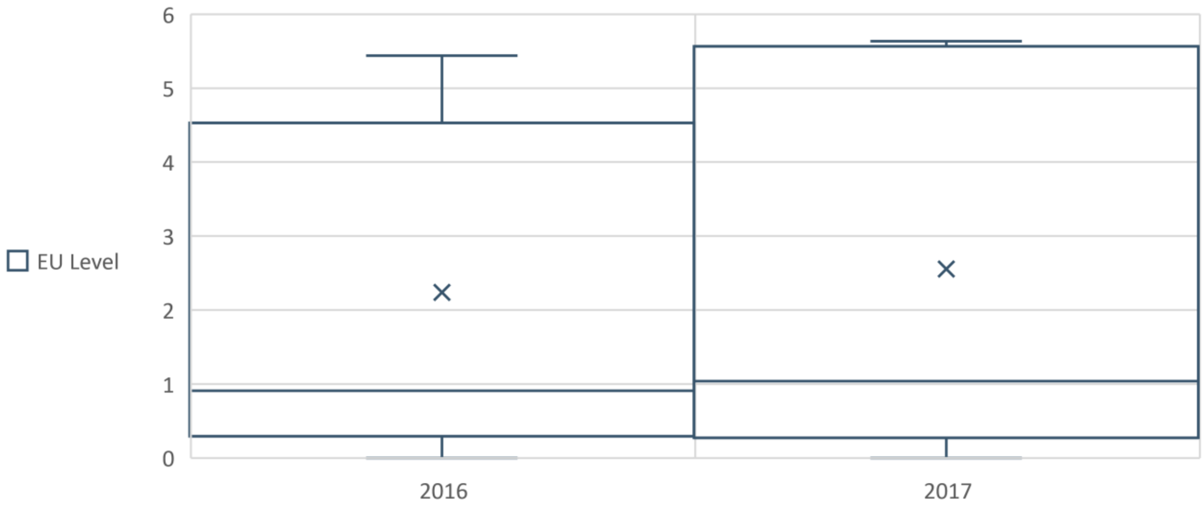
Indicator	2016	2017
EU simple average	2.0	2.4
EU weighted average	2.0	2.4

Note: Weighting factor: production output. At the EU level there were 8 observations for 2016 and 2017.
Source: Authors' elaboration

Other fuel costs (fuel oil)

Regarding the costs of fuel oil in €/tonne, the EU average moved from about €2.2/tonne in 2016 to €2.5/tonne in 2017. The NWE, SE and CEE regions did not provide enough independent observations to allow for an estimation of a regional average. The range between the maximum and minimum value is high as some plants use only low volumes of fuel oil (in addition to natural gas) while others use high volumes of fuel oil that partially replace natural gas.

Figure 219 Fuel oil costs (€/tonne) – Simple averages



Note: There were 7 observations in 2016 and 2017 for the EU level. No regions are shown as there were not enough independent observations per region in each year.
Source: Authors' elaboration

The fuel oil costs are weighted against production output. Table 268 shows that the EU weighted average is lower than the simple average in both 2016 and 2017.

Table 268 Fuel oil costs (€/tonne) – Simple and weighted averages

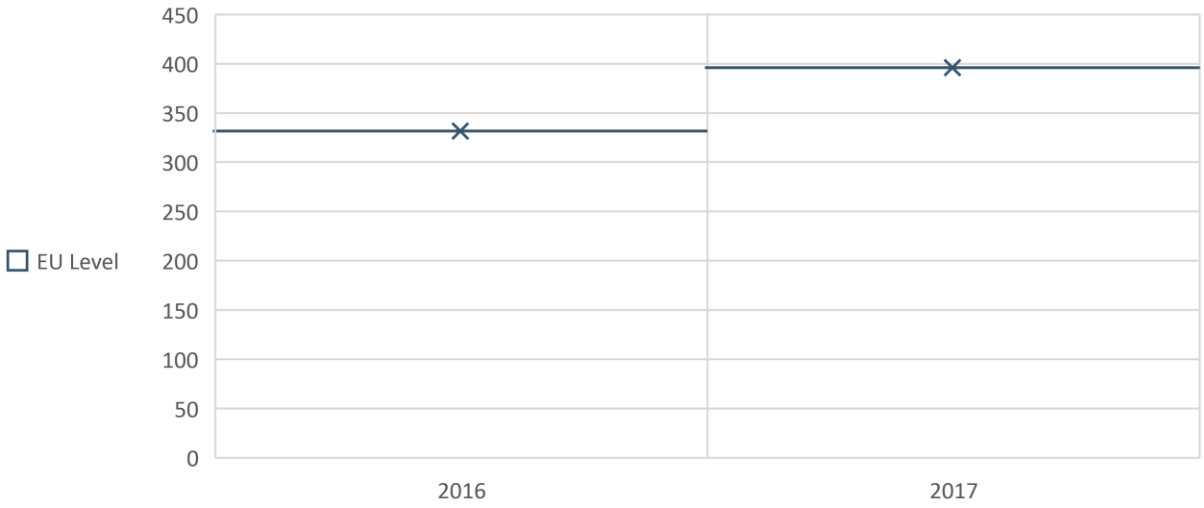
Indicator	2016	2017
EU simple average	2.2	2.5
EU weighted average	1.9	2.2

Note: Weighting factor: production output. There were 7 observations in 2016 and 2017 for the EU level.
Source: Authors' elaboration

Other fuel costs (crude oil)

Regarding the costs of crude oil in €/tonne, the EU average moved from about €331.5/tonne in 2016 to €395.8/tonne in 2017. The NWE, SE and CEE regions did not provide enough observations to allow for an estimation of a regional average. In Figure 220 no box plots are shown because of confidentiality reasons (there were only three observations).

Figure 220 Crude oil costs (€/tonne) – Simple averages



Note: There were 3 observations in 2016 and 2017 for the EU level. For NWE, SE and CEE regions, there was only 1 observation per region in each year.
Source: Authors' elaboration

The crude oil costs are weighted against production output. Table 269 shows that the EU weighted average is lower than the simple average in both 2016 and 2017.

Table 269 Crude oil costs (€/tonne) – Simple and weighted averages

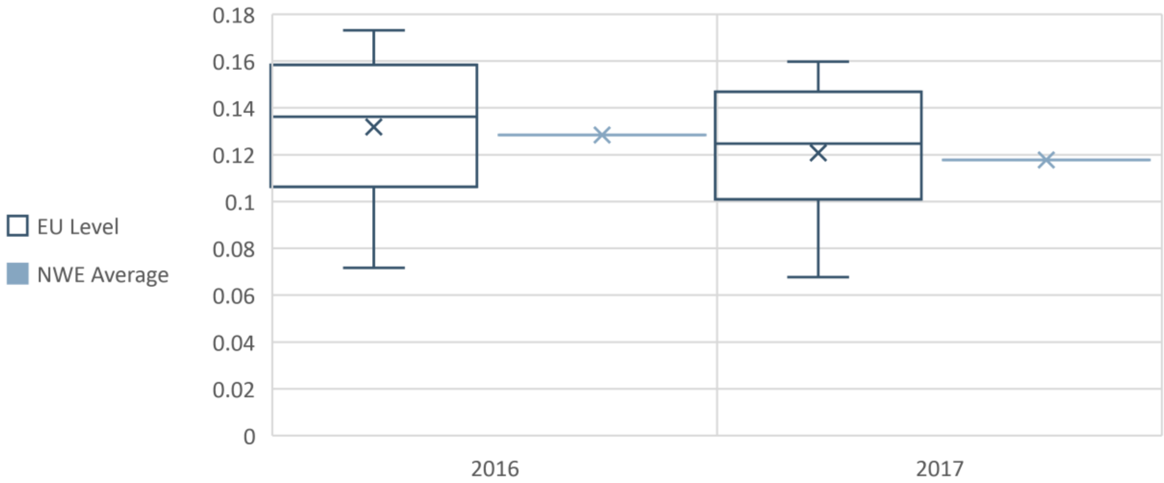
Indicator	2016	2017
EU simple average	331.5	395.8
EU weighted average	322.7	386.3

Note: Weighting factor: production output. There were 3 observations in 2016 and 2017 for the EU level.
Source: Authors' elaboration

Other fuel intensity (coke)

The average for the solid fuel (coke) intensity went down in 2017 in comparison with 2016, from about 0.13 to 0.12 MWh/tonne. The average value for the NWE region is slightly below the European average value. The minimum value decreased by only 0.004 from 2016 to 2017, while the maximum value decreased by 0.01 MWh/tonne.

Figure 221 Coke intensity (MWh/tonne) – Box plots and simple averages



Note: There were 8 observations in 2016 and 2017 for the EU level. For NWE, the regional average is presented as there are 5 observations. For the other regions, with only 2 and 1 observation per region, no regional average is presented.
Source: Authors' elaboration

The coke intensity is weighted against production output. Table 270 shows that the EU weighted average is higher than the simple average in 2016 and the same in 2017.

Table 270 Coke intensity (MWh/tonne) – Simple and weighted averages

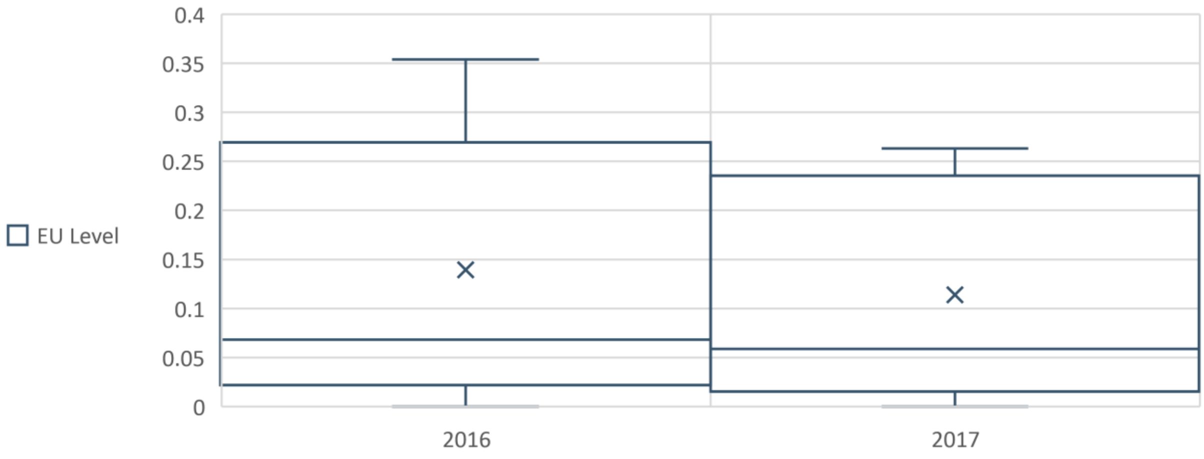
Indicator	2016	2017
EU simple average	0.13	0.12
EU weighted average	0.14	0.12

Note: Weighting factor: production output. There were 8 observations in 2016 and 2017 for the EU level.
Source: Authors' elaboration

Other fuel intensity (fuel oil)

The fuel oil intensity at the EU level dropped slightly from 2016 to 2017. The average fuel oil intensity decreased from 0.14 MWh/tonne to 0.11 MWh/tonne.

Figure 222 Fuel oil intensity (MWh/tonne) – Simple averages



Note: There were 7 observations in 2016 and 2017 for the EU level. No regions are shown as there were not enough independent observations per region in each year.
Source: Authors' elaboration

The fuel oil intensity is weighted against production output. Table 271 shows that the EU weighted average is lower than the simple average in both 2016 and 2017. This means that large producers seem to have a lower fuel oil intensity than smaller ones.

Table 271 Fuel oil intensity (MWh/tonne) – Simple and weighted averages

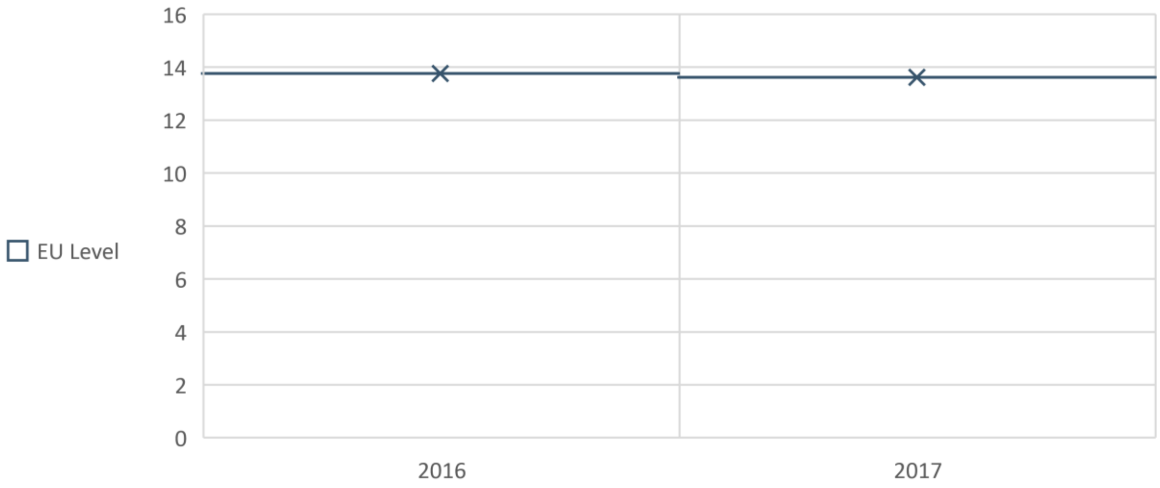
Indicator	2016	2017
EU simple average	0.14	0.11
EU weighted average	0.12	0.10

Note: Weighting factor: production output. There were 7 observations in 2016 and 2017 for the EU level.
Source: Authors' elaboration

Other fuel intensity (crude oil)

The crude oil intensity at the EU level hardly changed from 2016 to 2017, with values in 2017 being just slightly lower than in 2016. The average crude oil intensity decreased with less than 0.2 MWh/tonne (from about 13.76 to 13.62 MWh/tonne).

Figure 223 Crude oil intensity (MWh/tonne) – Simple averages



Note: There were 3 observations in 2016 and 2017 at the EU level. For the NWE, SE and CEE regions, the regional averages are not presented given that only 1 observation per region per year was obtained.
Source: Authors' elaboration

The crude oil intensity is weighted against production output. Table 272 shows that the EU weighted average is lower than the simple average in both 2016 and 2017.

Table 272 Crude oil intensity (MWh/tonne) – Simple and weighted averages

Indicator	2016	2017
EU simple average	13.76	13.62
EU weighted average	13.51	13.38

Note: Weighting factor: production output. There were 3 observations in 2016 and 2017 for the EU level.
Source: Authors' elaboration

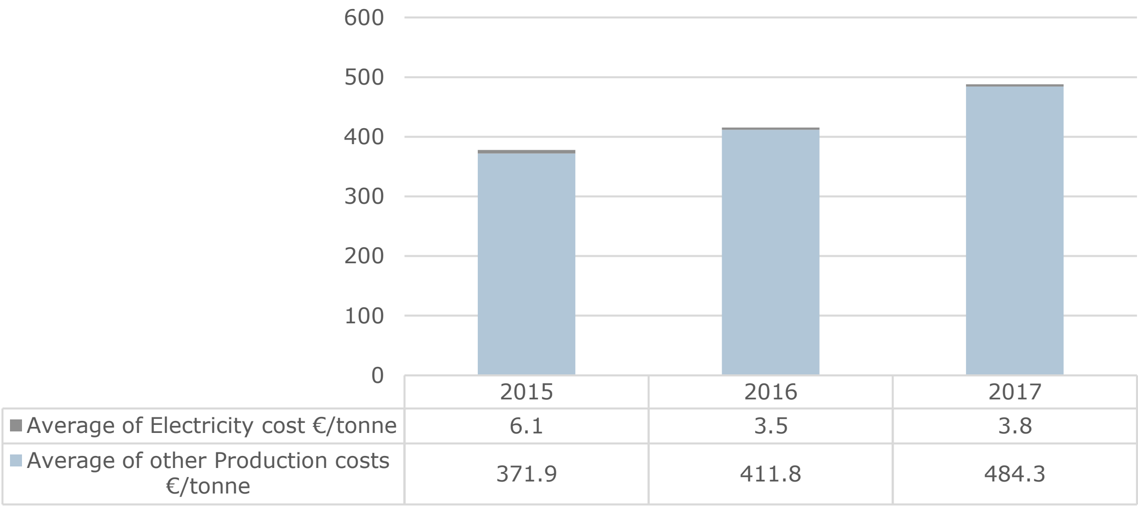
9.5 Competitiveness

<u>Cost competitiveness</u>

Electricity

The average of other production costs per tonne of product increased by 30% from €371.9/tonne in 2015 to €488.1/tonne in 2017 (see Figure 224). The average costs for electricity per tonne of product, in contrast, decreased by 38% from €6.1/tonne in 2016 to €3.8/tonne in 2017. Electricity costs per tonne make up less than 1% of the total production costs per tonne.

Figure 224 Electricity costs as a share of production costs (€/tonne, EU) – Simple averages



Note: For electricity costs, there were 11 observations in 2015 and 13 in 2016 and 2017. For production costs, there were 3 observations in 2015 and 8 observations in 2016 and 2017.
Source: Authors' elaboration

The electricity costs and production costs are weighted against production output. Table 273 shows that weighted averages for both indicators are lower than the simple averages. This could indicate that economies of scale are relevant in the sector; however, from the earlier data presented on electricity costs this was not similar for all regions (notably it did not show for SE).

Table 273 Electricity costs as a share of production costs (€/tonne) – Simple and weighted averages

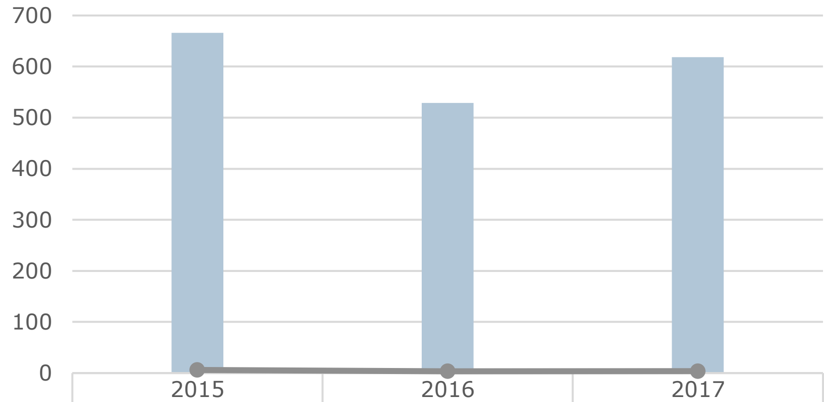
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity costs simple average (€/tonne)	6.2	n.a.	6.7	n.a.	6.9	6.8	7.1	6.1	3.5	3.8
Electricity costs weighted average (€/tonne)	5.7	n.a.	5.8	n.a.	6.7	6.5	6.5	5.8	3.2	3.6
Production costs simple average (€/tonne)	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	378.0	415.3	488.1
Production costs weighted average (€/tonne)	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	348.0	369.4	435.2
Electricity costs as a share of production costs simple	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	1.6%	0.8%	0.8%

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
averages (%)										
Electricity costs as a share of production costs weighted averages (%)	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	1.7%	0.9%	0.8%

Note: Weighting factor: production output. For electricity costs, there were 11 observations in 2015 and 13 in 2016 and 2017. For production costs, there were 3 observations in 2015 and 8 observations in 2016 and 2017.
Source: Authors' elaboration

The average turnover per unit of production decreased 7%, from €666.1/tonne in 2015 to €618.6/tonne in 2017. The electricity costs per unit of production decreased 38% from €6.1/tonne in 2015 to €3.8/tonne in 2017. The share of electricity costs in relation to turnover decreased from about 0.9% in 2015 to 0.6% in 2017.

Figure 225 Electricity costs versus turnover (€/tonne, EU) – Simple averages



	2015	2016	2017
Average of Turnover €/tonne	666.1	528.9	618.6
Average of Electricity cost €/tonne	6.1	3.5	3.8

Note: For electricity costs, there were 11 observations in 2015 and 13 in 2016 and 2017. For turnover, there were 3 observations in 2015 and 6 observations in 2016 and 2017.
Source: Authors' elaboration

The electricity costs and turnover are weighted against production output. Table 274 shows that weighted averages for electricity costs are lower than the simple averages, while for turnover the weighted average is higher than the simple average.

Table 274 Electricity costs vs. turnover (€/tonne) – Simple and weighted averages

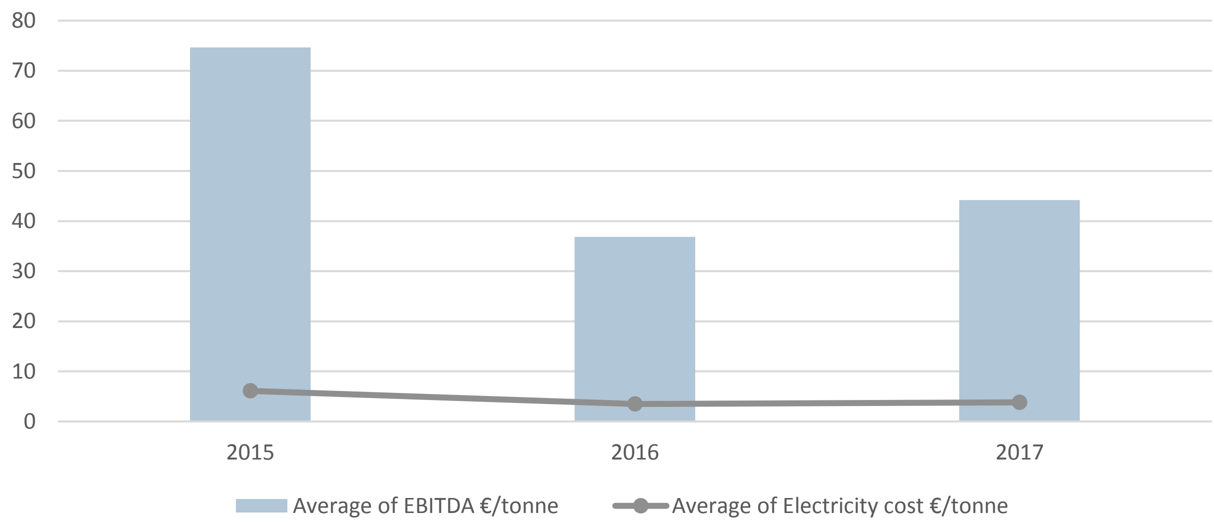
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity costs simple average (€/tonne)	6.2	n.a.	6.7	n.a.	6.9	6.8	7.1	6.1	3.5	3.8
Electricity costs weighted	5.7	2.3	5.8	2.7	6.7	6.5	6.5	5.8	3.2	3.6

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
average (€/tonne)										
Turnover simple average (€/tonne)	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	666.1	528.9	618.6
Turnover weighted average (€/tonne)	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	695.4	532.4	651.1
Electricity costs as a share of turnover simple averages (%)	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	0.9%	0.7%	0.6%
Electricity costs as a share of turnover weighted averages (%)	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	0.8%	0.6%	0.5%

Note: Weighting factor: production output. For electricity costs, there were 11 observations in 2015 and 13 in 2016 and 2017. For turnover, there were 3 observations in 2015 and 6 observations in 2016 and 2017.
Source: Authors' elaboration

In the case of EBITDA per tonne, it underwent a 41% decrease from 2015 to 2017 (see Figure 226). Compared with the decrease in electricity costs, this decrease apparently did not improve margin sufficiently to compensate for other factors negatively influencing EBITDA.

Figure 226 Electricity costs versus EBITDA (€/tonne, EU) – Simple averages



Note: For electricity costs, there were 11 observations in 2015 and 13 in 2016 and 2017. For EBIDTA/tonne, there were 3 observations in 2015 and 10 observations in 2016 and 2017.
Source: Authors' elaboration

The electricity costs and EBITDA are weighted against production output. Weighted averages for electricity costs are lower than the simple averages, in all cases. For EBITDA the weighted averages are in most cases lower than the simple averages.

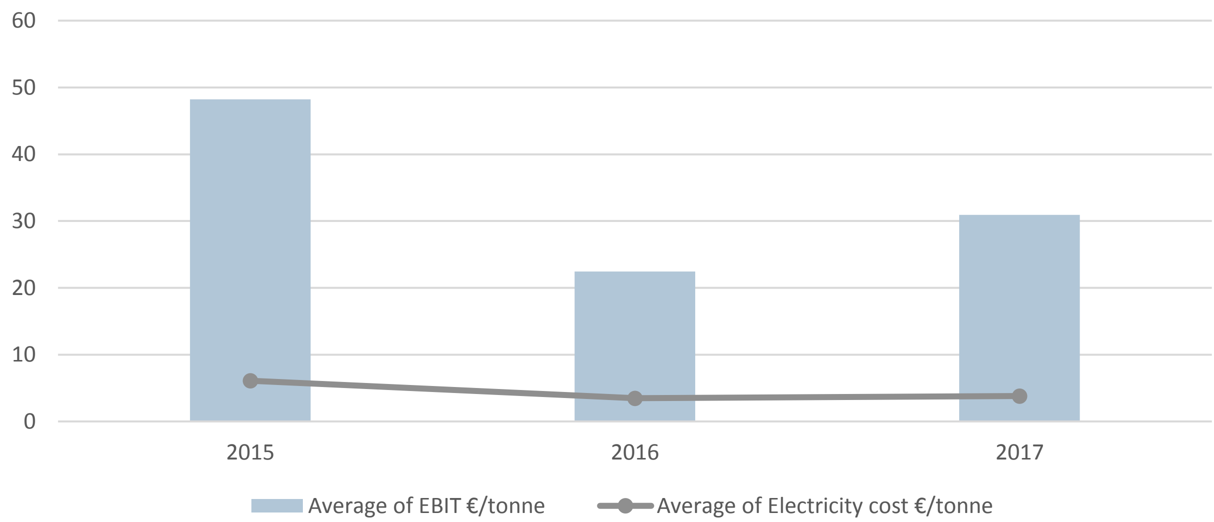
Table 275 Electricity costs vs. EBITDA (€/tonne) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity costs simple average (€/tonne)	6.2	n.a.	6.7	n.a.	6.9	6.8	7.1	6.1	3.5	3.8
Electricity costs weighted average (€/tonne)	5.7	n.a.	5.8	n.a.	6.7	6.5	6.5	5.8	3.2	3.6
EBITDA simple average (€/tonne)	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	74.6	36.9	44.2
EBITDA weighted average (€/tonne)	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	64.8	34.8	45.9

Note: Weighting factor: production output. For electricity costs, there were 11 observations in 2015 and 13 in 2016 and 2017. For EBIDTA/tonne, there were 3 observations in 2015 and 10 observations in 2016 and 2017.
Source: Authors' elaboration

Figure 227 below shows a 38% decrease in average electricity costs from 2015 to 2017. Furthermore, it shows that EBIT per unit of production decreased 36% from €48.2/tonne in 2015 to €30.9/tonne in 2017. Apparently other factors influenced EBIT more strongly since it decreased even though average electricity costs decreased.

Figure 227 Electricity costs versus EBIT (€/tonne, EU) – Simple averages



Note: For electricity costs, there were 11 observations in 2015 and 13 in 2016 and 2017. For EBIT/tonne, there were 3 observations in 2015 and 10 observations in 2016 and 2017.
Source: Authors' elaboration

The electricity costs and EBIT are weighted against the production output. Table 276 shows that weighted averages for both indicators are lower than the simple averages.

Table 276 Electricity costs vs. EBIT (€/tonne) – Simple and weighted averages

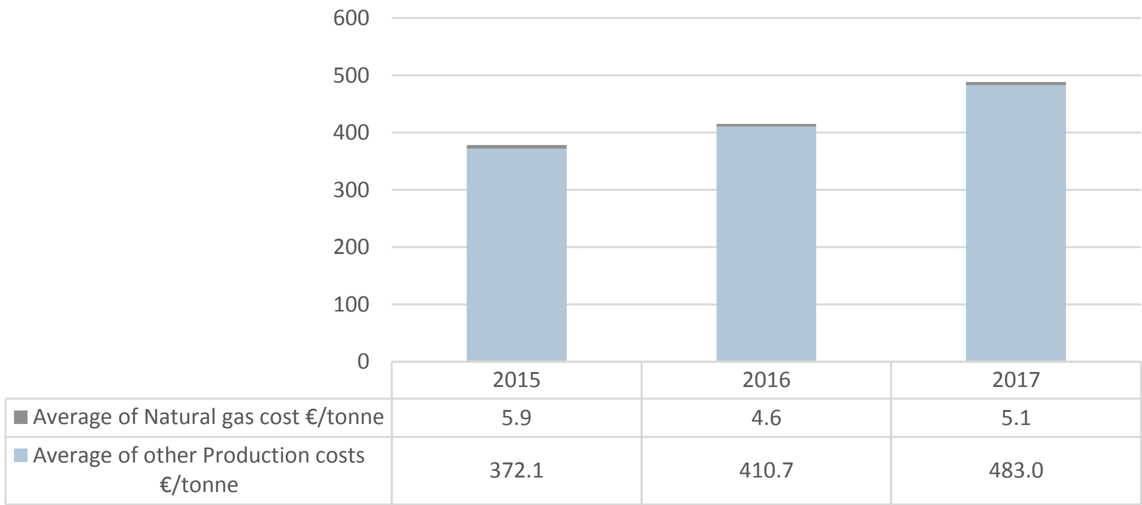
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity costs simple average (€/tonne)	6.2	n.a.	6.7	n.a.	6.9	6.8	7.1	6.1	3.5	3.8
Electricity costs weighted average (€/tonne)	5.7	n.a.	5.8	n.a.	6.7	6.5	6.5	5.8	3.2	3.6
EBIT simple average (€/tonne)	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	48.2	22.5	30.9
EBIT weighted average (€/tonne)	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	33.3	18.3	30.0

Note: Weighting factor: production output. For electricity costs, there were 11 observations in 2015 and 13 in 2016 and 2017. For EBIT/tonne, there were 3 observations in 2015 and 10 observations in 2016 and 2017.
Source: Authors' elaboration

Natural gas

From Figure 228, it can be seen that costs for natural gas make up around 1% of total production costs. From 2015 to 2017, the natural gas costs decreased 13.6%, while the average of other production costs increased 30%.

Figure 228 Natural gas costs as a share of production costs (€/tonne, EU) – Simple averages



Note: For natural gas costs, there were 10 observations in 2015 and 12 in 2016 and 2017. For other production costs, there were 3 observations in 2015 and 8 observations in 2016 and 2017.
Source: Authors' elaboration

The natural gas costs and production costs are weighted against production output. Table 277 shows that weighted averages for natural gas costs and production costs are lower than the simple averages, in all cases. This suggests that economies of scale play a role in the sector.

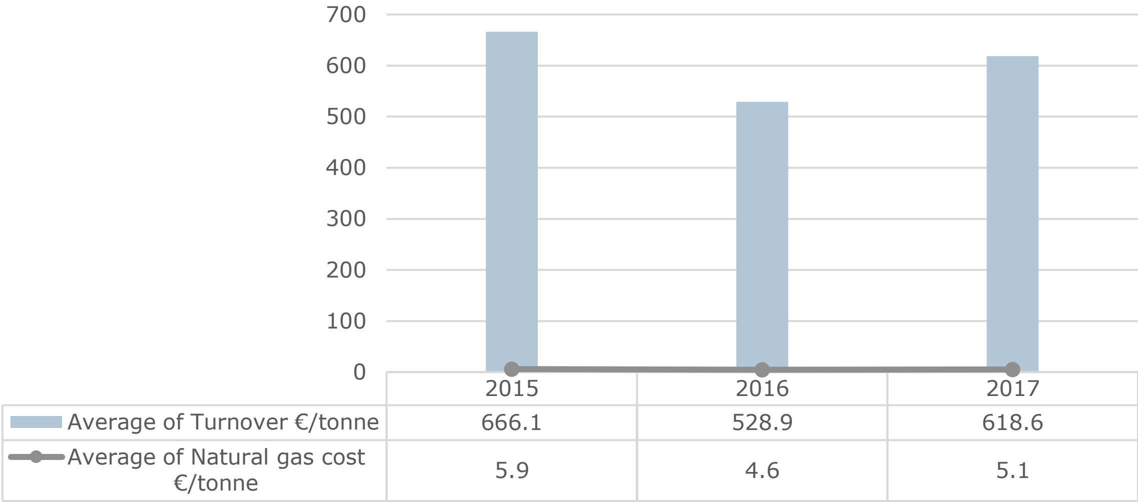
Table 277 Natural gas costs as a share of production costs (€/tonne) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas costs simple average (€/tonne)	10.7	n.a.	9.3	n.a.	11.7	12.0	8.2	5.9	4.6	5.1
Natural gas costs weighted average (€/tonne)	10.5	n.a.	8.7	n.a.	11.7	11.6	7.8	5.6	3.1	3.7
Production costs simple average (€/tonne)	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	378.0	415.3	488.1
Production costs weighted average (€/tonne)	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	348.0	369.4	435.2
Natural gas costs as a share of production costs simple averages (%)	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	1.6%	1.1%	1.1%
Natural gas costs as a share of production costs weighted averages (%)	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	1.6%	0.8%	0.8%

Note: Weighting factor: production output. For natural gas costs, there were 10 observations in 2015 and 12 in 2016 and 2017. For other production costs, there were 3 observations in 2015 and 8 observations in 2016 and 2017.
Source: Authors' elaboration

The average turnover per unit of production decreased 7%, from €666.1/tonne in 2015 to €618.6/tonne in 2017. The natural gas costs per unit of production decreased 13.6% from €5.9/tonne in 2015 to €5.1/tonne in 2017. The share of natural gas costs in turnover remained fairly stable at around 0.9%.

Figure 229 Natural gas costs versus turnover (€/tonne, EU) – Simple averages



Note: For natural gas costs, there were 10 observations in 2015 and 12 in 2016 and 2017. For other production costs, there were 3 observations in 2015 and 6 observations in 2016 and 2017.
Source: Authors' elaboration

The natural gas costs and turnover are weighted against production output. Table 278 shows that weighted averages for electricity costs are lower than the simple averages, in all cases. For turnover, the weighted average is higher than the simple averages, in all cases.

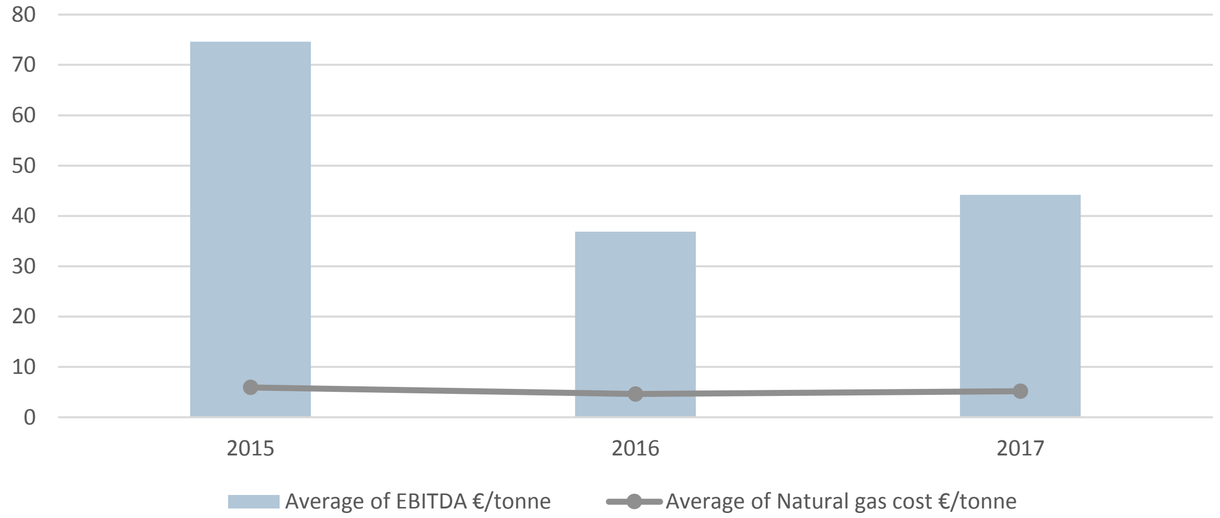
Table 278 Natural gas costs vs. turnover (€/tonne) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas costs simple average (€/tonne)	10.7	n.a.	9.3	n.a.	11.7	12.0	8.2	5.9	4.6	5.1
Natural gas costs weighted average (€/tonne)	10.5	n.a.	8.7	n.a.	11.7	11.6	7.8	5.6	3.1	3.7
Turnover simple average (€/tonne)	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	666.1	528.9	618.6
Turnover weighted average (€/tonne)	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	695.4	532.4	651.1
Natural gas costs as a share of turnover simple averages (%)	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	0.9%	0.8%	0.9%
Natural gas costs as a share of turnover weighted averages (%)	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	0.8%	0.6%	0.6%

Note: Weighting factor: production output. For natural gas costs, there were 10 observations in 2015 and 12 in 2016 and 2017. For other production costs, there were 3 observations in 2015 and 6 observations in 2016 and 2017.
Source: Authors' elaboration

Figure 230 shows a 13.2% decrease in average natural gas costs from 2015 to 2017. In the case of EBITDA per tonne, it underwent a 41% decrease from 2015 to 2017.

Figure 230 Natural gas costs versus EBITDA (€/tonne, EU) – Simple averages



Note: For natural gas costs, there were 10 observations in 2015 and 12 in 2016 and 2017. For other EBITDA/tonne, there were 3 observations in 2015 and 10 observations in 2016 and 2017.
Source: Authors' elaboration

The natural gas costs and EBITDA are weighted against production output. The weighted averages for natural gas costs are lower than the simple averages, in all cases. For EBITDA the weighted average is slightly lower than the simple averages, except in 2017. This does not align with the fact that economies of scale normally generate an efficiency benefit per unit of production.

Table 279 Natural gas costs vs. EBITDA (€/tonne) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas costs simple average (€/tonne)	10.7	n.a.	9.3	n.a.	11.7	12.0	8.2	5.9	4.6	5.1
Natural gas costs weighted average (€/tonne)	10.5	n.a.	8.7	n.a.	11.7	11.6	7.8	5.6	3.1	3.7
EBITDA simple average (€/tonne)	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	74.6	36.9	44.2
EBITDA weighted	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	64.8	34.8	45.9

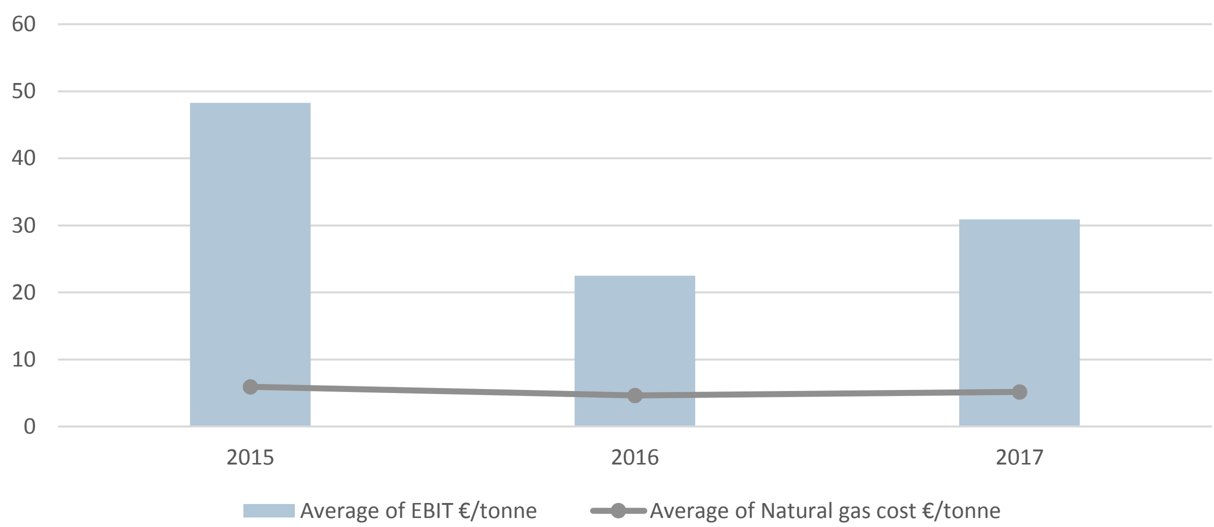
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
average (€/tonne)										
Natural gas costs as a share of EBITDA simple averages (%)	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	7.9%	12.6%	11.6%
Natural gas costs as a share of EBITDA weighted averages (%)	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	8.6%	9.0%	8.0%

Note: Weighting factor: production output. For natural gas costs, there were 10 observations in 2015 and 12 in 2016 and 2017. For other EBITDA/tonne, there were 3 observations in 2015 and 10 observations in 2016 and 2017

Source: Authors' elaboration

Figure 231 shows a 13.2% decrease in average natural gas costs from 2015 to 2017. Furthermore, it shows that EBIT per unit of production decreased 36% from €48.2/tonne in 2015 to €30.9/tonne in 2017. This might indicate that companies are experiencing difficulties in current market conditions (low EBIT per tonne of production), and are trying to be more efficient by reducing natural gas costs per tonne of production.

Figure 231 Natural gas costs versus EBIT (€/tonne, EU) – Simple averages



Note: For natural gas costs, there were 10 observations in 2015 and 12 in 2016 and 2017. For other EBIT/tonne, there were 3 observations in 2015 and 10 observations in 2016 and 2017.

Source: Authors' elaboration

The natural gas costs and EBIT are weighted against production output. Table 280 shows that weighted averages for natural gas costs are lower than the simple averages, in all cases. For EBIT the weighted average is lower than the simple averages, in all cases.

Table 280 Natural gas costs vs. EBIT (€/tonne) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Natural gas costs simple average (€/tonne)	10.7	n.a.	9.3	n.a.	11.7	12.0	8.2	5.9	4.6	5.1
Natural gas costs weighted average (€/tonne)	10.5	n.a.	8.7	n.a.	11.7	11.6	7.8	5.6	3.1	3.7
EBIT simple average (€/tonne)	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	48.2	22.5	30.9
EBIT weighted average (€/tonne)	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	33.3	18.3	30.0
Natural gas costs as a share of EBIT simple averages (%)	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	12.3%	20.6%	16.6%
Natural gas costs as a share of EBIT weighted averages (%)	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	16.7%	17.1%	12.3%

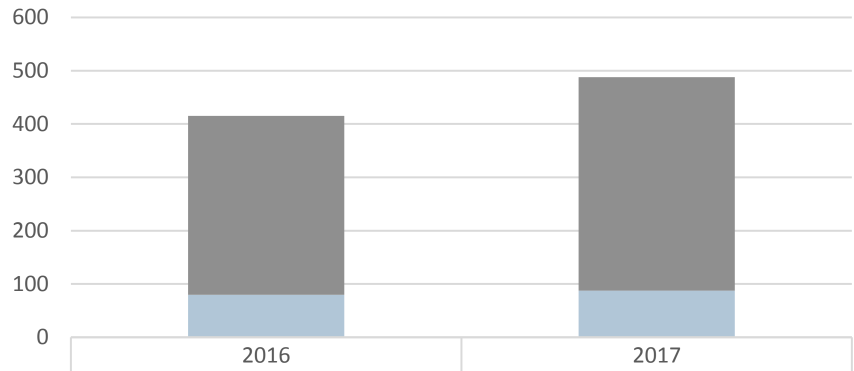
Note: Weighting factor: production output. For natural gas costs, there were 10 observations in 2015 and 12 in 2016 and 2017. For other EBIT/tonne, there were 3 observations in 2015 and 10 observations in 2016 and 2017.
Source: Authors' elaboration

Other fuels[68]

The average of production costs per tonne of product increased from €335.8/tonne in 2015 to €488.1/tonne in 2017. Other fuel costs per tonne make up a large component of the total production costs per tonne, i.e. around 88%. The major cost by far is the crude oil costs, which account for 86% of these costs. The crude oil costs thus have a much larger impact on the production costs than electricity and gas costs.

[68] Other fuels in this chapter refer to coke, fuel oil and crude oil. While coke and fuel oil are used as a fuel, only a portion of crude oil (4–8%) is used as a fuel in the transformation and cracking processes of refineries. We nonetheless also cover crude oil in this chapter as crude oil costs represent the largest part of refineries' production costs and are thus of particular relevance.

Figure 232 Other fuel costs including crude oil as a share of production costs (€/tonne, EU) – Simple averages



	2016	2017
Other fuel costs €/tonne (coke, fuel oil, crude oil)	335.8	400.9
Average of other Production costs €/tonne	79.5	87.2

Note: In 2016 and 2017, there were 8 observations for production costs and different number of observations for other fuel costs: 8 for coke consumption, 7 for fuel oil consumption and 3 for crude oil consumption.
Source: Authors' elaboration

The other fuel costs and production costs are weighted against production output. Table 281 shows that weighted averages for both indicators are lower than the simple averages. This could again indicate economies of scale are relevant in the sector.

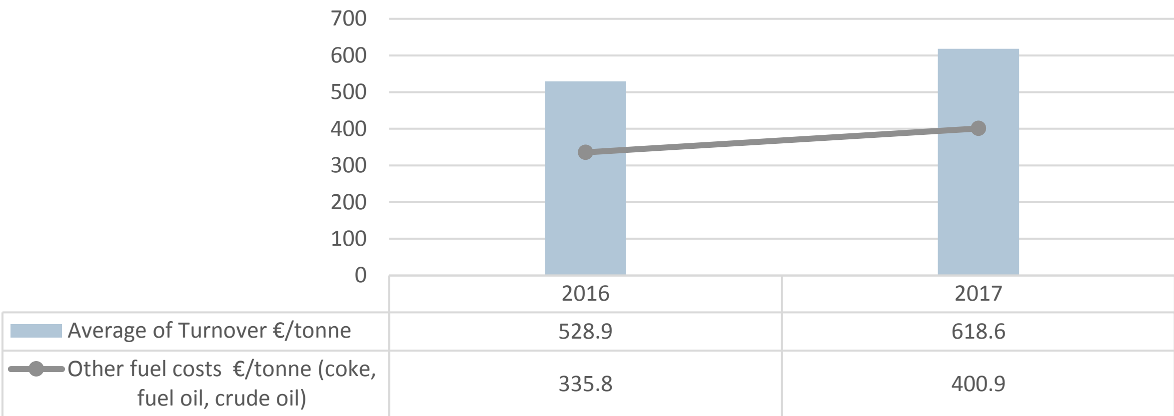
Table 281 Other fuel costs including crude oil as a share of production costs (€/tonne) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Other fuel simple average (€/tonne)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	335.8	400.9
Other fuel weighted average (€/tonne)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	326.6	390.9
Production costs simple average (€/tonne)	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	378.0	415.3	488.1
Production costs weighted average (€/tonne)	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	348.0	369.4	435.2
Other fuel costs as a share of production costs simple averages (%)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	79.8%	81.1%
Other fuel costs as a share of production costs weighted averages (%)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	87.4%	88.8%

Note: Weighting factor: production output. In 2016 and 2017, there were 8 observations for production costs and different numbers of observations for other fuel costs: 8 for coke consumption, 7 for fuel oil consumption and 3 for crude oil consumption.
Source: Authors' elaboration

The average turnover per unit of production increased from €528.9/tonne in 2016 to €618.6/tonne in 2017. The other fuel costs per unit of production increased by 19% from €528.9 to €618.6/tonne. Other fuel costs made up between 63% in 2016 and 75% in 2017 of total turnover.

Figure 233 Other fuel costs including crude oil versus turnover (€/tonne, EU) – Simple averages



Note: In 2016 and 2017, there were 6 observations for turnover and different numbers of observations for other fuel costs: 8 for coke consumption, 7 for fuel oil consumption and 3 for crude oil consumption.

The other fuel costs and turnover are weighted against production output. Table 282 shows that weighted averages for other fuel costs are lower than the simple averages, while for turnover the weighted average is higher than the simple average.

Table 282 Other fuel costs including crude oil vs. turnover (€/tonne) – Simple and weighted averages

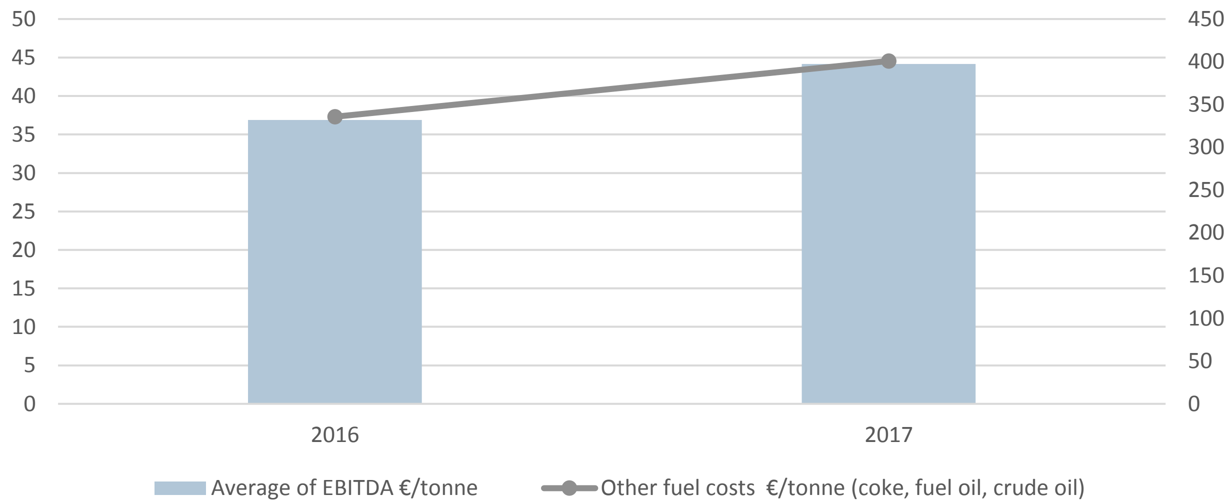
Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Other fuel simple average (€/tonne)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	335.8	400.9
Other fuel weighted average (€/tonne)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	326.6	390.9
Turnover simple average (€/tonne)	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	666.1	528.9	618.6
Turnover weighted average (€/tonne)	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	695.4	532.4	651.1
Other fuel costs as a share of	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	n.a.	63.5%	64.8%

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
turnover simple averages (%)										
Other fuel costs as a share of turnover weighted averages (%)	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	n.a.	61.3%	60.0%

Note: Weighting factor: production output. In 2016 and 2017, there were 6 observations for turnover and different numbers of observations for other fuel costs: 8 for coke consumption, 7 for fuel oil consumption and 3 for crude oil consumption.
Source: Authors' elaboration

EBITDA per tonne underwent a 19% increase from 2016 to 2017 despite an increase in other fuel costs of also around 19% (see Figure 234).

Figure 234 Other fuel costs including crude oil (right axis) versus EBITDA (left axis) (€/tonne, EU) – Simple averages



Note: In 2016 and 2017, there were 10 observations for EBITDA and different numbers of observations for other fuel costs: 8 for coke consumption, 7 for fuel oil consumption and 3 for crude oil consumption.
Source: Authors' elaboration

The other fuel costs and EBITDA are weighted against production output. Weighted averages for other fuel costs are lower than the simple averages, in all cases. For EBITDA the weighted averages are in most cases lower than the simple averages.

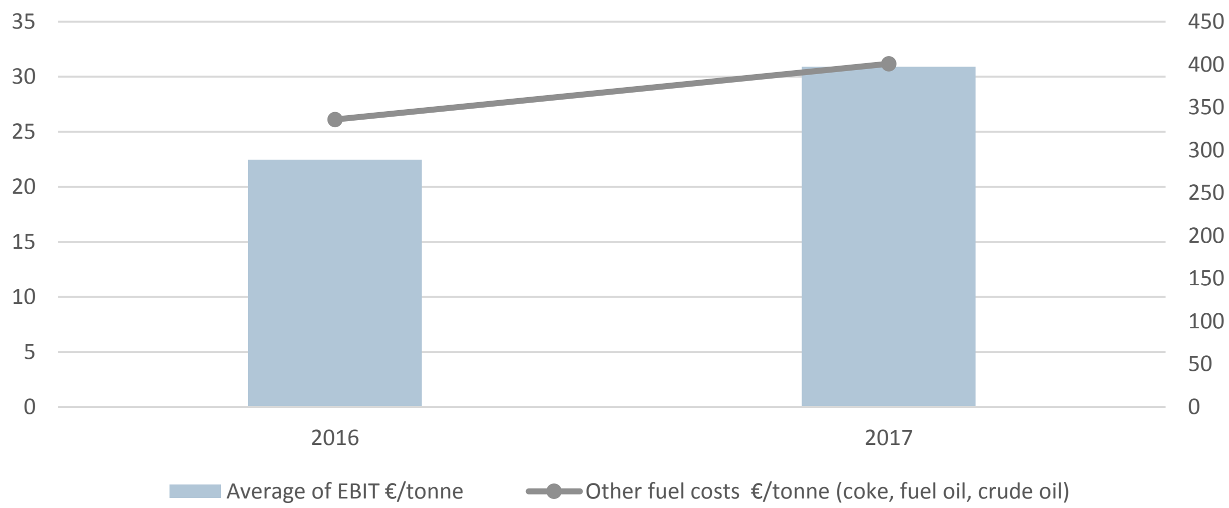
Table 283 Other fuel costs including crude oil vs. EBITDA (€/tonne) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Other fuel simple average (€/tonne)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	335.8	400.9
Other fuel weighted average (€/tonne)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	326.6	390.9
EBITDA simple average (€/tonne)	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	74.6	36.9	44.2
EBITDA weighted average (€/tonne)	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	64.8	34.8	45.9

Note: Weighting factor: production output. In 2016 and 2017, there were 10 observations for EBITDA and different numbers of observations for other fuel costs: 8 for coke consumption, 7 for fuel oil consumption and 3 for crude oil consumption.
Source: Authors' elaboration

Figure 235 shows a 19% increase in the averages of other fuel costs from 2016 to 2017. Furthermore, it shows that EBIT per unit of production increased by 37% from 2016 to 2017. Other factors apparently influenced EBIT more strongly since it rose despite the increase in the average of other fuel costs.

Figure 235 Other fuel costs including crude oil (right axis) versus EBIT (left axis) (€/tonne, EU) – Simple averages



Note: In 2016 and 2017, there were 10 observations for EBITDA and different numbers of observations for other fuel costs: 8 for coke consumption, 7 for fuel oil consumption and 3 for crude oil consumption.
Source: Authors' elaboration

The other fuel costs and EBIT are weighted against production output. Table 284 shows that weighted averages for both indicators are lower than the simple averages.

Table 284 Other fuel costs including crude oil vs. EBIT (€/tonne) – Simple and weighted averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Other fuel simple average (€/tonne)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	335.8	400.9
Other fuel weighted average (€/tonne)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	326.6	390.9
EBIT simple average (€/tonne)	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	48.2	22.5	30.9
EBIT weighted average (€/tonne)	Conf.	n.a.	Conf.	n.a.	Conf.	Conf.	Conf.	33.3	18.3	30.0

Note: Weighting factor: production output. For electricity costs, there were 11 observations in 2015 and 13 in 2016 and 2017. For EBIT/tonne, there were 3 observations in 2015 and 10 observations in 2016 and 2017.
Source: Authors' elaboration

10 Cross-sectoral analysis

Box 20 Highlights - Cross-sectoral analysis

Electricity

- There is a clear inverse relationship between electricity prices and costs in €/MWh with electricity consumption. As electricity consumption increases, electricity prices and costs in €/MWh decline. This result has several possible explanations: larger consumers may negotiate more favourable supply price conditions, they may be granted exemptions from certain taxes and levies, and plants in some industries run a flat profile process from day to night, so that they tend to access cheaper base load electricity.
- Average electricity costs (simple averages) are below average electricity prices (simple averages) for each sector, because plants benefit from reimbursements of levies, revenues from flexibility schemes and self-generation. Average electricity costs range from €37/MWh in the primary aluminium sector to €93.9/MWh in the secondary aluminium sector, while average electricity prices range from €39.4/MWh in the primary aluminium sector to €99.2/MWh in the wall and floor tile sector.
- In 2016, the standard deviation of the average electricity price for each sector ranged from €5.8/MWh in the primary aluminium sector to €43.2/MWh in the refineries sector. The average standard deviation for all sectors was €24.84/MWh.
- In most Member States included in the analysis, overall electricity prices increased from 2008 onwards. Since 2012-2013, electricity prices paid by energy intensive users have declined in France, Germany, the Netherlands, Greece, Spain and Bulgaria, mostly as a result of lower energy supply components. Of those six Member States, four Member States saw electricity price increases in 2016 or 2017 (Germany, the Netherlands, Spain and France).
- In some Member States the peak came later, as in Poland, where there was a peak in 2014, and in the UK, where electricity prices peaked in 2015.
- Poland-based plants also reported an increase in electricity prices for 2017, mainly resulting from an increase in the energy supply component.
- In some Member States renewable electricity generation increased significantly in recent years, associated with an increase and more recent drop in the renewable support component. In several Member States, additional exemptions from paying these levies have been granted (e.g. in France and Spain).
- Network costs have been increasing in all Member States included in the analysis, except for Greece and the Netherlands. The share of other non-recoverable taxes/levies, as components of the energy price, has constantly increased since 2008.

Gas

- There is an inverse relationship between natural gas prices in €/MWh and natural gas consumption. However, the relationship is less marked than in electricity. There are two possible reasons. First, the proportion of regulatory costs is relatively small in the natural gas price, so there are fewer opportunities for regulators or governments to adapt prices through discounts and exemptions. Second, natural gas costs depend heavily on international prices set by natural gas producing countries, mostly outside the EU, so there is less opportunity for price negotiation.
- Average gas prices are less divergent across the sectors when compared to electricity prices. Average natural gas prices range from €18.8/MWh in the nitrogen fertiliser sector to €25.1/MWh in the bricks and roof tiles sector.

- The standard deviation of the average natural gas price for each sector was also less divergent and ranged from €1.8/MWh in the secondary aluminium sector to €9.2/MWh in the refineries sector.
- In almost all Member States included in the analysis, overall natural gas prices increased from 2008 and then started to decline from 2012-2013 (France, Germany, the Netherlands, the UK, Italy, Greece and Bulgaria).
- In some Member States the peak came later, as in Portugal, Spain and Poland where there was a peak in 2014.
- In almost all Member States, regulatory costs, including network costs as well as taxes, levies and charges generally make up 8-15% of the natural gas price.
- Network costs have for the most part remained stable in Member States, with very slight increases over the period 2008-2017 in Germany, the UK, Italy, Spain and Bulgaria.

Sample and limitations

- The sample (on which the cross-sectoral analysis is based) includes electricity data from 185 plants and natural gas data from 173 plants across the EU.
- In the Member State price component analysis, the number of available observations varies across years; therefore, trends may be affected by changes in the sample size. More details are provided within the tables beneath each figure.

Table 285 Key results included in the cross-sectoral analysis (2016) – Median values and simple averages

Sector	Median consumption of electricity (GWh)	Average price of electricity (€/MWh)	Average cost* of electricity (€/MWh)	Median consumption of natural gas (GWh)	Average price of natural gas (€/MWh)
Bricks and roof tiles	5.9	86.3	79.3	51.3	25.1
Wall and floor tiles	13.5	99.2	88.1	146.4	24.1
Glass tableware	25.2	92.4	85.8	150.3	23.8
Packaging glass	49.0	75.4	68.9	266.5	22.3
Primary aluminium	2267.1	39.4	37.0	199.8	20.9
Secondary aluminium	14.9	97.6	93.9	82.8	24.4
Downstream aluminium	42.4	80.0	80.0	97.4	24.7
Steel EAF	330.7	53.7	50.6	209.8	19.2
Steel BOF	817.5	57.6	52.1	1,499.1	17.2
Nitrogen fertiliser	86.0	66.5	60.3	4,464.7	18.8
Refineries	277.4	69.0	62.9	1,596.9	20.3

* The cost of electricity takes into account reimbursements, self-production and flexibility schemes.

10.1 Introduction

This Chapter presents a cross-sectoral analysis of total energy prices and the structure of energy prices in Europe. The analyses in the sectoral case studies are presented at the EU and regional level rather than the Member State level in order to ensure that no data can be attributed to any particular plant. This cross-sectoral analysis, however, presents findings across all sectors at the EU level as a whole and across selected Member States. The Member State-level analysis shows the different levels of taxes, levies, network costs and other components in energy prices at the national level.

Electricity prices can be broken down into the following four cost components:

i. energy supply costs
ii. network costs and capacity market costs
iii. support payments to finance renewables ('RES support payment')
iv. other non-recoverable levies and taxes (excluding VAT).

Gas prices can be broken down into the following three cost components:

i. energy supply costs
ii. network costs
iii. other non-recoverable levies and taxes (excluding VAT).

This cross-sectoral analysis includes a breakdown of the annual data for those Member States with reliable data for three or more plants belonging to three independent companies. The analysis comprises the sectors bricks and roof tiles, wall and floor tiles, refineries, steel Electric Arc Furnace (EAF), steel Basic Oxygen Furnace (BOF), primary aluminium, secondary aluminium, downstream aluminium, glass tableware, packaging glass and nitrogen fertiliser.

Note that all electricity and gas prices in €/MWh reported in this Section, and used throughout the analysis are net prices, as reported on energy bills. Exemptions or reductions for specific components, such as renewables supports (RES support payments), are counted as deductions when they are accounted for as financial benefits that lower both the final energy bill and the total energy cost for the plant. All electricity costs in €/MWh reported in this Section, and used throughout the analysis, are the total price paid to purchase electricity accounting for reimbursements, payments for flexibility schemes and revenues from self-generated electricity sold to the grid. Please refer to Table 1 for the complete definition of the electricity cost in €/MWh. Natural gas costs have not been included in the cross-sectoral analysis since natural gas prices in €/MWh and natural gas costs in €/MWh are very similar.

10.2 Sample composition

After removing plants whose data were inconsistent or incomplete, 185 plants remained in the sample for the analysis of electricity consumption and 173 plants remained for the analysis of gas consumption.

The number of plants in the electricity analysis is slightly higher because more plants provided data on their consumed electricity and some plants reported that they consumed no natural gas at all. The data collected on price components was further filtered, as described later in this Section.

Table 286 shows the number of questionnaires that were evaluated for this cross-sectoral analysis.

Data on price components are analysed at the national level. In the analysis on price components, other plants were removed, mostly due to the lack of comprehensive and consistent component data from the companies. Member States with fewer than three observations from independent companies were omitted from this analysis to ensure confidentiality. Years where fewer than three observations were available were also omitted.

Table 286 Number of responses used in the cross-sectoral analysis

Sector	Electricity questionnaire	Gas questionnaire
Brick and Roof Tiles	57	58
Wall and Floor Tiles	22	21
Refineries	13	12
Steel EAF	18	17
Steel BOF	7	4
Primary Aluminium	9	6
Secondary Aluminium	9	9
Downstream Aluminium	8	8
Glass tableware	12	12
Packaging glass	24	20
Fertiliser	7	6
Total	**185**	**173**

Source: Authors' elaboration

After filtering the data, a sufficient number of observations was available to analyse electricity price components in 10 Member States and nine Member States in the analysis of natural gas price components. Given that, in most Member States, the number of observations changes for the different years, the number of observations for each year is available in each table following a graph.

10.3 Electricity

<u>Electricity consumption and price analysis across sectors</u>

This section analyses the relationship between electricity consumption and price levels across the various sectors and consumption bands for all EU respondents.

Figure 236 shows the differences in both electricity consumption and average electricity prices between each of the sectors for the year 2016. This year was selected based on the number of observations and reliable data points available. When the survey was conducted, some plants did not have data available for 2017 and for some sectors data were only collected for the most recent two years, so 2016 is the year with the highest number of observations.

The dark circles in the graph presented represent average electricity prices and are presented as simple averages. The vertical lines above and below the circle illustrate the standard deviation of the price for each sector. The standard deviation is used to quantify the variation of values within a set of data values. Roughly 68% of the observations fall within one standard deviation of the mean.

The consumption range is illustrated by a box plot, in which the upper and lower boundary line of the grey box represent the first and third quartiles of the data set. This means that 25% of the plants consume less than the value indicated by the lower line, while 25% of the plants consume more than the value indicated by the upper line. In other words, the box comprises the middle half of the data sample. Moreover, the middle line that divides the box into two parts represents the median value, where 50% of the values are below the median. The median is the mid-point in the data regardless of the rest of the data and it is more appropriate to use it instead of the average when data are skewed and/or include exceptionally high or low values. For many sectors energy consumption varies significantly, which reflects the various plant sizes within the sample; therefore, the median is the most appropriate measure when it comes to energy consumption values.

Two different y-axes have been used: one for price, which is linear, and one for consumption, which is logarithmic due to the disparity in plant consumption.

The 2016 data shown for each different sector of the study reflect a straightforward relationship between increased consumption levels and decreased average power prices. This correlation is illustrated by the low consumption rates found in the bricks and tiles industry, with a median consumption of 5.9 GWh of electricity per plant and an average electricity price of €83.8/MWh, compared with the primary aluminium industry, which has a median consumption of 2,264 GWh of electricity per plant and an average electricity price of €39.4/MWh.

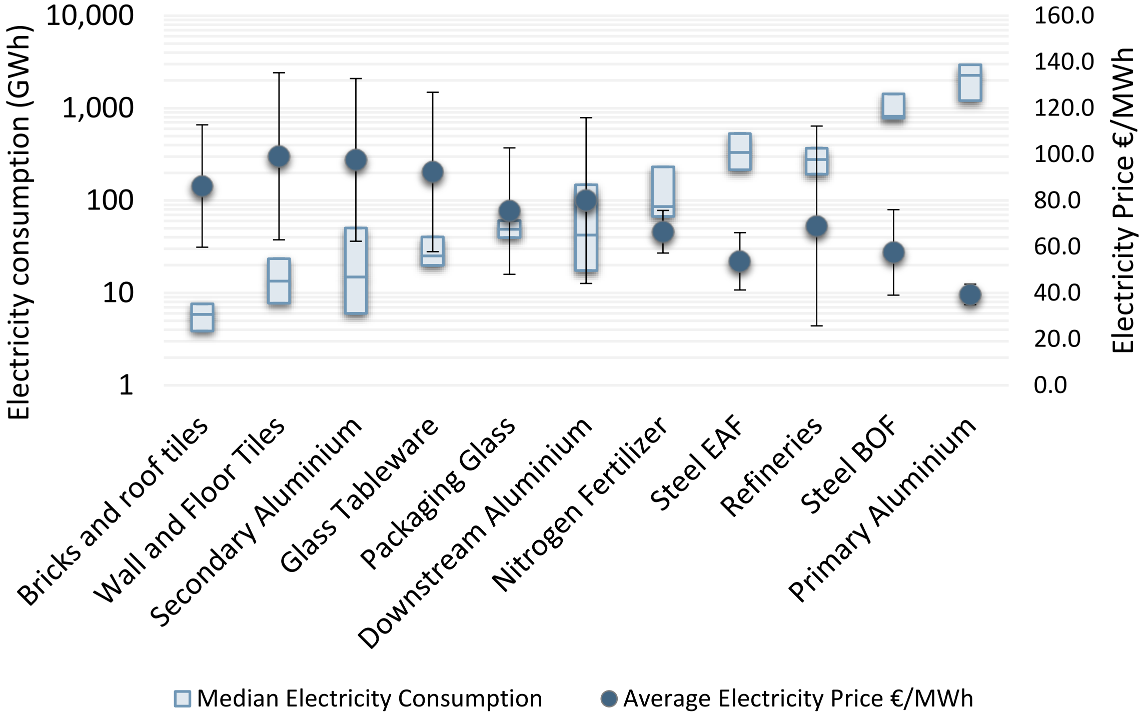
There are a number of possible reasons for the trend of lower prices for industries that have plants with high electricity consumption:

i. Some larger consumers may negotiate more favourable supply price conditions through the wholesale market or through striking better deals with providers in exchange for the amount of power they purchase and their load consumption profile
ii. Larger consumers from energy intensive sectors may be granted exemptions from certain taxes and levies, or be provided with lower prices in Member States with regulated prices. The possible role of exemptions is discussed later in this Section.
iii. Some industries, in particular the primary aluminium industry, run a flat profile process from day to night, hence benefitting from lower electricity prices (base load prices).

It is important to note that the sample included in this study may not be representative for the median consumption of all plants within a sector. For example, the downstream aluminium industry is a fragmented industry, where plant sizes range from very small, producing around 5,000 tonnes annually, to very large, producing 1,500,000 tonnes per year. While, in general, larger downstream aluminium plants responded, smaller plants often said that they did not have the internal resources to complete the questionnaire.

These average prices represent the values aggregating multiple Member States with different price levels and a different legislative framework. Price spreads are high because electricity prices and price components are specific to each Member State. To isolate the effects of national policies, national analyses of the price structure are also conducted within this Section.

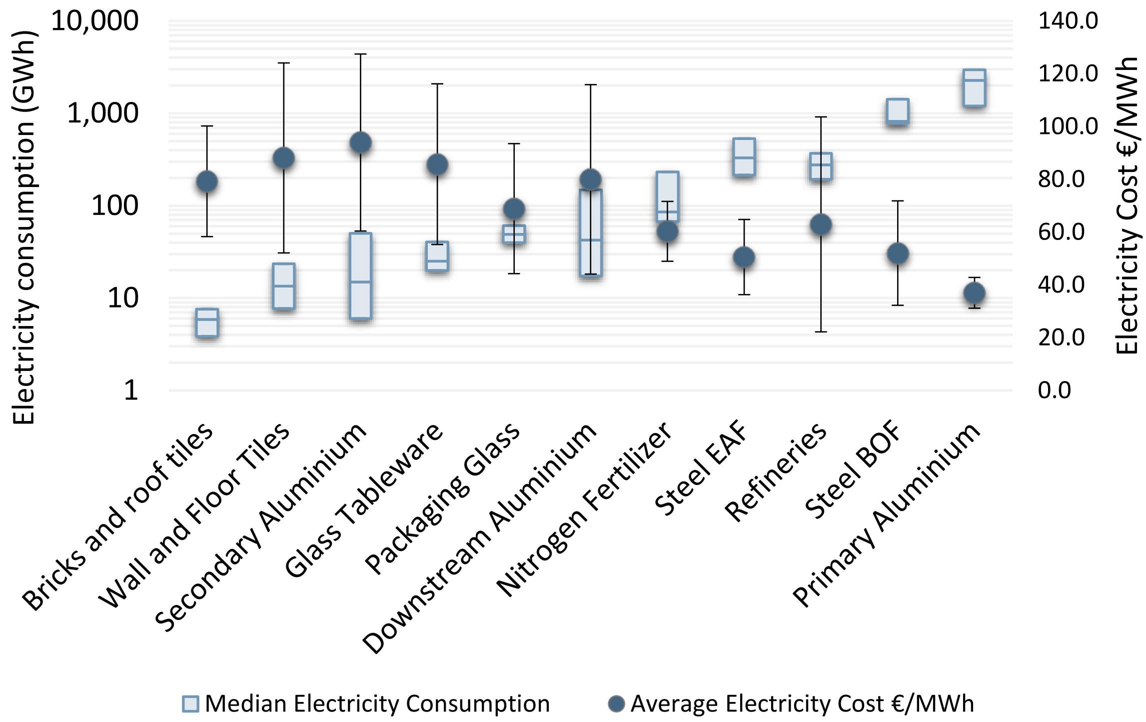
Figure 236 Electricity consumption (median, first quartile, third quartile) and prices by sector (simple averages, standard deviation), 2016



Note: based on 185 observations in 2016.
Source: Authors' elaboration

Figure 237 shows electricity consumption and electricity cost (in €/MWh) variations, grouped by sector. These costs are the total price paid to purchase electricity but also take into account reimbursements, payments for flexibility schemes and revenues from self-generated electricity sold to the grid. For all sectors, electricity costs are the same or lower than electricity prices. This is because plants either receive reimbursements, payments for flexibility schemes or self-produce electricity, resulting in lower electricity costs. The difference between electricity prices and costs in €/MWh varies between sectors and ranges from <1% to 11%. The sectors with the largest difference are wall and floor tiles, nitrogen fertilisers, refineries and steel BOF.

Figure 237 Electricity consumption (median, first quartile, third quartile) and costs by sector (simple averages, standard deviation), 2016



Note: based on 185 observations in 2016.
Source: Authors' elaboration

Table 287 Simple average electricity prices and median electricity consumption by sector (2016)

Sector	Average Electricity Price €/MWh	Standard Deviation of Electricity Price	Average Electricity Cost €/MWh	Standard Deviation of Electricity Cost	Median consumption (GWh)	Lower quartile cons (GWh)	Upper quartile cons (GWh)
Bricks and roof tiles	86.3	26.5	79.3	21.0	5.9	3.9	7.6
Wall and Floor Tiles	99.2	36.2	88.1	36.0	13.5	7.7	23.5
Secondary Aluminium	97.6	35.2	93.9	33.5	14.9	6.0	50.4
Glass Tableware	92.4	34.5	85.8	30.4	25.2	19.9	40.5
Packaging Glass	75.4	27.4	68.9	24.6	49.0	39.8	60.8
Downstream Aluminium	80.0	35.9	80.0	35.9	42.4	17.5	148.6
Nitrogen Fertiliser	66.5	9.2	60.3	11.3	86.0	67.3	232.3
Steel EAF	53.7	12.4	50.6	14.2	330.7	214.9	532.3
Refineries	69.0	43.2	62.9	40.7	277.4	193.4	369.6
Steel BOF	57.6	18.5	52.1	19.8	817.5	780.5	1,423.5
Primary Aluminium	39.4	26.5	37.0	5.8	2,267.1	1,204.2	2,949.5

Note: based on 185 observations in 2016.
Source: Authors' elaboration

Electricity consumption and price analysis across consumption bands

Figure 238 shows the average electricity price of plants grouped by consumption bands. The same plants included in Figure 236 have been included in this analysis.

Four bands have been defined using a logarithmic scale:

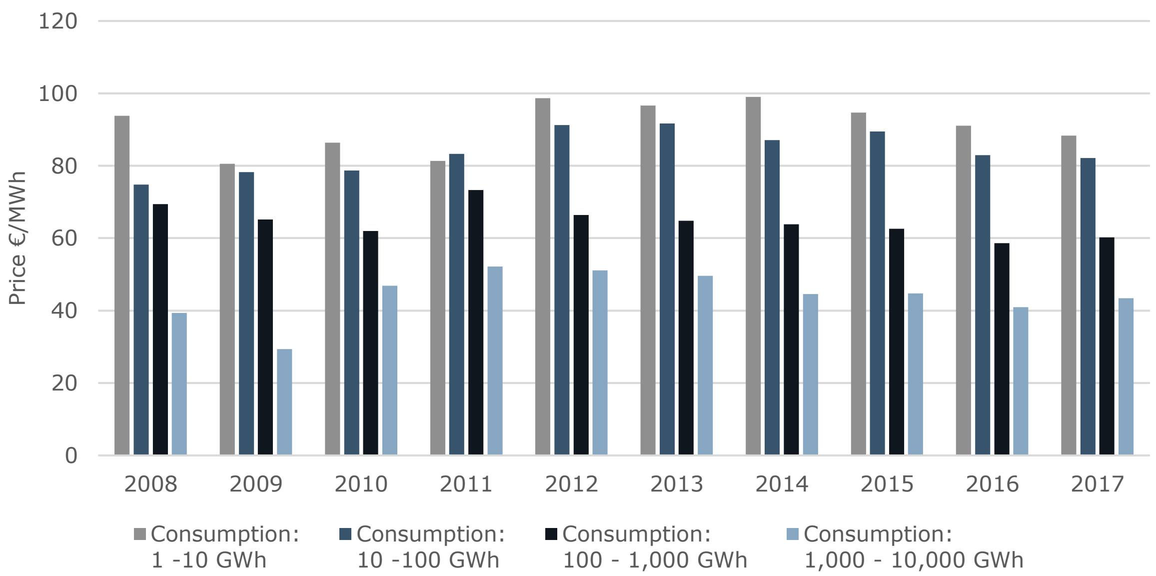
i. annual electricity consumption between 1 and 10 GWh (35% of plants)
ii. annual electricity consumption between 10 and 100 GWh (37% of plants)
iii. annual electricity consumption between 100 and 1,000 (21% of plants)
iv. annual electricity consumption between 1,000 and 10,000 GWh (7% of plants).

Taking the year with the highest number of observations, 2016, over 70% of plants are within the first two groups in which annual consumption is between 1 GWh and 100 GWh (1,000 MWh and 100,000 MWh).

In general, prices have also been decreasing since 2012 for the plants in all four consumption bands.

It is clear that electricity prices for plants in the two lower electricity consumption bands (consumption levels of between 1 GWh and 100 GWh) are relatively similar and that larger plants in the higher two electricity consumption bands (consumption levels of between 100 GWh and 10,000 GWh) generally benefit from lower electricity prices.

Figure 238 Electricity prices by consumption band – Simple averages



Source: Authors' elaboration

Table 288 Electricity prices by consumption band– Simple averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Number of observations	120	73	141	86	154	161	161	158	185	182
Average Elec price (€/MWh) for plants that consume 1 to 10 GWh of Elec	93.8	80.5	86.4	81.3	98.6	96.6	99.0	94.7	91.0	88.3

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Average Elec price (€/MWh) for plants that consume 10 to 100 GWh of Elec	74.8	78.3	78.7	83.3	91.2	91.7	87.1	89.4	83.0	82.1
Average Elec price (€/MWh) for plants that consume 100 to 1,000 GWh of Elec	69.4	65.1	61.9	73.3	66.4	64.9	63.8	62.6	58.7	60.2
Average Elec price (€/MWh) for plants that consume 1,000 to 10,000 GWh of Elec	39.3	29.3	46.9	52.2	51.2	49.7	44.6	44.8	40.9	43.4

Source: Authors' elaboration

Electricity price component analysis across Member States

This Section discusses the various components that together make up electricity prices at the Member State level.

As discussed previously in the cross-sectoral analysis, 10 Member States have been included in the electricity price component analysis. Total and average plant electricity consumption of the sample for each of the 10 Member States, along with details regarding sample representativeness, are provided in Table 289.

Since the sample in each Member State is relatively small, the electricity price is not representative for all plants within that Member State. For example, if only larger plants are included among respondents from a Member State, then the results might be biased towards lower electricity prices. On the other hand, Member States with mostly small plants among respondents of this study may show higher electricity prices. Therefore, this analysis should be taken with caution and some of the results may not represent electricity components faced by all energy intensive plants within a given Member State. A top-down approach with statistically representative data may give more accurate results on the prices paid by energy intensive industries. This analysis should be seen as a complementary exercise and used to validate or challenge top-down results.

Table 289 Sample electricity consumption and representative for each Member State

Member State	Annual electricity consumption of plants within the sample (GWh)*		Member State sample representativeness
	Total	Average	
France	7,341	306	In the French sample, 50% of the plants are from the bricks and roof tiles sector, 26% from the steel sector and a number of plants from the glass, aluminium and refineries sectors.
Germany	6,096	677	One-third of plants included in the sample are from the aluminium sector. Since electricity price components are not weighted by

Member State	Annual electricity consumption of plants within the sample (GWh)*		Member State sample representativeness
	Total	Average	
			consumption, they represent 33% of the results for Germany. Over half the plants within the sample are from the ceramics industry.
The Netherlands	3,496	583	The sample representativeness of plants providing electricity component data is split across the sectors. The sample includes plants from the ceramics, glass, refineries and steel industries.
The UK	1,863	186	In the sample of UK plants that returned questionnaires with reliable electricity component data, 40% of the plants are from the ceramics sector, 20% from the steel sector and the remaining plants are from the glass, aluminium and refineries sectors.
Portugal	103	34	The glass sector makes up 66% of the sample of Portuguese plants. Plants from the ceramics sector make up the remaining share. Because the average annual plant electricity consumption in the sample is low compared to other Member States, the number of exemptions experienced by plants in Portugal and the opportunity to negotiate more favourable supply contracts is small.
Italy	812	45	In the Italian sample, 50% of plants are from the ceramics industry, 22% from the glass industry and 11% from the aluminium industry. Because the majority of plants are from the glass and ceramics industries, which typically consume less electricity, the magnitude of exemptions and opportunities to negotiate more favourable supply contracts is reduced.
Spain	1,231	77	Forty-four percent of plants included in the Spanish sample are from the ceramics industry, while plants from the glass, steel and aluminium industry make up 37.5% in equal shares.
Greece	3,237	539	In the Greek sample, the average annual electricity consumption of the plants included in the analysis is high. One plant has a very high annual electricity consumption rate, and this increases the average. The aluminium industry represents one-third of the sample, while the other sectors that make up the sample are the nitrogen fertiliser sector and the refineries sector.
Poland	3,378	422	Half of the plants in the sample in Poland are from the steel sector. The remaining plants that make up the Polish sample are from the ceramics, nitrogen fertiliser, glass and aluminium sectors.
Bulgaria	3,399	425	In regard to Bulgaria, half of the plants included in the sample are from the ceramics industry, 25% are from the aluminium industry and the remaining plants are from the steel and glass industries.

Note: values taken from the year 2017.*
Source: Authors' elaboration

Figure 239, Figure 240 and Figure 241 show the structure of absolute electricity prices for Member States in the NWE, SE and CEE regions respectively. Figure 242, Figure 243 and Figure 244 show the information in relative terms in 10 Member States. Simple averages of price components at the Member States level are used and, to ensure that confidentiality agreements are met, only Member States with reliable data available for three or more plants have been included in this part of the analysis.

Data are considered reliable if price components add up to total electricity prices. Estimations have not been used in this study, so as a consequence, prices in some years may include fewer observations than in others. Subsequently, results for plants in the Netherlands and the UK in 2008 were not included in the analysis; similarly, results for plants in Portugal, Greece and Poland in 2008 and 2010 were also not included.

General trends

There are a number of trends that can be seen from the data provided by plants. In most Member States, overall electricity prices increased from 2008 and then started to decline from 2012-2013. This can be seen in France, Germany, the Netherlands, Greece, Spain and Bulgaria. In some cases, the peak in electricity prices came later, for example in Poland, electricity prices peaked in 2014; and in the UK there was a peak in 2015. In some of those Member States that experienced a peak in electricity prices in 2012 or 2013, prices started to increase again in 2016 or 2017. This is the case for France, Germany, the Netherlands and Spain. Polish plants also reported that prices increased in 2017.

From the data received by companies, plants in Germany, the UK and Italy see noticeably higher electricity prices compared to most other Member States included in the analysis. This is a result of higher taxes, levies and network costs. More specifically, for the UK, it is also a result of higher wholesale prices. Differences can be observed between all price components across the Member States analysed, but the differences in the so-called 'regulatory components', i.e. network costs, renewables support, other taxes and levies, are more pronounced. Regulatory components are set by national policies, which explains the differences seen between Member States.

The energy component along with each of the regulatory components are described in the following sub-sections.

Energy supply component

The energy component is largely linked to electricity wholesale market prices. Wholesale electricity prices vary between Member States. By analysing the evolution of the lowest and highest regional wholesale electricity prices in the EU as well as the Platts European Power Index (PEP) benchmark, it is clear that electricity wholesale prices saw a significant peak towards the end of 2008 and then plummeted rapidly, more than halving in price. This is mainly a result of a reduction in electricity demand, which is related to the 2008 economic crisis, an increase in the share of renewables participating in the market, and a decrease in European Union Allowances prices (EUA). From then, prices in the EU gradually rose and in 2012 started to decline again, moderately[69]. Only since the second quarter of 2016 have wholesale market prices in the EU increased again[70] and this is illustrated by the data. In half of the Member States analysed (the Netherlands, Portugal, Italy, Spain and Poland) we see a slight increase in the energy component in 2017, particularly in the SE region.

Energy supply costs in the NWE region are the lowest in general out of the three regions. Despite that, plants in the UK reported higher electricity supply prices compared to the other Member States. This is because wholesale market prices in the UK are in general higher than prices in Germany and the Netherlands. France reported the lowest electricity supply costs of all the Member States included in the analysis. The highest electricity supply costs were reported by plants in the SE region, which is a result of high wholesale electricity prices observed in the SE markets, as compared to other regions.

A likely underlying cause for these differences in electricity supply costs is the electricity generation mix within each Member State. For example, gas has a higher share in the Italian, Spanish, British and Portuguese power mix than in Germany or Bulgaria, where coal plays a more important role. In the absence of a strong EUA price, coal-fired electricity production typically is more competitive than gas-fired generation, resulting in lower energy prices. More recently, in 2017, significant nuclear capacities were offline in NWE and this led to an increase in electricity prices traded in this region.

[69] See European Commission (2016), "Quarterly Report on European Electricity Markets; fourth quarter of 2016".

[70] See European Commission (2017), "Quarterly Report on European Electricity Markets; fourth quarter of 2017".

RES levy regulatory component

The level of the renewables support component in electricity prices is determined by a number of factors.

Firstly, the deployment of subsidised renewable electricity in a Member State plays a major role in the magnitude of RES levy costs within electricity prices. One notable example is the deployment of solar photovoltaic in the early 2010s, when technology costs were at least twice as high as they are today. From 2010 to 2012, solar PV was aggressively deployed especially in Italy, Germany and the UK, leading to a sharp increase in end-consumer prices for non-exempted consumers.

Secondly, the RES levy depends on the design of RES support systems, i.e. whether they enable RES investors to recover their full costs, even if wholesale electricity prices decrease. Feed-in tariffs belong to this category, as they offer a fixed compensation, whereas green certificate systems do not. As a result, the decline in wholesale electricity prices led to an increase in relative terms of RES support payments in countries with feed-in tariffs, for example in Germany, Italy, Spain and Bulgaria.

The RES levy depends on whether public money is well spent. In this context, economic efficiency is an important performance indicator, as it compares the subsidy payments to the actual generation costs, thus disclosing potential overcompensation for renewable energy generators[71]. An extensive analysis made within the DiaCore project for the year 2014 revealed that the level of remuneration for onshore wind farms exceeded actual generation costs by at least €10/MWh in Greece, Hungary, Romania and Slovenia – indicating higher-than-necessary profit margins for generators[72].

Renewable levies reported by plants are increasing in most Member States. Most of the RES levies in electricity prices are a result of obligations set by EU legislation through the Renewable Energy Directive. The Renewable Energy Directive (2009/28/EC) came into force in 2009 and set vigorous renewable energy targets for Member States. Since it became effective, RES levies have seen a significant increase, which is illustrated by the significant increases in RES levies in most Member States over the study period.

In Germany, plants reported significant increases in RES levies within electricity prices and the increase is likely down to the EEG (Erneuerbare-Energien-Gesetz) surcharge. This surcharge is part of the German Renewable Energy Sources Act and finances the expansion of renewables in the electricity system. It is paid by the transmission system operators (TSOs) to electricity generators but passed on to consumers. Industrial consumers may be partially exempted from the EEG surcharge. For the first GWh of electricity, the full EEG surcharge is paid, but for every subsequent kWh only 15% of the surcharge is paid, up to a maximum of 4% of gross output of the company. This exemption was updated in 2014 following a court ruling that the compensation for the surcharge was too generous. Electricity intensive firms in Germany are also compensated for indirect carbon costs arising from the electricity sector's compliance with the EU ETS. The reimbursements for the surcharge and indirect carbon costs are given annually and are therefore not represented in the prices reported in Figure 239.

In some Member States renewable electricity generation has increased significantly in recent years but a drop in the renewable support component illustrates that additional exemptions from paying these levies have been granted (e.g. in France and Spain). These exemptions are described in more detail later in this section.

[71] Boie et al. 2014 - Renewables in the EU: Policy performance, drivers and barriers, accessible at: https://www.ceps.eu/system/files/DIACORE_ Renewables_Policy_Performance_Barriers_And_Drivers.pdf

[72] Held et al. 2014 - Assessing the performance of renewable energy support policies with quantitative indicators – Update 2014, accessible at: http://diacore.eu/images/files2/MyFolder/D2.1_Assessing_the_performance _of_renewable_energy_support_policies_with_quantitative_indicators__Up date_2014.pdf

Network costs + capacity market regulatory component

Network costs also differ largely between Member States. Generally, these costs are higher if there have been extensive grid upgrades. Nevertheless, in many Member States, network costs are funded through both consumer bills and generator access fees. The level of network costs observed in this study, therefore, heavily depends on how these costs are distributed between consumers and generators. This analysis only observes funding of costs from the consumer side, hence it does not fully represent the total sum of network costs in each Member State.

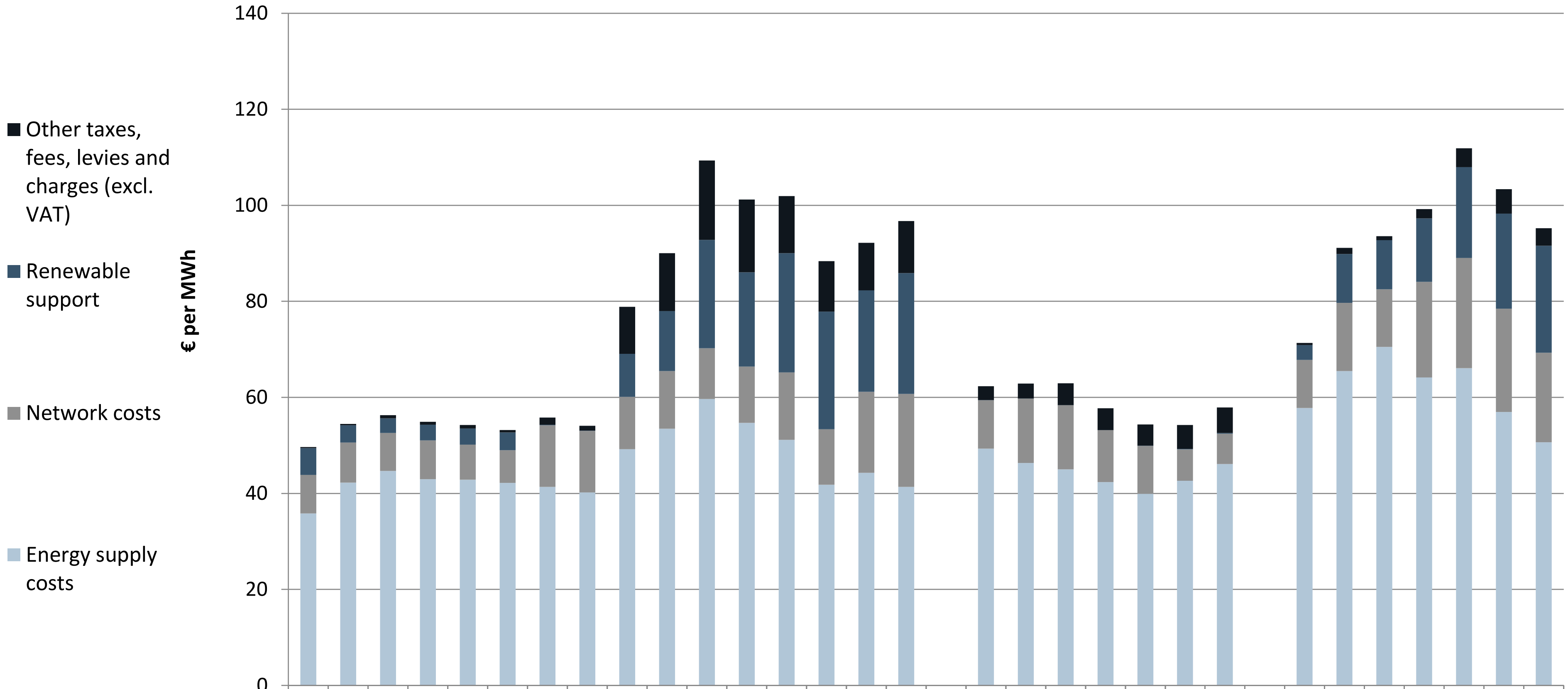
EU legislation that affects network costs includes both internal market legislation and the Renewable Energy Directive. Network costs can be broken down into transmission grid fees and distribution grid fees. The internal market legislation impacts transmission grid fees due to the cross-border interconnector projects that it promotes. As for the Renewable Energy Directive, this legislation can generate both transmission as well as distribution grid fees since integrating renewable energy into electricity grids requires new infrastructure at the transmission level but more importantly when connecting renewable generation to the distribution grid.

In all Member States included in the analysis, except for Greece and the Netherlands, plants reported that network costs have increased over the period under observation. As for transmission network costs, this trend has been confirmed by a report from the European Network of Transmission System Operators (ENTSO-E)[73].

Only a few plants reported capacity market payments and those that did reported negligible costs, hence these have been included with network costs. In general, capacity market payments are only significant in the prices of Member States in the SE region. For example, plants reported that in Italy these payments make up €4/MWh of the price, in Portugal €10/MWh and in Greece €3/MWh of the electricity price. In the NWE region, plants reported much lower capacity payments that make up between €0-1/MWh of the electricity price, while in the CEE region, no plants included in the analysis reported capacity market payments.

[73] ENTSO-E, Overview of Transmission Tariffs in Europe: Synthesis 2016, June 2017

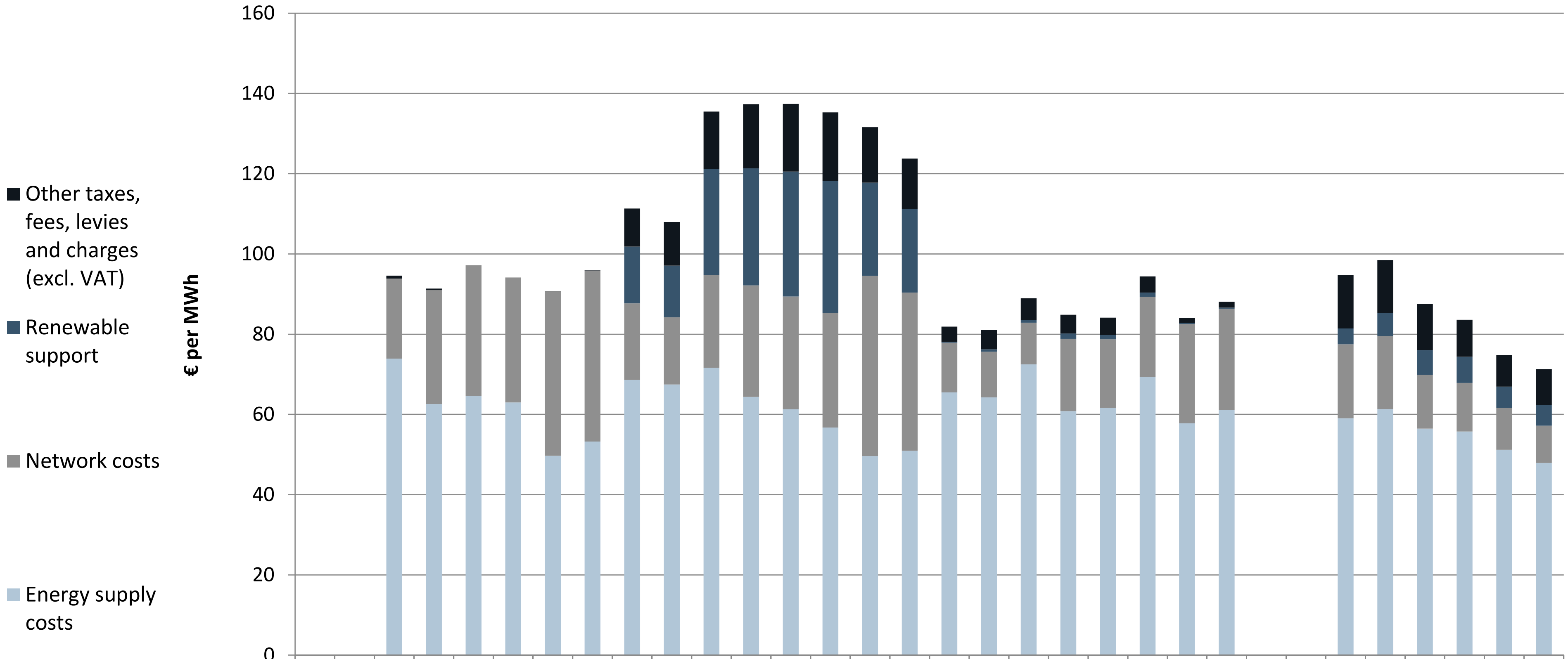
Figure 239 Structure of electricity prices of Member States in the NWE region (France, Germany, the Netherlands and the UK) in absolute terms (€/MWh) – Simple averages



	France								Germany								Netherlands								UK							
	2008	2010	2012	2013	2014	2015	2016	2017	2008	2010	2012	2013	2014	2015	2016	2017	2008	2010	2012	2013	2014	2015	2016	2017	2008	2010	2012	2013	2014	2015	2016	2017
Number of observations	3	8	10	11	11	12	23	24	9	10	10	11	11	11	10	9		6	6	6	6	6	6	6		5	5	7	8	8	8	10
Other taxes, fees, levies and charges (excl. VAT)	0.2	0.3	0.7	0.6	0.7	0.5	1.5	1.0	9.8	12.1	16.5	15.2	11.9	10.5	9.9	10.9		2.9	3.1	4.6	4.6	4.5	5.0	5.3		0.4	1.2	0.8	1.9	3.9	5.1	3.7
Renewable support	5.6	3.6	3.0	3.2	3.4	3.7	0.1	0.1	9.0	12.5	22.6	19.6	24.9	24.5	21.1	25.1		0.0	0.0	0.0	0.0	0.0	0.1	0.2		3.1	10.2	10.2	13.2	18.9	19.8	22.3
Network costs	8.0	8.3	7.9	8.1	7.3	6.8	12.8	12.8	10.9	12.0	10.6	11.8	14.0	11.6	16.9	19.4		10.1	13.5	13.4	10.8	9.9	6.5	6.3		10.0	14.2	12.0	19.9	22.9	21.5	18.6
Energy supply costs	35.8	42.3	44.7	43.0	42.8	42.2	41.4	40.2	49.2	53.5	59.6	54.7	51.2	41.8	44.3	41.4		49.3	46.3	45.0	42.3	39.9	42.6	46.1		57.8	65.5	70.5	64.1	66.1	56.9	50.6

Source: Authors' elaboration

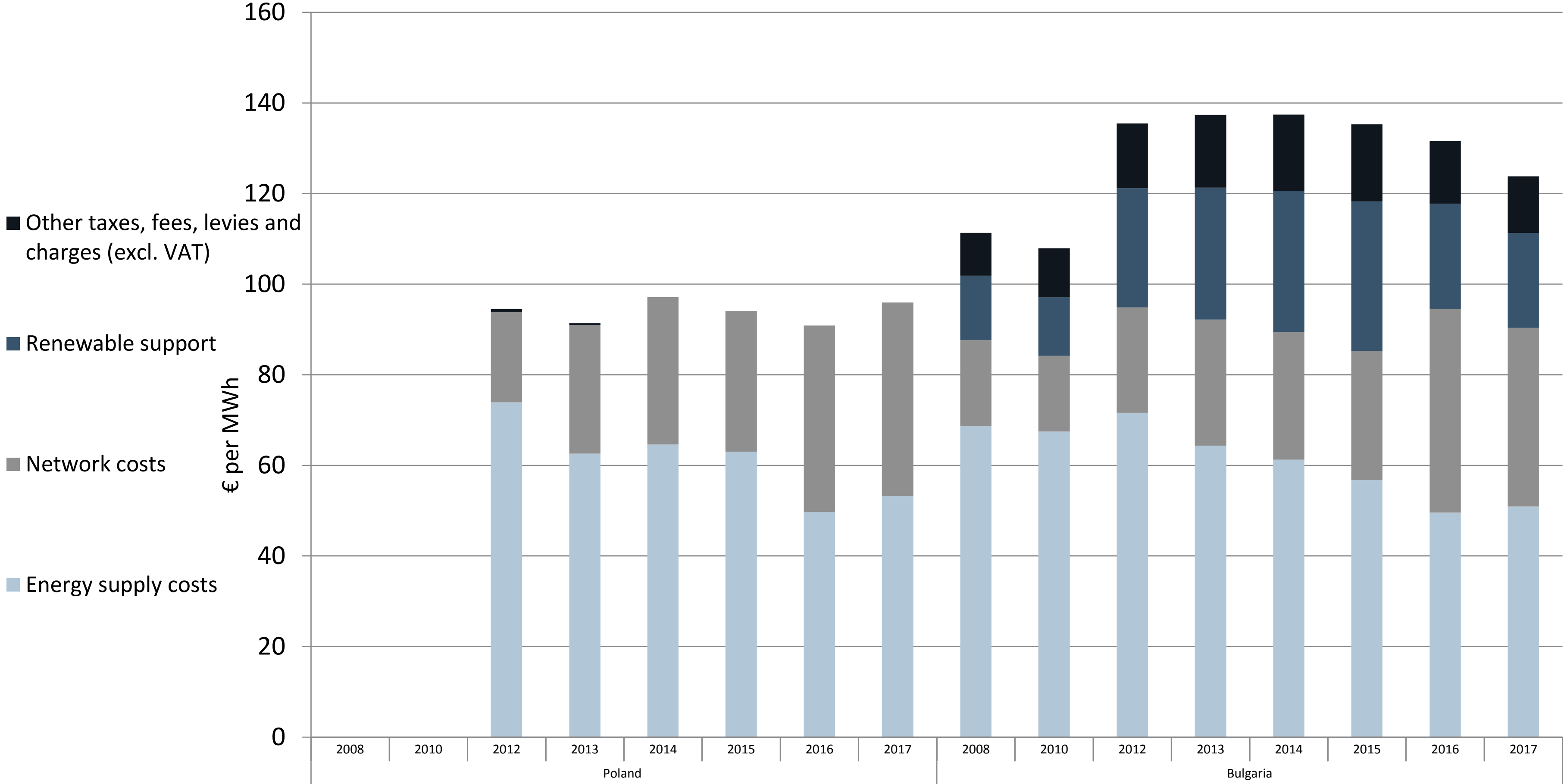
Figure 240 Structure of electricity prices of Member States in the SE region (Portugal, Italy, Spain and Greece) in absolute terms (€/MWh) – Simple averages



	Portugal								Italy								Spain								Greece							
	2008	2010	2012	2013	2014	2015	2016	2017	2008	2010	2012	2013	2014	2015	2016	2017	2008	2010	2012	2013	2014	2015	2016	2017	2008	2010	2012	2013	2014	2015	2016	2017
Number of observations			3	3	3	3	3	3	10	14	14	14	14	14	18	18	6	8	10	11	10	10	16	16			6	6	6	6	6	6
Other taxes, fees, levies and charges (excl. VAT)			0.7	0.4	0.0	0.0	0.0	0.0	9.4	10.8	14.3	16.0	16.9	17.0	13.8	12.5	3.8	4.8	5.4	4.7	4.4	4.0	1.2	1.4			13.3	13.2	11.5	9.2	7.9	8.9
Renewable support			0.0	0.0	0.0	0.0	0.0	0.0	14.2	13.0	26.4	29.2	31.1	33.0	23.3	20.9	0.2	0.6	0.6	1.3	1.0	1.1	0.3	0.3			4.0	5.7	6.2	6.5	5.3	5.2
Network costs			20.0	28.4	32.5	31.1	41.1	42.6	19.1	16.7	23.2	27.8	28.1	28.5	44.9	39.5	12.4	11.4	10.4	18.1	17.1	20.0	24.7	25.2			18.5	18.2	13.4	12.1	10.4	9.3
Energy supply costs			73.9	62.6	64.6	63.0	49.7	53.2	68.6	67.5	71.6	64.3	61.2	56.7	49.6	50.9	65.5	64.2	72.5	60.8	61.6	69.3	57.8	61.1			59.0	61.3	56.5	55.8	51.2	47.9

Source: Authors' elaboration

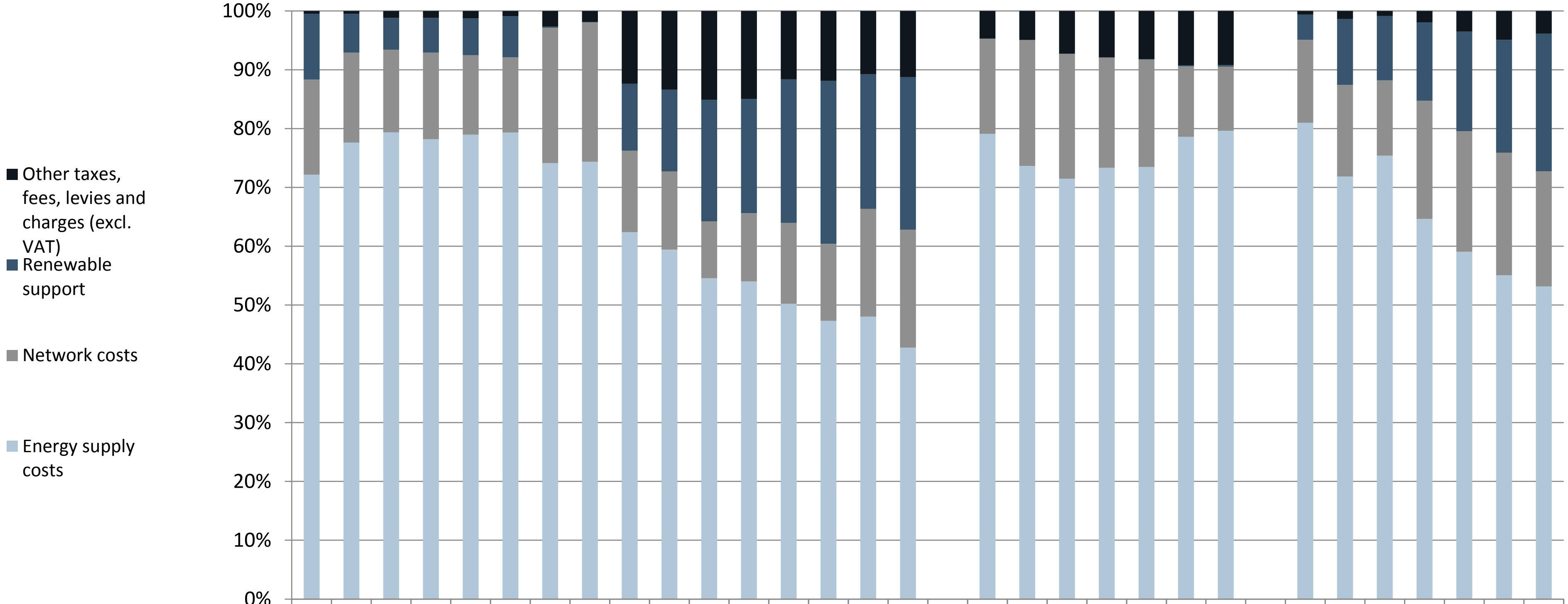
Figure 241 Structure of electricity prices of Member States in the CEE region (Poland and Bulgaria) in absolute terms (€/MWh) – Simple averages



	Poland 2008	Poland 2010	Poland 2012	Poland 2013	Poland 2014	Poland 2015	Poland 2016	Poland 2017	Bulgaria 2008	Bulgaria 2010	Bulgaria 2012	Bulgaria 2013	Bulgaria 2014	Bulgaria 2015	Bulgaria 2016	Bulgaria 2017
Number of observations			8	8	8	5	10	8	3	4	4	3	3	3	4	4
Other taxes, fees, levies and charges (excl. VAT)			0.7	0.4	0.0	0.0	0.0	0.0	9.4	10.8	14.3	16.0	16.9	17.0	13.8	12.5
Renewable support			0.0	0.0	0.0	0.0	0.0	0.0	14.2	13.0	26.4	29.2	31.1	33.0	23.3	20.9
Network costs			20.0	28.4	32.5	31.1	41.1	42.6	19.1	16.7	23.2	27.8	28.1	28.5	44.9	39.5
Energy supply costs			73.9	62.6	64.6	63.0	49.7	53.2	68.6	67.5	71.6	64.3	61.2	56.7	49.6	50.9

Source: Authors' elaboration

Figure 242 Structure of electricity prices of Member States in the NWE region (France, Germany, the Netherlands and the UK) in relative terms (%) – Simple averages

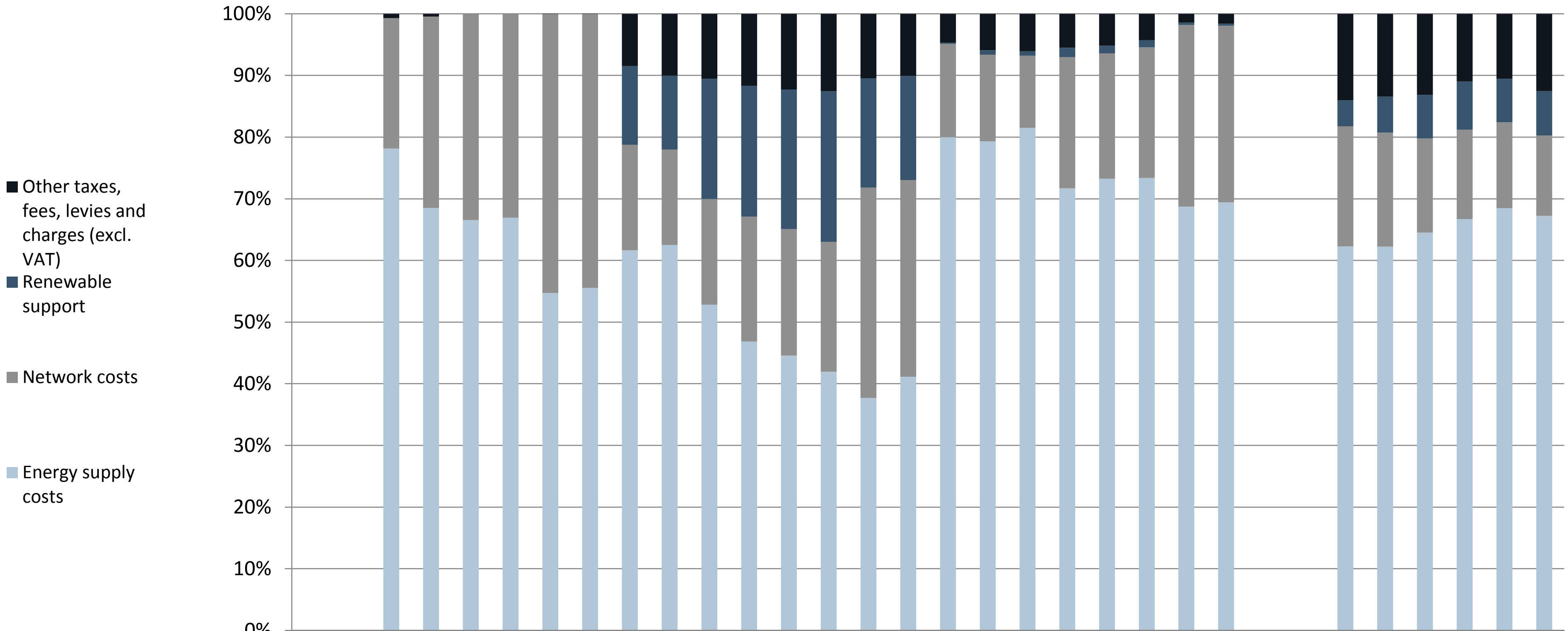


	France								Germany							
	2008	2010	2012	2013	2014	2015	2016	2017	2008	2010	2012	2013	2014	2015	2016	2017
Other taxes, fees, levies and charges (excl. VAT)	0.5	0.5	1.2	1.2	1.3	0.9	2.7	1.9	12.4	13.4	15.1	15.0	11.6	11.9	10.8	11.2
Renewable support	11.2	6.6	5.4	5.9	6.3	7.0	0.2	0.1	11.4	13.9	20.7	19.4	24.4	27.7	22.9	26.0
Network costs	16.2	15.3	14.1	14.7	13.5	12.8	23.0	23.7	13.8	13.3	9.7	11.6	13.8	13.1	18.3	20.0
Energy supply costs	72.2	77.6	79.3	78.2	79.0	79.3	74.2	74.4	62.4	59.4	54.6	54.0	50.2	47.3	48.0	42.8

	Netherlands								UK							
	2008	2010	2012	2013	2014	2015	2016	2017	2008	2010	2012	2013	2014	2015	2016	2017
Other taxes, fees, levies and charges (excl. VAT)	0.0	4.7	4.9	0.2	7.9	8.2	9.2	9.2	0.0	0.6	1.4	0.0	2.0	3.5	4.9	3.8
Renewable support	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.3	0.0	4.3	11.2	0.5	13.3	16.9	19.2	23.4
Network costs	0.0	16.2	21.4	0.6	18.7	18.3	12.0	10.9	0.0	14.1	15.6	0.6	20.1	20.5	20.8	19.6
Energy supply costs	0.0	79.1	73.7	2.2	73.3	73.5	78.6	79.6	0.0	81.0	71.9	3.3	64.6	59.1	55.1	53.2

Source: Authors' elaboration

Figure 243 Structure of electricity prices of Member States in the SE region (Portugal, Italy, Spain and Greece) in relative terms (%) – Simple averages



Portugal	2008	2010	2012	2013	2014	2015	2016	2017
Other taxes, fees, levies and charges (excl. VAT)	0.0	0.0	0.7	0.5	0.0	0.0	0.0	0.0
Renewable support	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Network costs	0.0	0.0	21.2	31.0	33.5	33.1	45.3	44.5
Energy supply costs	0.0	0.0	78.1	68.5	66.5	66.9	54.7	55.5

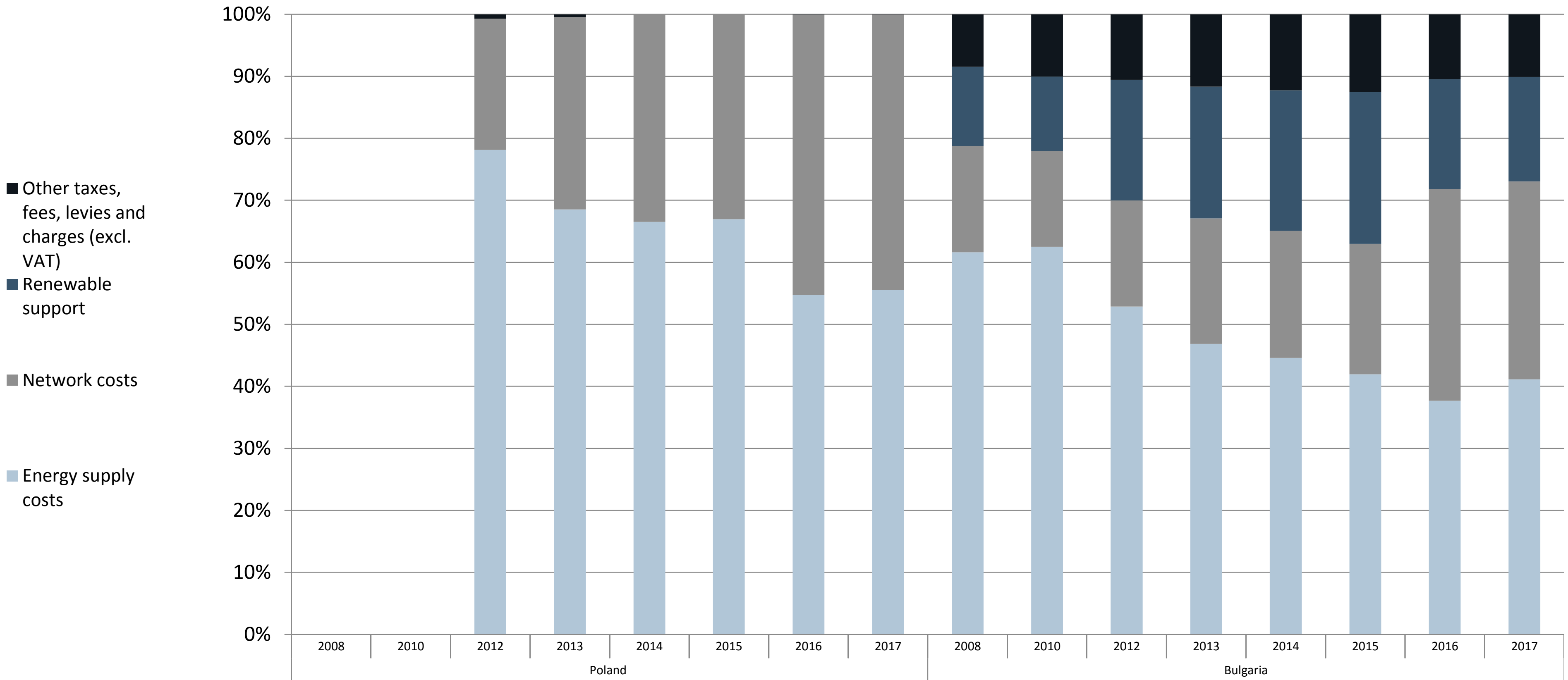
Italy	2008	2010	2012	2013	2014	2015	2016	2017
Other taxes, fees, levies and charges (excl. VAT)	8.5	10.0	10.5	11.7	12.3	12.6	10.5	10.1
Renewable support	12.8	12.0	19.5	21.3	22.7	24.4	17.7	16.9
Network costs	17.1	15.5	17.1	20.2	20.5	21.1	34.1	31.9
Energy supply costs	61.6	62.5	52.8	46.8	44.6	41.9	37.7	41.1

Spain	2008	2010	2012	2013	2014	2015	2016	2017
Other taxes, fees, levies and charges (excl. VAT)	4.7	5.9	6.1	0.2	5.2	4.3	1.5	1.6
Renewable support	0.2	0.7	0.7	0.1	1.2	1.1	0.4	0.3
Network costs	15.1	14.1	11.7	0.9	20.4	21.2	29.4	28.6
Energy supply costs	80.0	79.3	81.5	2.9	73.2	73.4	68.7	69.4

Greece	2008	2010	2012	2013	2014	2015	2016	2017
Other taxes, fees, levies and charges (excl. VAT)	0.0	0.0	14.0	0.6	13.2	11.0	10.5	12.5
Renewable support	0.0	0.0	4.2	0.3	7.0	7.8	7.1	7.2
Network costs	0.0	0.0	19.5	0.9	15.3	14.5	13.9	13.0
Energy supply costs	0.0	0.0	62.3	2.9	64.5	66.7	68.5	67.2

Source: Authors' elaboration

Figure 244 Structure of electricity prices of Member States in the CEE region (Poland and Bulgaria) in relative terms (%) – Simple averages



	Poland 2008	Poland 2010	Poland 2012	Poland 2013	Poland 2014	Poland 2015	Poland 2016	Poland 2017	Bulgaria 2008	Bulgaria 2010	Bulgaria 2012	Bulgaria 2013	Bulgaria 2014	Bulgaria 2015	Bulgaria 2016	Bulgaria 2017
Other taxes, fees, levies and charges (excl. VAT)	0.0	0.0	0.7	0.5	0.0	0.0	0.0	0.0	8.5	10.0	10.5	11.7	12.3	12.6	10.5	10.1
Renewable support	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.8	12.0	19.5	21.3	22.7	24.4	17.7	16.9
Network costs	0.0	0.0	21.2	31.0	33.5	33.1	45.3	44.5	17.1	15.5	17.1	20.2	20.5	21.1	34.1	31.9
Energy supply costs	0.0	0.0	78.1	68.5	66.5	66.9	54.7	55.5	61.6	62.5	52.8	46.8	44.6	41.9	37.7	41.1

Source: Authors' elaboration

The relative share of different price components varies significantly between Member States for three main reasons:

- Firstly, there are exemptions for electricity intensive sectors or consumers, the rules and magnitude of which differ considerably between Member States;
- Secondly, the visibility of price components in bills varies from one Member State to another. For example, in some Member States, renewable support levies are not visible and therefore these costs may have been included in either the 'energy supply costs' component or the 'network costs' component. As a result, some costs appear higher and RES support payments are absent;
- Thirdly, there are different overall network costs and RES support payments within Member States, as these costs depend on the way in which renewables and the network grid are funded, the extent of renewable deployment and the level of grid upgrades within a Member State.

Exemptions

The rules determining levy exemptions differ between Member States. The magnitude of levy exemptions for electricity intensive consumers is increasing. In many Member States, certain consumers are exempted from both levies and taxes; for example, in Italy since 2014 energy intensive consumers have been given tariff exemptions. In Spain plants receive discounts on network costs and RES support and these costs are distributed through an access tariff. Large companies operating in Spain with flat consumption profiles connected to a medium or high voltage power line pay significantly lower access tariffs than small companies with high peak loads. In France, Article D. 351-1 of the Energy Code defines the status of electricity intensive users. Reductions of network tariffs, as well as indirect costs compensation, exoneration of the RES surcharge (*Contribution au service public de l'électricité* - CSPE) and access to flexibility mechanisms are being offered to electricity intensive companies. For Dutch plants there are two main regulated price components: an energy tax for electricity and a RES levy in the form of a Feed-in Premium called SDE+. The tariff for these components depends on electricity usage and it is reduced for business users with a high level of consumption (above 10 GWh).

More specific details are provided on the exemptions for energy intensive industries in each Member State covered by this analysis in Table 290. This was taken directly from a 2017 report by the Council of European Energy Regulators (CEER) on the status reviews of renewable support schemes in Europe that provided an overview of RES levy exemptions within Annex 6 of the report[74].

Table 290 Overview of exemption from contribution to RES support schemes

Country	Exemptions for: *				Specifications
	EII	SC	NL	Other	
France	X	X			**Some industries (metallurgy, chemistry, etc.) are totally exempted from the tax**. Moreover, energy intensive industries are subject to reduced rates of the applicable tax on electricity consumption, which finances RES support. While the nominal tax rate is €22.5/MWh, the reduced rates range from €0.5 to €7.5/MWh. **Self-consumption** is exempted from the tax, under a threshold fixed at 240 TWh/year.
Germany	X	X	X		**Energy intensive industries (**see §63-69 EEG 2014): Exemptions apply only to electricity intensive companies in sectors that compete internationally. In concrete terms, the Special Equalisation Scheme works as follows: beneficiaries pay the full EEG surcharge for the first gigawatt hour and then 15% of the EEG surcharge for every kilowatt hour of electricity they consume above and beyond this. This burden is limited to a maximum of 4% of the respective enterprise's gross value added or, in the case of enterprises with an electricity cost intensity of 20% or more, a maximum of 0.5%.

[74] CEER (2017), "Status Review of Renewable Support Schemes in Europe".

Country	Exemptions for: * EII	SC	NL	Other	Specifications
					Self-consumption (see § 61 EEG 2014): self-consumption of conventional and RES energy is exempted from the RES surcharge when the installation was put into service before the new Renewable Energy Sources Act went into force on 1 August 2014. • For new conventional installations, 100% of the surcharge is imposed. • Self-suppliers who use new renewable energy installations or new, highly efficient heat-power cogeneration systems have to pay only a reduced EEG surcharge. In order to progressively introduce the new provisions, the reduced surcharge rate will initially be 30% through 2015 and 35% for 2016. • All renewable energy installations and highly efficient heat-power cogeneration systems that are put into service from 1 January 2017 onwards will pay a reduced EEG surcharge of 40%. • For self-consumed electricity generated by RES installations ≤10 kW and for up to 10 MwH per year, no RES surcharge is imposed.
Netherlands		X			Self-generated electricity is netted against the same consumer tariff as used energy (with a max of 5,000 kWh), including taxes and levies etc.
UK	X	X			Self-consumption: the costs of the renewables obligation and FITs scheme are passed through by suppliers onto customer bills. As customers are not billed for self-consumption, the costs of the RES support cannot be spread across this part of the electricity use.
Portugal		X		X	**SC:** according to Decree-Law no. 153/2014, self-consumption with an installed power higher than 1.5 kW that is connected to the grid **pays a monthly fixed compensation in the first 10 years of exploration**. This compensation integrates an amount for RES support. **Other:** every consumer pays for RES support but, as the distribution of RES support by each voltage level is carried out in accordance with the number of consumers in each voltage level, **the majority of RES support is paid by Low Voltage under 20.7 kVA of contracted power.**
Italy	X	X			The tariff component A3 is applied to electricity consumed (not only withdrawn from the grid) by final customers except: • Energy intensive customers connected in Medium Voltage (MV) in relation to monthly consumption greater than 8 GWh and connected in High Voltage (HV) and Extra High Voltage (EHV) in relation to monthly consumption greater than 12 GWh; Self-consumption: a very slight change for self-consumption has been introduced: from 2015 onwards, in cases of what is called Sistemi Efficienti di Utenza – SEU (systems with RES generation facilities or high efficiency CHP plants installed at the consumption site) and in the case of what is called Reti Interne d'Utenza – RIU (networks in specific industrial or commercial sites), 5% of the unit value of the tariff component identified as A3 (which accounts for RES support) is applied to self-consumption as well. Up to 2014, this A3 component was applied to electricity withdrawn from the grid but not at all to self-consumption.
Spain					No specifications provided.
Greece				X	The RES levy is attributed differently to consumer categories (HV, MV agricultural, MV consumption >13 GWh, MV consumption <13 GWh, LV agricultural, LV residential, LV commercial) according to specific methodology based on non-competitive electricity charges. An annual cap on the total amount of RES levy is set (€991,000/year), which favours only a few energy intensive industries.
Poland	X				
Bulgaria					No specifications provided.

Note: EEI: Energy intensive industries. SC: Self-consumption (i.e. consumption of self-generated RES and/or conventional electricity). NL: Network losses.
Source: CEER (2017), "Status Review of Renewable Support Schemes in Europe".

Visibility of price component costs

The data collected for this study indicate that plants in the Netherlands, Portugal and Spain face very little or no renewable support component. This is misleading as plants that pay RES levies might not have this cost visible on their electricity bill during the full period and these costs may have been included in either the 'network costs' or the 'energy supply costs'. For example:

- In the Netherlands an RES levy was introduced in 2013 with a steadily increasing tariff. This tariff, however, does not appear in the replies to the questionnaire. It has probably been incorporated into the electricity tax and therefore has been included in the 'other taxes and levies' component instead. Some plants may receive complete exemption from this tax as they are part of the metallurgical sector, which explains the low 'other taxes and levies' price component figures.
- In Portugal there is a public service obligation (PSO) that appears on electricity bills and covers the cost of certain policies including renewables support. It is likely that Portuguese plants have included this PSO in the 'network costs' component. Similarly, in France, a PSO also appears on bills rather than a breakdown of the components in the study.
- In Spain electricity bills have a component called 'Access to network' (ATR payment), which includes access to networks, CHP and renewables compensation. It is likely that respondents have included these costs under the 'network costs' components.

10.4 Natural gas

Gas consumption and price analysis across sectors

This section analyses the relationship between gas consumption and price levels across both the various sectors and consumption bands for all EU respondents. Average gas prices presented below are the simple averages of the respondents across the EU in the respective sectors. Figure 245 shows the variation in the data for each of the sectors included in this study with an average for the year 2016, with aluminium split into primary, secondary and downstream plants, and steel split into steel EAF and steel BOF. This year was selected based on the number of observations and reliable data points available. When the survey was conducted, some plants did not have data available for 2017 and for some sectors data was only collected for the most recent two years; hence 2016 is the year with the highest number of observations.

The dark circles in the graph presented represent average natural gas prices and are presented as simple averages. The vertical lines above and below the circle illustrate the standard deviation of the natural gas price for each sector. The standard deviation is used to quantify the variation of values within a set of data values. Roughly 68% of the observations fall within one standard deviation of the mean.

The natural gas consumption range is illustrated by a box plot, in which the upper and lower boundary line of the grey box represent the first and third quartiles of the data set. This means that 25% of the plants consume less than the value indicated by the lower line, while 25% of the plants consume more than the value indicated by the upper line. In other words, the box comprises the middle half of the data sample. Moreover, the middle line that divides the box into two parts represents the median value, where 50% of the values are below the median.

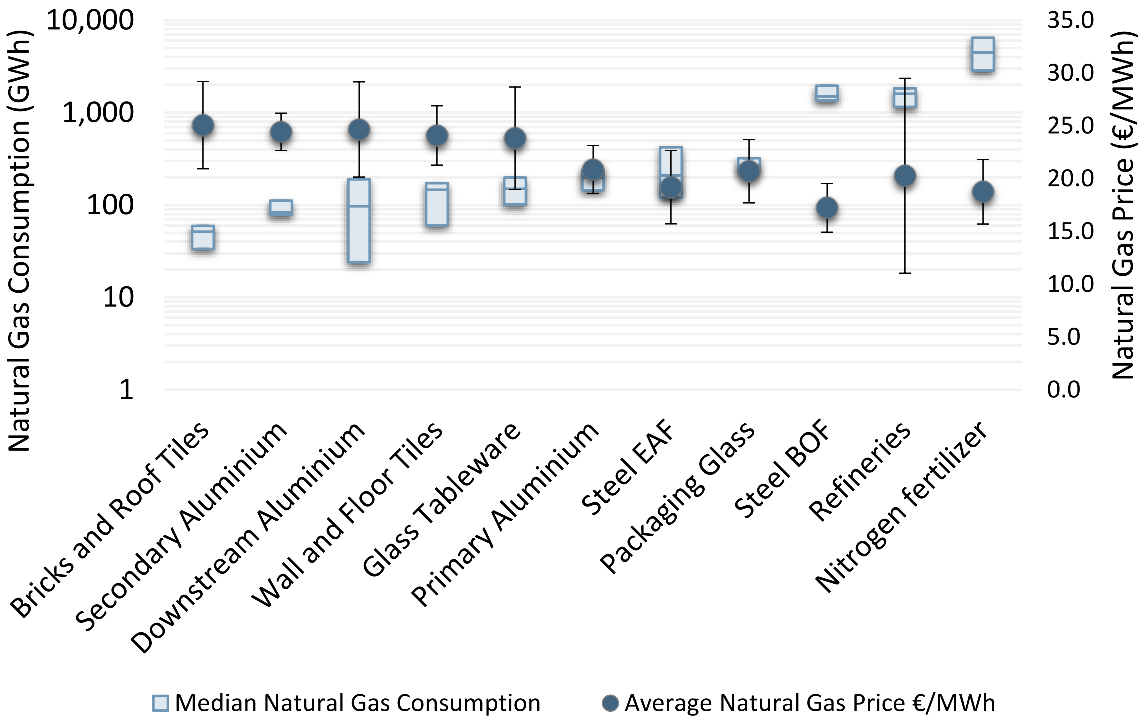
Two different y-axes have been used: one for price, which is linear, and one for consumption, which is logarithmic due to the disparity in plant natural gas consumption.

A correlation between natural gas consumption and the natural gas price paid by plants can be seen, but is less marked than in the analysis on electricity prices. Consumption levels in the nitrogen fertiliser sector are much higher than in the brick and roof tiles sector, but the difference in price is minor compared to power. In 2016, the median natural gas consumption of nitrogen fertiliser plants included in the study is 4,465 GWh and the average natural gas price is €18.8/MWh, while plants from the bricks and roof tiles industry report a median natural gas consumption of 5.9 GWh and pay an average natural gas price of €25.1/MWh, which is 33% higher than the average price for nitrogen fertilisers.

The variation in prices across all sectors is lower than in the case for electricity, due to the fact that:

1. The proportion of taxes, levies and network costs is relatively small in the total gas price. Consequently, there is less opportunity for governments to adapt prices through discounts and exemptions. Figure 247 and Figure 248 illustrate this situation;
2. Natural gas costs heavily depend on international prices set by natural gas producing countries. Since EU Member States are mostly net importers of natural gas, there is little room for price negotiation. By contrast, electricity prices depend on the generation mix within that Member State and the surrounding Member States, so are more country and region specific.

Figure 245 Natural gas consumption (median, first quartile, third quartile) and costs by sector (simple averages, standard deviation), 2016



Note: Based on 165 facilities.
Source: Authors' elaboration

Table 291 Simple average natural gas prices and median natural gas consumption by sector (2016)

Sector	Average Natural Gas Price €/MWh	Standard Deviation of Natural Gas Price	Median consumption (GWh)	Lower quartile cons (GWh)	Upper quartile cons (GWh)
Bricks and Roof Tiles	25.1	4.1	51.3	33.6	59.6
Secondary Aluminium	24.4	1.8	82.8	78.9	111.2
Downstream Aluminium	24.7	4.5	97.4	24.2	190.7
Wall and Floor Tiles	24.1	2.8	146.4	60.1	173.0
Glass Tableware	23.8	4.9	150.3	101.2	198.2

Sector	Average Natural Gas Price €/MWh	Standard Deviation of Natural Gas Price	Median consumption (GWh)	Lower quartile cons (GWh)	Upper quartile cons (GWh)
Primary Aluminium	20.9	2.3	199.8	145.2	237.1
Steel EAF	19.2	3.5	209.8	121.0	423.7
Packaging Glass	22.3	3.0	266.5	225.9	321.6
Steel BOF	17.2	2.3	1,499.1	1,359.4	1,959.7
Refineries	20.3	9.2	1,596.9	1,150.4	1,826.5
Nitrogen fertiliser	18.8	3.1	4,464.7	2,875.6	6,458.4

Note: based on 185 observations in 2016.
Source: Authors' elaboration

Natural gas consumption and price analysis across consumption bands

Figure 246 shows the average gas price of plants grouped by consumption levels. The same plants included in Figure 245 have been included in this analysis, but the plants have been grouped by consumption level rather than sector.

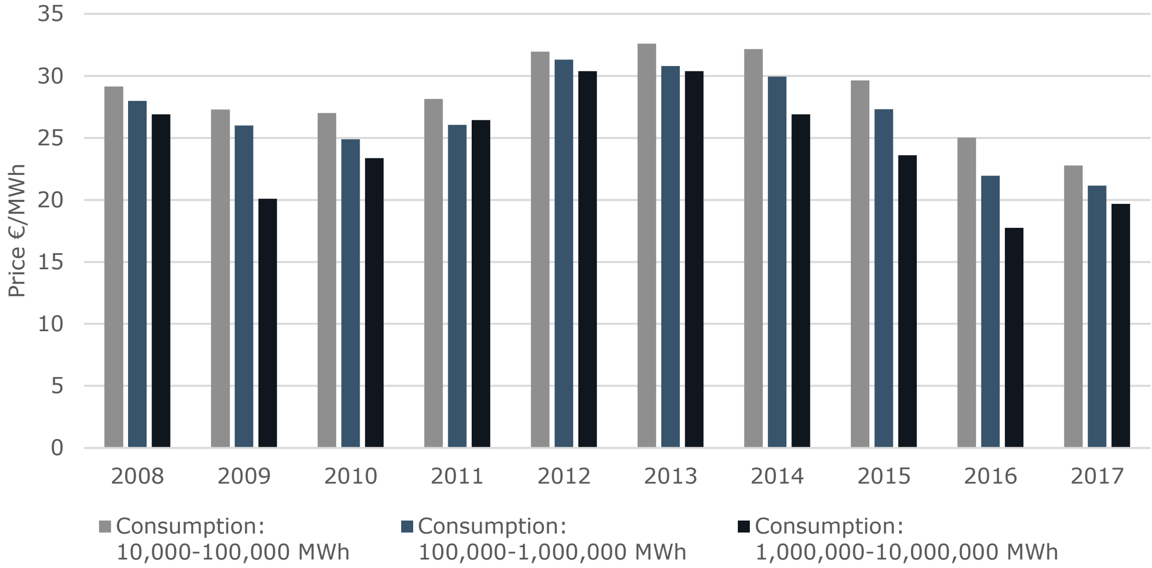
Three bands have been used following a logarithmic scale:

i. Annual natural gas consumption between 10 and 100 GWh (42% of plants)
ii. Annual natural gas consumption between 100 and 1,000 GWh (44% of plants)
iii. Annual natural gas consumption between 1,000 and 10,000 GWh (11% of plants).

Taking the year with the greatest number of observations, 2016, 86% of plants are within the first two bands in which annual consumption is between 10 GWh and 1,000 GWh (1,000 MWh and 1,000,000 MWh). Plants with consumption greater than 10,000 GWh or smaller than 10 GWh were not included as defining more bands would result in a very limited number of plants within these lower and upper bands.

As with electricity prices, gas prices also decrease as consumption increases, but this trend is not as strong as for electricity prices for reasons described above.

Figure 246 Natural gas prices by consumption band – Simple averages



Source: Authors' elaboration

Table 292 Natural prices by consumption band – Simple averages

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Number of observations	110	74	129	81	137	145	149	147	165	163
Average gas price (€/MWh) for plants that consume 10 to 100 GWh of gas	29.1	27.3	27.0	28.1	31.9	32.6	32.1	29.6	25.0	22.8
Average gas price (€/MWh) for plants that consume 100 to 1,000 GWh of gas	28.0	26.0	24.9	26.0	31.3	30.8	29.9	27.3	21.9	21.2
Average gas price (€/MWh) for plants that consume 1,000 to 10,000 GWh of gas	26.9	20.1	23.4	26.4	30.4	30.4	26.9	23.6	17.7	19.7

Source: Authors' elaboration

Gas price component analysis across Member States

This section discusses the various components that together make up natural gas prices at the Member State level.

Nine Member States have been included in the natural gas price component analysis. Total and average plant gas consumption of the sample for each of the nine Member States, along with details regarding sample representativeness, are provided in Table 293.

Similar to the electricity price component analysis, since the sample in each Member State is relatively small, the natural gas price is not representative for all plants within that Member State. For example, if only larger plants are included among respondents from a Member State, then the results might be biased towards lower natural gas prices. On the other hand, Member States with mostly small plants among respondents to this study may show higher natural gas prices. Therefore, this Member States analysis should be taken with caution and some of the results may not represent natural gas components faced by all energy intensive plants within that Member State. A top-down approach with statistically representative data may give more accurate results on the prices paid by energy intensive industries in a given Member State. This analysis should be seen as a complementary exercise and used to validate or challenge top-down results.

Table 293 Sample natural gas consumption and representative for each Member State

Member State	Annual natural consumption of plants within the sample (GWh)*		Member State sample representativeness
	Total	Average	
France	5,920	247	In the French sample, 50% of the plants are from the bricks and roof tiles sector, 21% from the steel sector, 17% from the aluminium sector and a number of plants from the glass and refineries sectors.
Germany	899	100	One-third of plants included in the sample are from the aluminium sector. Over half the plants within the sample are from the ceramics industry.
The Netherlands	8,773	1,462	The sample representativeness of plants providing gas component data is split across the sectors. The sample includes mostly large natural gas consuming plants from the ceramics, glass, refineries and steel industries.
The UK	2,126	304	In the sample of UK plants that returned questionnaires with reliable price component data, 57% of the plants are from the ceramics sector, the remaining plants are from the steel, glass and refineries sectors.
Portugal	811	162	The plants included in the natural gas price component analysis in Portugal are all from the ceramics and glass sectors. The glass sector makes up 60% of the sample of Portuguese plants. Plants from the ceramics sector make up the remaining share.
Italy	11,026	551	In the Italian sample, 45% of plants are from the ceramics industry, 30% from the glass industry and 20% from the aluminium industry. Because the majority of plants are from the glass and ceramics industries that typically consume more natural gas, the average annual consumption of plants within the sample for Italy is relatively high.
Spain	10,010	556	Thirty-nine percent of plants included in the Spanish sample are from the ceramics industry, while plants from the glass, steel and aluminium industry make up the remaining share.
Poland	8,788	1,098	Half of the plants in the sample in Poland are from the steel sector. The remaining facilities that make up the Polish sample are from the ceramics, nitrogen fertiliser, glass and aluminium sectors.
Bulgaria	727	182	In regard to Bulgaria, all plants included in the sample are either from the ceramics or glass sectors. 75% of plants are from the glass sector, while 25% are from the ceramics sector.

*Note: * values taken from the year 2017.*
Source: Authors' elaboration

Figure 247, Figure 248 and Figure 249 show the structure of absolute natural gas prices for Member States in the NWE, SE and CEE regions respectively. Figure 250, Figure 251 and Figure 252 show the information in relative terms in nine Member States.

Averages of price components at the Member State level are used. To ensure confidentiality agreements are met, only Member States with reliable data available for three or more plants belonging to independent companies have been included in this part of the analysis. The data are considered reliable if price components add up to total gas prices.

Results for British plants in 2008 and Portuguese plants in 2008 and 2010 were removed from the graphs, as the data received at the price component level for that year were considered unreliable.

The general trend is that gas prices initially increased from 2008 until a peak in 2012-13 and since then natural gas prices have been decreasing in all Member States, with much lower gas prices in the more recent years. For example, natural gas prices for French respondents declined by 27.3% in the period from 2014 until the end of 2017, and in the UK, gas prices decreased by 32.0% during the period from 2013 until the end of 2017. Similarly, in Italy plants reported that the natural gas price declined by 34.4% from 2013 until the end of 2017 and over the same period Bulgarian plants reported that the natural gas price declined by 33%. Previously, overall gas prices in most Member States increased from 2008.

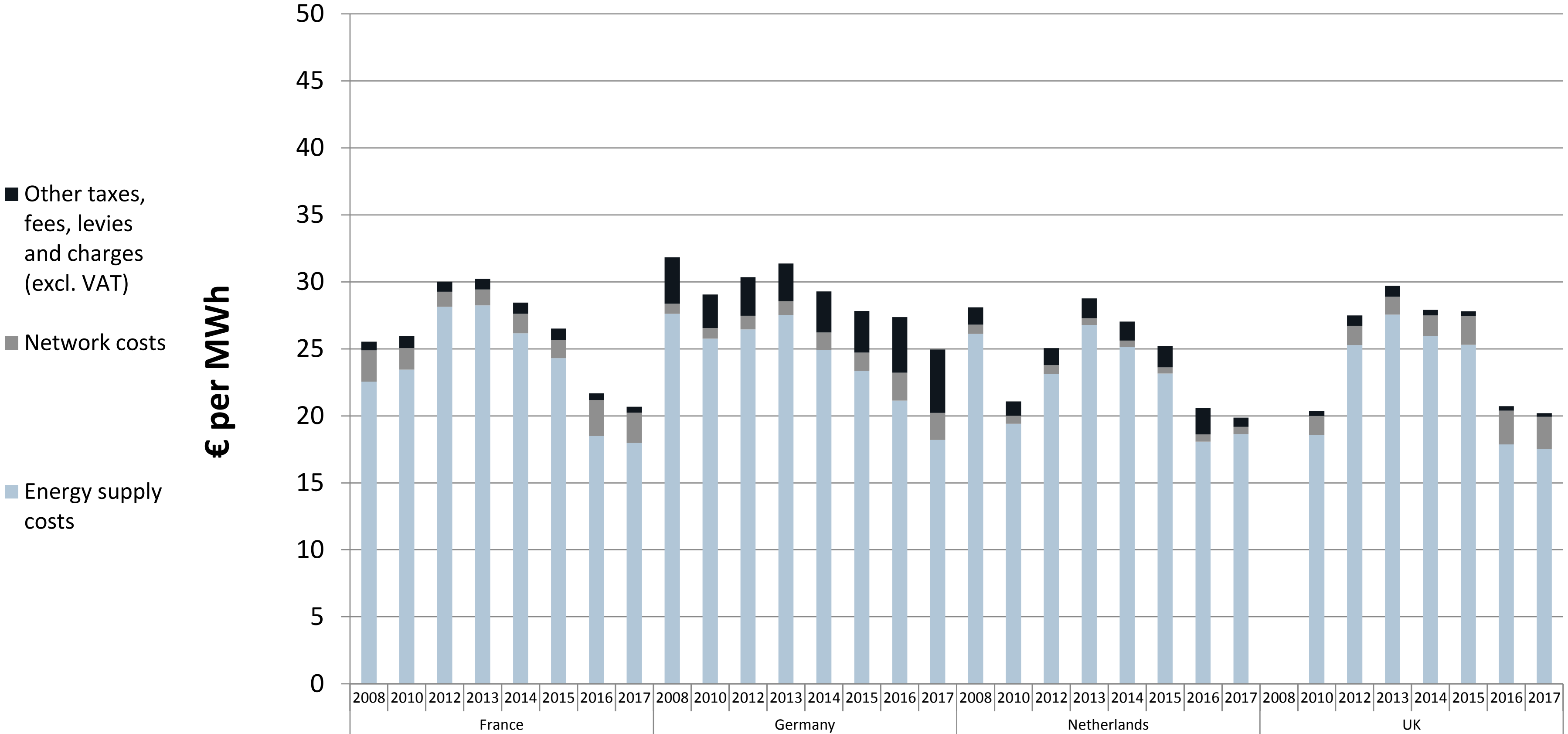
Less variation in gas prices was observed across Member States compared to electricity prices. The regulatory components play a much larger role in the electricity price when compared to the natural gas price and this means governments have less leverage to adapt gas prices through intervening with regards to taxes and levies, as well as the fact that there are no differences in generation costs.

Plants in the NWE region appear to benefit from relatively low gas prices, compared to other Member States in the SE and CEE regions. This is mostly attributable to lower wholesale gas prices, but also to lower network costs.

Plants in Portugal, Bulgaria, Italy and Spain see the highest gas prices. Although this is largely due to higher wholesale gas prices, these Member States (with the exception of Spain) also have higher network costs.

No general trends are observed from the respondents' data in the regulated price components 'network costs' and 'other taxes and levies'. Nevertheless, the proportion of taxes, levies and network costs is relatively small in the total gas price when compared to electricity, so there is limited importance of these regulated gas components when analysing gas prices. Regulatory costs, including network costs and taxes, levies and charges make up between 8-15% of the natural gas price and this trend is seen in the majority of Member States included in the analysis. In Germany, however, regulatory costs made up a share of between 12-15% in the years 2008-2015 and in the last two years increased to 22% in 2016 and 27% in 2017. The Research Team has checked and this is a result of changes in the number of sampled plants rather than regulator costs actually increasing in this Member State.

Figure 247 Structure of natural gas prices of Member States in the NWE region (France, Germany, the Netherlands and the UK) in absolute terms (€/MWh) – Simple averages



France	2008	2010	2012	2013	2014	2015	2016	2017
Number of observations	3	7	9	9	10	10	23	24
Other taxes, fees, levies and charges (excl. VAT)	0.7	0.9	0.7	0.8	0.8	0.8	0.5	0.4
Network costs	2.3	1.6	1.1	1.2	1.5	1.4	2.7	2.3
Energy supply costs	23	23	28	28	26	24	18	18

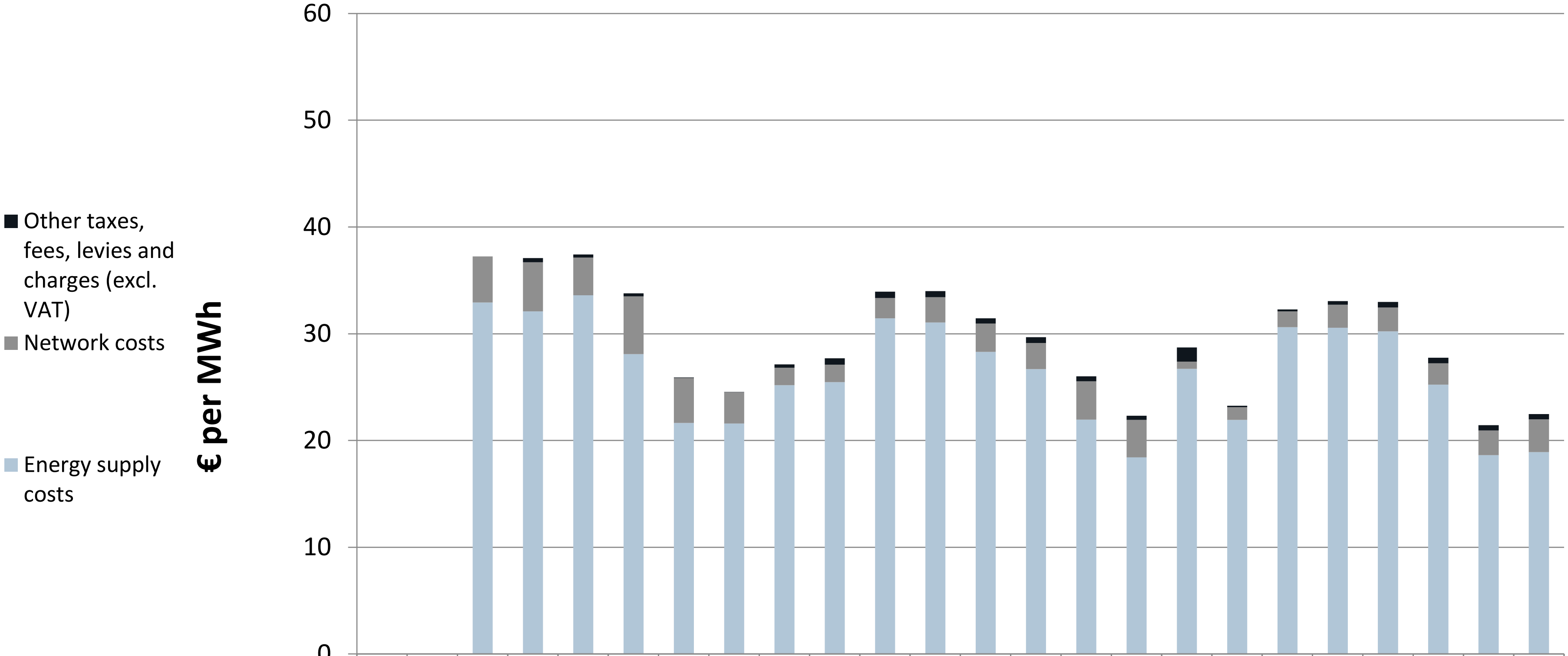
Germany	2008	2010	2012	2013	2014	2015	2016	2017
Number of observations	7	8	8	8	9	9	10	9
Other taxes, fees, levies and charges (excl. VAT)	3.5	2.5	2.9	2.8	3.1	3.1	4.1	4.7
Network costs	0.8	0.8	1.0	1.0	1.3	1.4	2.1	2.0
Energy supply costs	28	26	26	28	25	23	21	18

Netherlands	2008	2010	2012	2013	2014	2015	2016	2017
Number of observations	4	5	5	6	6	6	6	6
Other taxes, fees, levies and charges (excl. VAT)	1.3	1.1	1.3	1.5	1.4	1.6	2.0	0.7
Network costs	0.7	0.6	0.7	0.5	0.5	0.5	0.5	0.5
Energy supply costs	26	19	23	27	25	23	18	19

UK	2008	2010	2012	2013	2014	2015	2016	2017
Number of observations		5	7	7	8	7	7	7
Other taxes, fees, levies and charges (excl. VAT)		0.4	0.8	0.8	0.4	0.4	0.3	0.3
Network costs		1.4	1.4	1.3	1.5	2.1	2.5	2.4
Energy supply costs		19	25	28	26	25	18	18

Source: Authors' elaboration

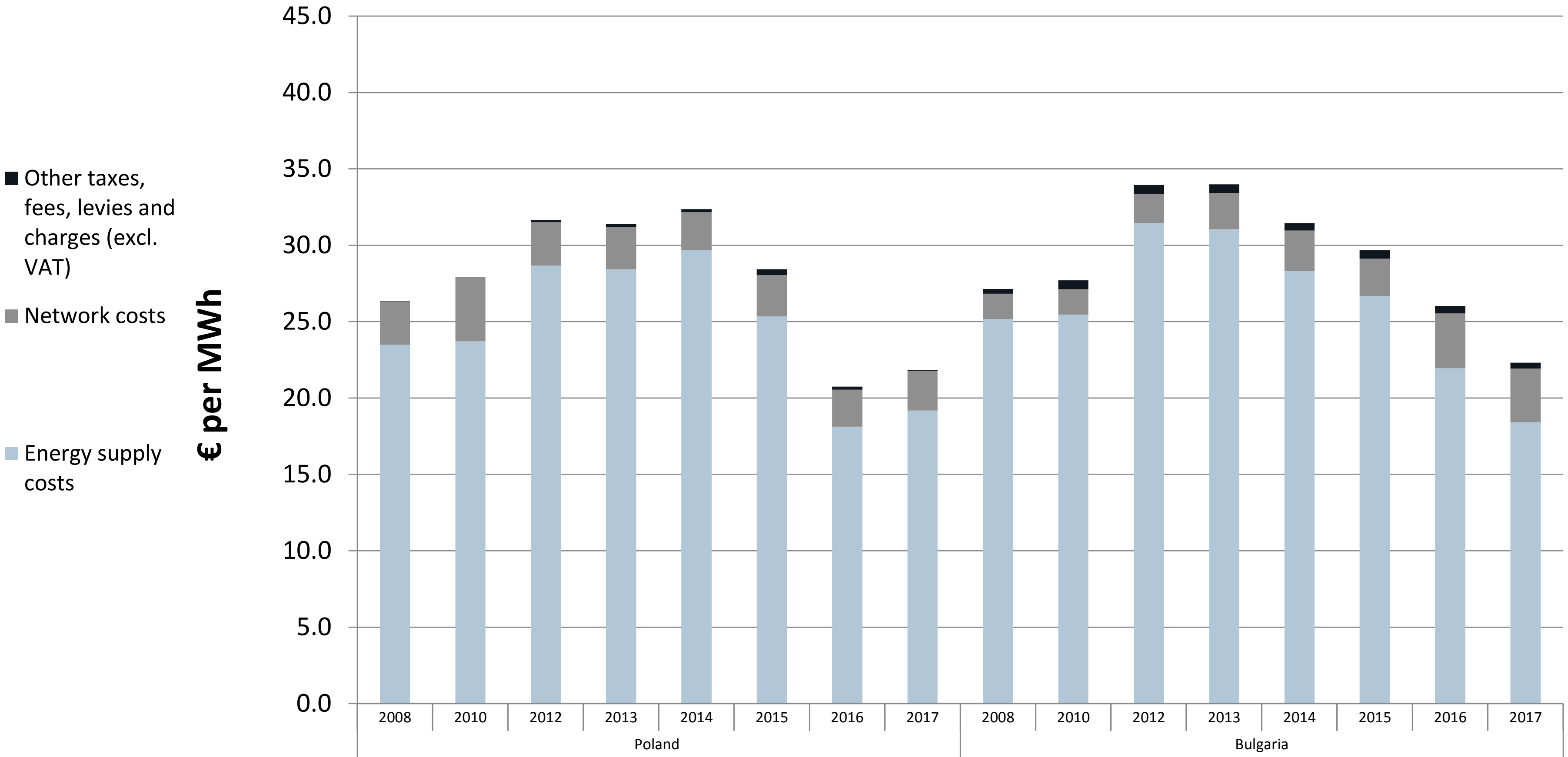
Figure 248 Structure of natural gas prices of Member States in the SE region (Portugal, Italy and Spain) in absolute terms (€/MWh) – Simple averages



	Portugal								Italy								Spain							
	2008	2010	2012	2013	2014	2015	2016	2017	2008	2010	2012	2013	2014	2015	2016	2017	2008	2010	2012	2013	2014	2015	2016	2017
Number of observations			3	3	4	4	5	5	8	13	15	15	16	14	19	20	9	11	13	12	12	12	18	18
Other taxes, fees, levies and charges (excl. VAT)			0.0	0.4	0.3	0.3	0.0	0.0	0.3	0.6	0.6	0.6	0.5	0.6	0.5	0.4	1.3	0.1	0.2	0.3	0.5	0.5	0.5	0.5
Network costs			4.3	4.6	3.5	5.4	4.2	2.9	1.7	1.6	1.9	2.4	2.7	2.4	3.6	3.5	0.7	1.2	1.5	2.2	2.2	2.0	2.3	3.1
Energy supply costs			32.9	32.1	33.6	28.1	21.6	21.6	25.2	25.5	31.5	31.0	28.3	26.7	22.0	18.4	26.7	21.9	30.6	30.6	30.2	25.2	18.6	18.9

Source: Authors' elaboration

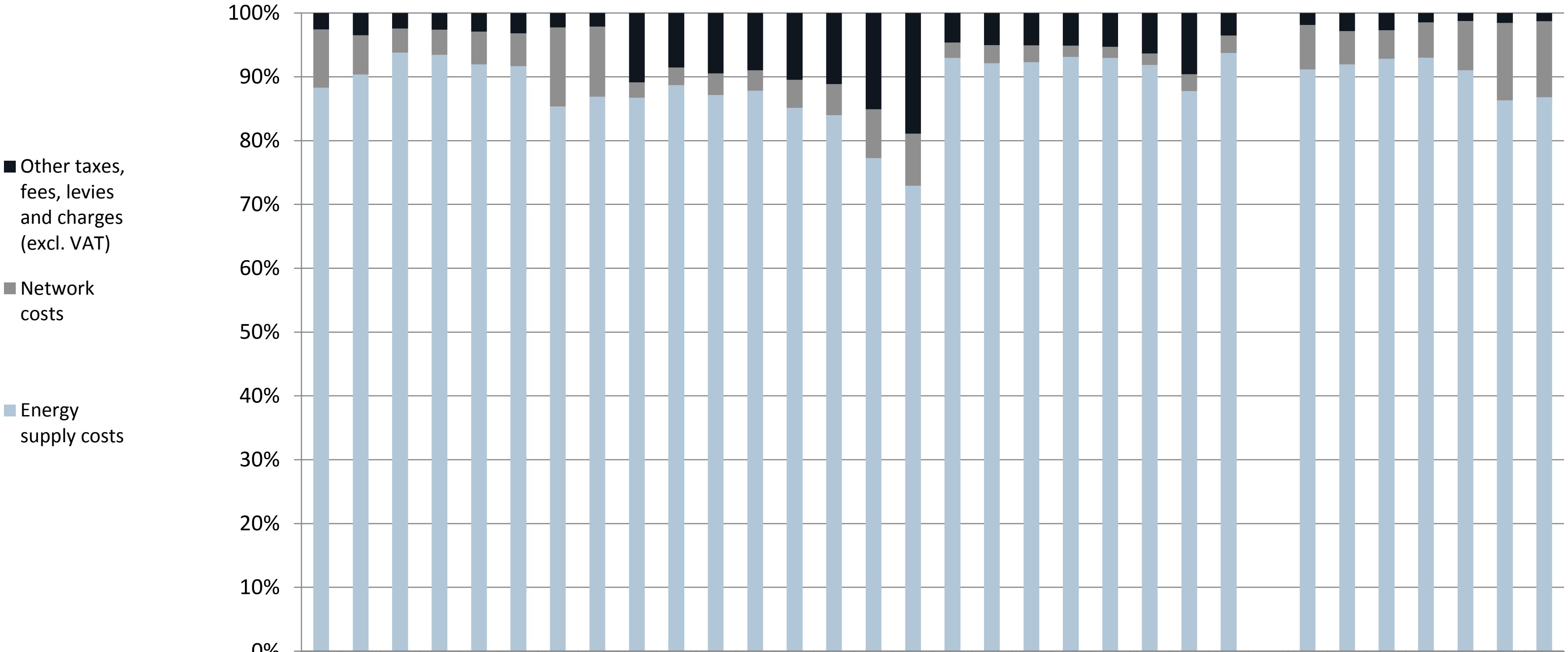
Figure 249 Structure of natural gas prices of Member States in the CEE region (Poland and Bulgaria) in absolute terms (€/MWh) – Simple averages



	Poland 2008	Poland 2010	Poland 2012	Poland 2013	Poland 2014	Poland 2015	Poland 2016	Poland 2017	Bulgaria 2008	Bulgaria 2010	Bulgaria 2012	Bulgaria 2013	Bulgaria 2014	Bulgaria 2015	Bulgaria 2016	Bulgaria 2017
Number of observations	5	7	8	8	8	5	10	8	3	4	4	4	4	4	4	4
Other taxes, fees, levies and charges (excl. VAT)	0.0	0.0	0.1	0.2	0.2	0.4	0.2	0.0	0.3	0.6	0.6	0.6	0.5	0.6	0.5	0.4
Network costs	2.8	4.2	2.8	2.8	2.5	2.7	2.4	2.6	1.7	1.6	1.9	2.4	2.7	2.4	3.6	3.5
Energy supply costs	23.5	23.7	28.7	28.4	29.7	25.3	18.1	19.2	25.2	25.5	31.5	31.0	28.3	26.7	22.0	18.4

Source: Authors' elaboration

Figure 250 Structure of natural gas prices of Member States in the NWE region (France, Germany, the Netherlands and the UK) in relative terms (€/MWh) – Simple averages



France	2008	2010	2012	2013	2014	2015	2016	2017
Other taxes, fees, levies and charges (excl. VAT)	2.6	3.5	2.4	2.6	2.9	3.2	2.3	2.1
Network costs	9.2	6.1	3.8	4.0	5.1	5.2	12.4	11.0
Energy supply costs	88.3	90.4	93.8	93.4	91.9	91.7	85.3	86.9

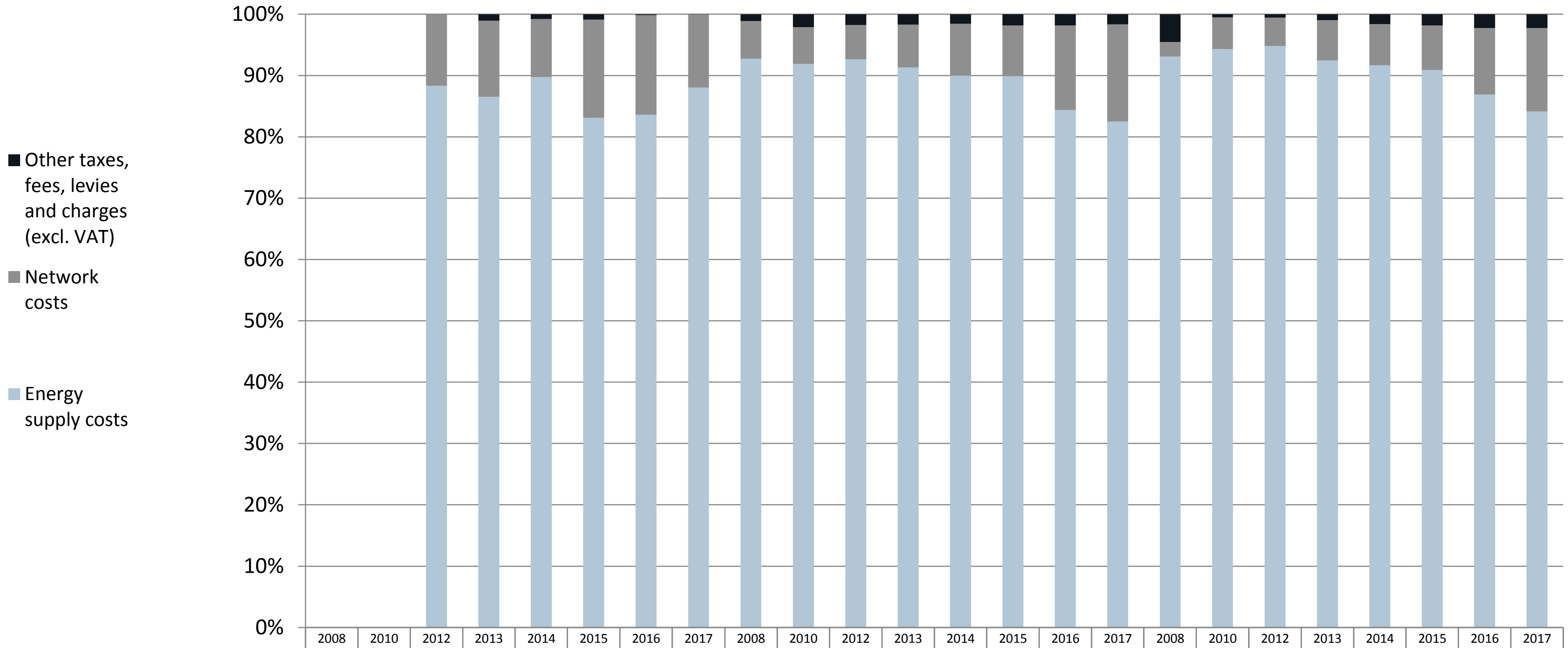
Germany	2008	2010	2012	2013	2014	2015	2016	2017
Other taxes, fees, levies and charges (excl. VAT)	10.9	8.6	9.5	9.0	10.5	11.2	15.1	18.9
Network costs	2.4	2.8	3.4	3.2	4.4	4.9	7.6	8.2
Energy supply costs	86.7	88.7	87.2	87.8	85.1	84.0	77.3	72.9

Netherlands	2008	2010	2012	2013	2014	2015	2016	2017
Other taxes, fees, levies and charges (excl. VAT)	4.6	5.0	5.1	0.1	5.3	6.4	9.6	3.5
Network costs	2.4	2.9	2.6	0.0	1.8	1.8	2.6	2.7
Energy supply costs	93.0	92.1	92.3	1.3	93.0	91.8	87.8	93.7

UK	2008	2010	2012	2013	2014	2015	2016	2017
Other taxes, fees, levies and charges (excl. VAT)	0.0	1.9	2.8	0.0	1.5	1.3	1.5	1.3
Network costs	0.0	7.0	5.2	0.1	5.6	7.7	12.1	11.9
Energy supply costs	0.0	91.2	91.9	1.3	93.0	91.0	86.3	86.8

Source: Authors' elaboration

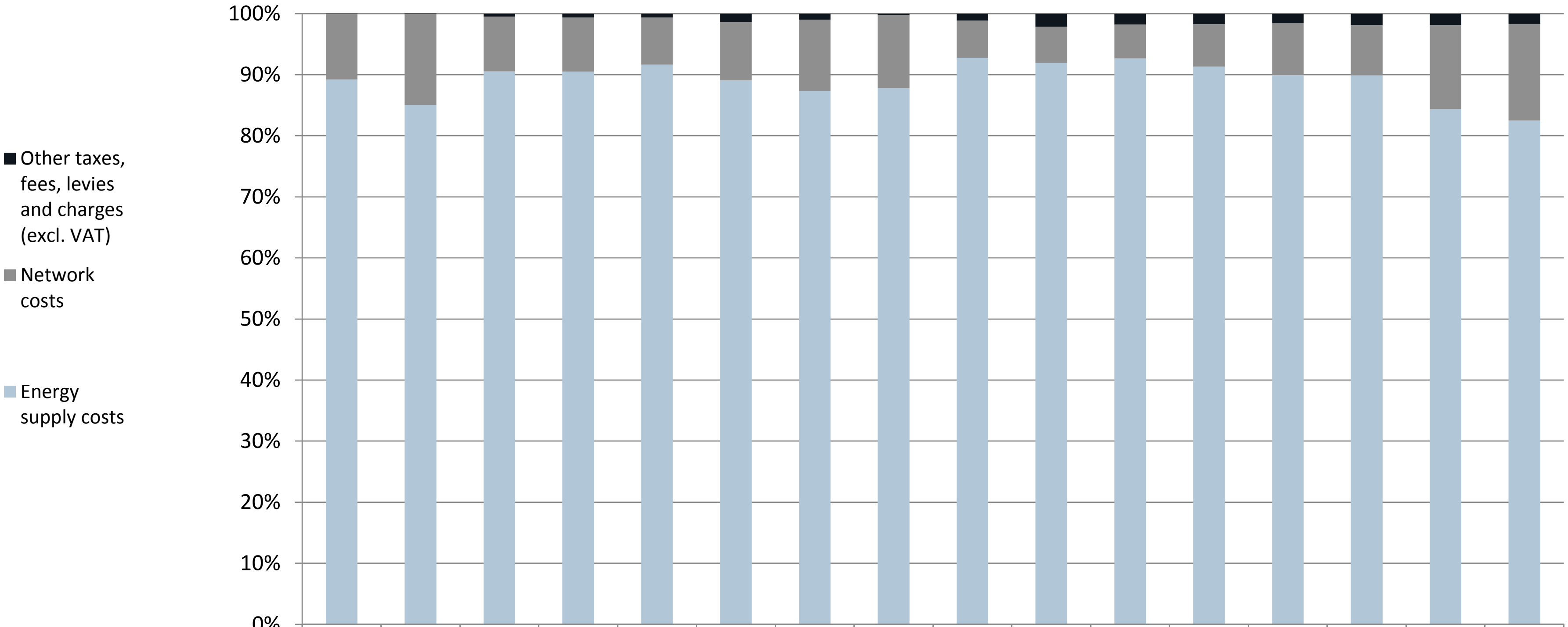
Figure 251 Structure of natural gas prices of Member States in the SE region (Portugal, Italy and Spain) in relative terms (€/MWh) – Simple averages



	Portugal								Italy								Spain							
	2008	2010	2012	2013	2014	2015	2016	2017	2008	2010	2012	2013	2014	2015	2016	2017	2008	2010	2012	2013	2014	2015	2016	2017
Other taxes, fees, levies and charges (excl. VAT)	0.0	0.0	0.0	1.1	0.8	0.9	0.1	0.0	1.1	2.1	1.8	1.7	1.6	1.9	1.8	1.7	4.5	0.5	0.6	0.0	1.6	1.8	2.3	2.3
Network costs	0.0	0.0	11.6	12.4	9.4	16.0	16.3	12.0	6.1	5.9	5.6	7.0	8.5	8.2	13.8	15.8	2.3	5.1	4.6	0.1	6.7	7.3	10.8	13.6
Energy supply costs	0.0	0.0	88.4	86.5	89.8	83.1	83.6	88.0	92.7	91.9	92.7	91.3	90.0	89.9	84.4	82.5	93.1	94.3	94.8	1.5	91.7	90.9	86.9	84.1

Source: Authors' elaboration

Figure 252 Structure of natural gas prices of Member States in the CEE region (Poland and Bulgaria) in relative terms (€/MWh) – Simple averages



	Poland								Bulgaria							
	2008	2010	2012	2013	2014	2015	2016	2017	2008	2010	2012	2013	2014	2015	2016	2017
Other taxes, fees, levies and charges (excl. VAT)	0.0	0.0	0.5	0.6	0.6	1.4	1.0	0.2	1.1	2.1	1.8	1.7	1.6	1.9	1.8	1.7
Network costs	10.8	15.0	9.0	8.8	7.7	9.6	11.7	12.0	6.1	5.9	5.6	7.0	8.5	8.2	13.8	15.8
Energy supply costs	89.2	85.0	90.6	90.5	91.7	89.1	87.3	87.8	92.7	91.9	92.7	91.3	90.0	89.9	84.4	82.5

Source: Authors' elaboration

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