Energy and environment

Analyses

Developments in the trade intensity and electro-intensity in the hardening sector (NACE 25.61 21) and in the NACE 25.61 economic sector (surface refinement and heat treatment) in Germany and the EU

Study commissioned by the Industrieverband Härtetechnik e.V. (IHT) and the Zentralverband Oberflächentechnik e.V. (ZVO)

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Summary

The present study shows that companies in the "contract hardening plant" sector (NACE 25.61 21) and the upper hierarchical level of "surface refinement and heat treatment" (NACE 25.61) together form one of the most energy-intensive industries in Europe. The proportion of electricity costs within gross value added for "contract hardening plants" is 21%, and 8.4% for "surface refinement and heat treatment".

The market, in which "contract hardening plants" and "surface refinement and heat treatment" companies operate, is characterised by a particularly high density of competition. Reason for this is the geographical distribution of hardening shops and surface-coating operations in Europe and the immediately surrounding regions, and also the simple and cost-effective ways of promptly transporting goods for heat treatment or surface coating to appropriate locations outside Europe. The trade intensity with third countries, which is derived from the customer base of the economic sector, is above 71% on an EU level, both for "contract hardening plants" and for the "surface refinement and heat treatment" industry as a whole.

In summary, "surface refinement and heat treatment" companies, according to the standards set out in the EEAG 2014-2020, are exposed to an increased risk of losing their competitiveness vis-à-vis non-European competitors. Therefore, the economic sector as a whole (NACE 25.61), and also the subsector "contract hardening plants" (NACE 25.61 21), should be included – in the course of the forthcoming revision of the guidelines – on the list of ex ante identified sectors eligible for relief.

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1. Task

The European Commission adopted guidelines for environmental and energy aid from 2014 to 2020 (Guidelines on State aid for environmental protection and energy 2014-2020) on 9 April 2014. A revision of these guidelines for 2021 is already adopted.

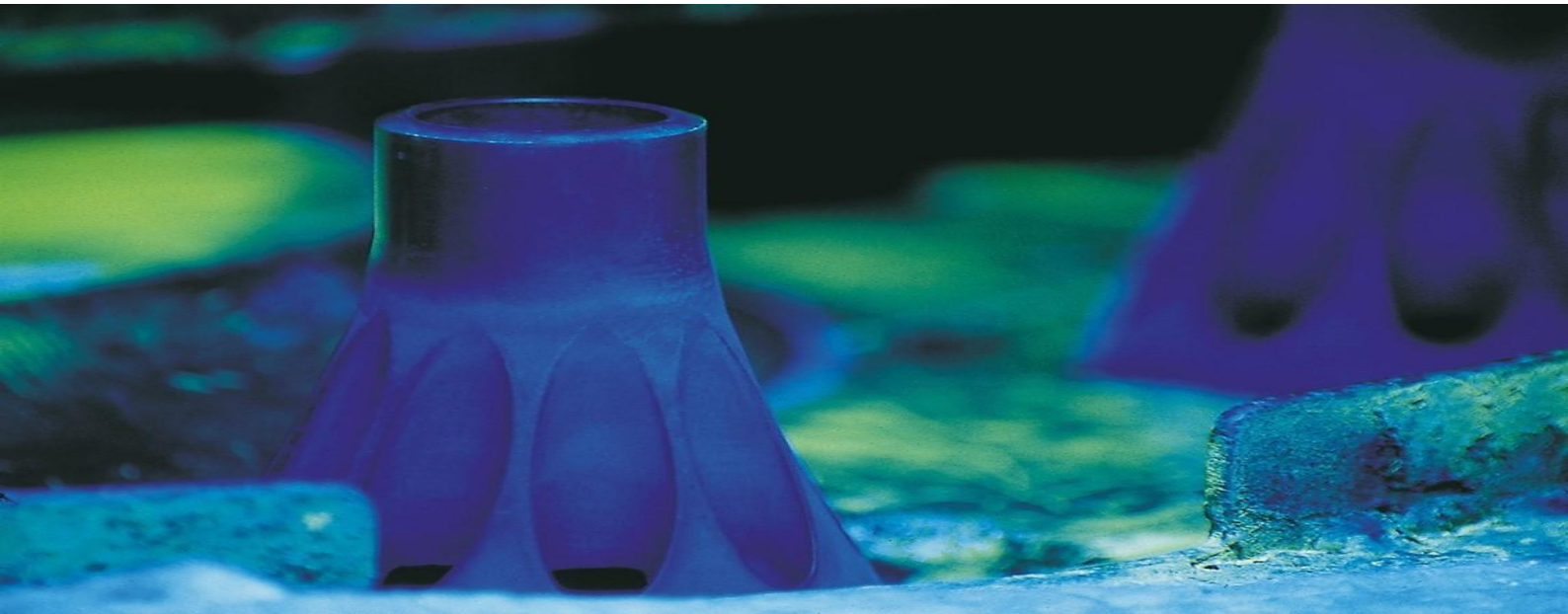
The currently valid guidelines aim to create fair and uniform conditions of competition in intra-EU markets through the harmonisation of the framework and/or the criteria for eligibility. It is not only existing criteria for the approval of aid in areas such as renewable energies or tradable CO_2-emission certificates. The guidelines also include criteria for reduction or relief of taxes and costs for the financing of the expansion of renewable energies for electro-intensive industries.

In particular, the EU grants relief for electro-intensive businesses only if sectors are exposed to international competition. To assess this level of competition, a standardised procedure is currently applied, which focuses on two key indicators: trade and electro-intensity.

Businesses can benefit from aid-compliant relief of costs associated with renewable energy promotion, if their competitive position would be compromised due to their trade or electro-intensity. In view of the EU Commission, a company must either

- belong to one of the 68 ex ante identified sectors listed in Annex 3 of the Directive and demonstrate an electro-cost intensity of at least 20%. (Identical risks to competitiveness exist in sectors which have a trade intensity ≥10% and an electro-intensity ≥10% at EU level, a low trade intensity, but of at least 4% where there is a markedly higher electro-intensity ≥80%, or where there is a very high trade intensity ≥80% with a low electro-intensity ≥7%).[1]

- or if they are one of the 152 likewise ex ante identified sectors (sectors with a trade intensity with third countries of greater than 4% at EU level), which are listed in the Directive in Annex 5, and also have an electro-cost intensity (proportion of electricity costs based on the full surcharge rate within gross value



added) of at least 20% on a company level.

An important precondition for appearing as an economic activity on ex ante defined lists, is the availability of statistical data to calculate the trade and electro-intensity at EU levels. In principle, the official surveys collect data for individual sectors according to the Classification of Economic Activities, 2008 Edition (NACE 2008).[2] The lists of economic activities in Annex 3 and Annex 5 of the current Directive, which may be eligible for preferential treatment, consider sectors at three or four digit levels in the economic activity system. Further subdivisions, such as six digit levels, are not given in lists in the Annex of the Directive.

It is important to note that the statistical data shows substantial gaps for some sectors even at the four-digit level. This makes it impossible to calculate – using official statistics alone – the proportion of electricity costs to gross value added and that of the trade intensity with third countries at EU level. This data situation is problematic, as some electro-intensive economic sectors facing international competition are not listed in the Annex lists of the Directive only because statistical data is lacking at an EU level. The lack of a sufficiently detailed, official data basis alone, however, should not be an exclusion criterion for consideration as a sector eligible for relief.

The "surface refinement and heat treatment" (NACE 25.61) economic sector contains companies in the metal industry, who refine products made from iron and steel either by depositing metallic and non-metallic coatings or by hardening or tempering using heat treatment ("contract hardening plants" NACE 25.61 21). The production processes (electrolysis, electroplating, anodising, etc. and hardening by heat treatment) encountered in this economic sector are very electro-intensive. The sector "surface refinement and heat treatment" is not listed in the current version of the Directive in Annex 3 nor in the additional Annex 5 list.

In order to scientifically evaluate questions regarding the calculation of trade intensity and importance of the proportion of electricity costs in gross value added for the sector "surface refinement and heat treatment" (NACE 25.61) as a whole and for "contract hardening plants" (NACE 25.61 21) in particular, the Industrieverband Härtetechnik e.V. (IHT) and the Zentralverband Oberflächentechnik e.V. (ZVO) awarded a research contract in 2021 to EEFA Institut GmbH & Co KG.

[2] The economic activities system has been created in execution of the so-called NACE regulation and serves to standardise the EU's statistical surveys. In the manufacturing sector, the PRODCOM regulation also applies. The latter requires not only a uniform product breakdown for product statistics, but also compliance with certain quality standards.

On the basis of the statistical data available today, the electro-cost intensity and trade intensity for the entire sector (NACE 25.61) as well as contract hardening plants, in particular at an EU level, are quantified for the period from 2010 to 2018. Within the scope of this research project, EEFA Institut GmbH & Co. KG the following text is updated evaluation report.

2. The "surface refinement and heat treatment" industry

The "surface refinement and heat treatment" sector is one of Germany's smaller manufacturing industries, commonly referred to as "German Mittelstand". In 2019, around 0.41 % of total German industry revenue was made there. Sectoral employment was 61 798, i.e. around 0.96% of total employees in German manufacturing.

Production in the sector in 2019 required the use of an average of 2.86 GJ of fossil fuels and 1.15 GJ of electric energy (equivalent to 322 kWh) per €1000 of gross production. With current production of €5.7 billion, this results in energy consumption of around 21.3 PJ and electricity consumption of 2.4 TWh (equivalent to around 9 PJ).

Despite this high specific consumption, "surface refinement and heat treatment" accounted for only 0.6% of final energy consumption in total German manufacturing in 2019 (electrical energy: 1.2 % of total electricity consumption in manufacturing). This low absolute energy consumption reflects the relatively small size of the economic sector "surface refinement and heat treatment".

The sector "surface refinement and heat treatment" (NACE 25.61) also includes "contract hardening plants" (NACE.25.61 21). The contract hardening sector in Germany is a typically medium-sized supply industry with about 180 hardening facilities. It generated a turnover of approx. €1.3 billion in 2019 and employs approximately 6 300 people. The entire "surface refinement and heat treatment" industrial sector can be roughly divided into two sub-areas, which are each characterised by specific production processes and energy inputs. The first sub-area ("surface finishing") includes companies and operations which refine metals or metal components by surface coating. Surface coating uses, depending on product requirements, both metal (for example: zinc, copper, chromium, gold, etc.) and non-metallic coatings of plastic, paint, etc. Given the multitude of different metal coatings, heterogeneous coating technologies are to be found in this production sector. These range from electrolysis and chemical

coating processes to those such as fluidised bed-coating, phosphating, gumming, varnishing, oxidation and high vacuum evaporation.

The second area (sector NACE 25.61 21) includes the "heat treatment" of metals ("contract hardening plants").[3] Heat treatment includes the time-limited, energy-intensive heating of metal work pieces – and particularly of steels – to certain temperatures, in accordance with the heating and cooling rates for the improvement of material properties.

It is through this heat treatment that the components gain the properties (such as hardness, toughness and tensile strength) required for their future applications in, for example, the automotive industry, mechanical and plant engineering, medical engineering, shipbuilding and the aviation industry.

The crucial factors impacting the heat-treatment processes are time (heating time and time at temperature), high temperature, atmosphere and quenching or cooling. The heating time must be measured such that the temperature rise is very uniform throughout the component, despite what can be very high temperatures, so as to keep the delay to a minimum. The time at temperature is chosen within a specified temperature range so that the desired structural changes occur or so that the carbon (in the case of case hardening) or the nitrogen (in the case of nitrogen hardening), can diffuse into the component.

[3] In addition to the hardening plants which offer heat treatment on an almost "external" basis, Germany also has numerous in-house hardening shops, which carry out heat treatment as part of their own operations (e.g. the automotive sector), in a separate department.

The choice of temperature depends on the material and on the desired heat-treatment result. For example, the magic threshold for steels with 0.8% carbon is at 723 C. At temperatures above this, a microstructure occurs whose properties can be changed selectively by appropriate cooling.

In heat treatment, there is a fundamental distinction between methods which bring about a thorough structural transformation and procedures which merely cause a transformation on the surface of a work piece. The former methods include annealing and hardening, i.e. thermal processes. Heat treatment processes which aim to transform the surface of the material, include diffusion and coating methods and/or thermo-chemical processes.

3. Definitions, data availability and methodological approach

The aim of the present study is to quantify the trade and electro-intensity indicators at an EU level within the meaning of the Guidelines on State aid for environmental protection and energy 2010-2014 for the sector "surface refinement and heat treatment" (NACE 25.61) and for "contract hardening plants" (NACE 25.61 21). To achieve this aim, the definition of the two indicators will be briefly explained in the following section. Subsequently, the data base available for the empirical calculation of the trade and electro-intensity will be examined more closely.

3.1. Definition: Trade intensity with third countries

Trade intensity is one of the group of ex-post indicators that attempt to empirically capture the intensity of competition in a sector using foreign trade data. It is defined as the ratio of the sum of exports and imports (trade volume) to the entire supply in the domestic market, i.e. domestic production plus imports:

$$(1)\ Trade\ intensity = \frac{Import\ value + Export\ value}{Production\ value + Import\ value}$$

In principle, the trade intensity indicator may be calculated on the basis of monetary aggregates or, if sufficient statistical information is available, using physical quantity variables (millions of tonnes, for example). Monetary aggregates offer the advantage that differences in the value intensity of the "trade intensity" indicator can be taken into account. Trade intensity typically assumes values between zero and one. Here, a value of zero means no foreign trade, and a value of one means no domestic production.

The trade intensity of an economic sector at EU level with third countries is obtained if, in formula (1), only the foreign trade with regions outside the EU are included or is set in relation to the production of the sector within the EU.

3.2. Definition: Electro-(cost-) intensity

In addition, the European Commission, in the Directive on environmental and energy aid, established a further criterion: electro-intensity. The electro-intensity criterion within the meaning of the Directive is not – as the name might suggest at first glance – an indicator of the use of electricity (MWh) in relation to an economic reference value such as the gross production value (in €) (specific electricity consumption in MWh per € gross production).

Instead, electro-intensity measures the proportion of electricity costs for a company or sector (in €) within gross value added (at factor costs).[4] The electro-intensity within the meaning of the Directive is essentially obtained as follows:

$$(2)\ Electro-(cost-)intensity = \frac{\text{Consumption of electricity (MWh)X price of electricity}(\frac{€}{\text{MWh}})}{\text{Gross value added at factor cost (€)}} \times 100$$

The gross value added includes the total of goods and services produced, valued at market prices, less any inputs that have gone into production. Thus it is the value added to the inputs through processing or refining.

If we subtract the amount of other indirect taxes less subsidies for current production from the gross value added, we obtain the gross value added at factor cost.[5]

3.3. Data used for Germany and the EU

The summary statement of the qualification criteria (trade and electro-intensity) for companies or sectors to be able to make use of preferential treatment and/or relief in terms of the costs of promoting renewable energy shows that the empirical implementation of the concept at the EU level requires an extensive and robust statistical basis.

Data for the EU is in principle provided by the Statistical Office of the European Commission (Eurostat). For some profoundly disaggregated economic activities such as the "surface refinement and heat treatment" sector (NACE 25.61) and subsets of this sector ("contract hardening plants" NACE 25.61 21), Eurostat's data displays, however, significant gaps, which appear to make a calculation of the proportion of the elec-

[4] cf. for further details: European Commission, Guidelines on State aid for environmental protection and energy 2014-2020, Annex 4.

[5] For a definition of gross value added, see Federal Statistical Office (ed.), Kostenstruktur der Unternehmen des Verarbeitenden Gewerbe sowie des Bergbaus und der Gewinnung von Steinen und Erden (Series 4, Volume 4.3).

tricity costs within gross value added almost impossible. The same is true of trade intensity with third countries at EU level (cf. Table 1).[6]

In particular, the quantification of trade intensity with third countries meets empirical barriers for the "surface refinement and heat treatment" sector and its sub-sectors, as the European foreign trade statistics do not give data regarding imports or exports. The background to this is that in the "surface refinement and heat treatment" sector, machining processes are performed on metallic work pieces on behalf of customers according to procedures which are customary for the sector ("extended workbench"). In this respect, the branch comes under the manufacturing sector, as the "coating" or "heat treatment" process step changes the chemical and physical properties of the product metal work piece.

Despite this unique character in terms of production – but because of the outsourced process step – the "surface refinement and heat treatment" sector's production is not visible in the statistics for foreign trade. The reason for this is that the international classification for foreign trade is done according to goods group and not according to sector. Metal work pieces are, according to this classification, assigned to those economic activities which produced them initially. In addition, a clear distinction between hardened/coated work pieces and those which have not been further refined is not possible through the use of the foreign trade statistics.

Table 1: Data availability for calculating the trade intensity

Sector name	NACE. No.	Production	Export	Import
Surface refinement and heat treatment	25.61	DE / EU	DE	-
including)	-	-	-	-
Contract hardening plants	25.61 21	DE / EU	-	-

Source: Destatis and Eurostat.

Empirical statements regarding the proportion of electricity costs within gross value added ("electro-cost intensity") are also not possible on an EU level, as the Statistical

[6] The EU Commission – in the context of a publication with indicators for the provisional Carbon Leakage List for the EU ETS Phase 4 dated 23.05.2018 – specified or determined an EU trade intensity of at least 37.9% (2013-2015) for the economic sector NACE 25.61.

Office of the European Commission does not publish data on electricity consumption or the electricity costs for the economic activities in question.

For Germany, reliable information can be found from official surveys[7] regarding electricity consumption and gross value added for the four-digit "surface refinement and heat treatment" sector. Using the electricity prices, which can also be derived for specific sectors from official sources[8], or which can be determined for the industry as a whole from the electricity price analysis of the German Association of Energy and Water Industries[9], the electricity costs can be determined.

For the "contract hardening plant" sector, the official statistics provide no information with regard to electricity consumption or gross value added. To fill these gaps in the data, Industrieverband Härtetechnik eV's detailed cost structure surveys are available for Germany (see Table 2).

Overall, inspection of the data available for an empirical analysis of electro-intensity at an EU level, a similar picture arises as for trade intensity. For the EU as a whole, only selected aspects (production) have fully detailed data for the economic sectors in question (NACE 25.61 and 25.61 21).

Table 2: Data availability for calculating electro-intensity

Sector name	NACE. No.	Consumption of electricity	Price/cost of electricity	Gross value added
Surface refinement and heat treatment	25.61	DE / -	DE / EU	DE / EU

[7] Official data on electricity consumption is provided by the Destatis (ed.) statistics: Erhebung über die Energieverwendung der Betriebe des Bergbaus und der Gewinnung von Steinen und Erden (Survey on the energy use of enterprises in mining and the quarrying of stone and earth and manufacturing enterprises), Statistic No. 060, Wiesbaden; Information on the gross value added for individual economic sectors is contained in Destatis (ed.):, Kostenstruktur der Unternehmen des Verarbeitenden Gewerbes sowie des Bergbaus und der Gewinnung von Steinen und Erden, (Cost structure of manufacturing enterprises as well as those involved in mining and the quarrying of stone and earth), Series 4 Volume 4.3, Wiesbaden.

[8] For individual economic sectors, average electricity prices can be ascertained, for example, by dividing the cost of electricity (as given by the materials and goods input statistics (Material- und Wareneingangserhebung im Verarbeitenden Gewerbe sowie im Bergbau und in der Gewinnung von Steinen und Erden, Series 4 Volume 4.2.4), by the electricity consumption (Erhebung über die Energieverwendung der Betriebe des Bergbaus und der Gewinnung von Steinen und Erden sowie des Verarbeitenden Gewerbes, Statistic No. 060).

[9] cf. German Association of Energy and Water Industries (ed.) BDEW-Strompreisanalyse May 2018, Haushalte und Industrie, Berlin.

including				
Contract hardening plants	25.61 21	DE[1] /-	DE[1]/ -	DE[1] / -

[1] Calculated from the Industrieverband Härtetechnik eV's (IHT's) association statistics.

3.4. Methodology

Against the background of the comparatively incomplete data base outlined, the present study adopts the approach of finding the missing data using plausibility considerations and plausible estimates, in order to determine the "trade intensity" and "electro-intensity" indicators for the "surface refinement and heat treatment" sectors and for "contract hardening plants" at an EU level, as required by the Directive.

The most important starting point for all considerations with a view to completing the data base at an EU level is constituted by existing information and indicators (electricity consumption and/or electro-intensity derived from this, data on structure of customer base, ratio of gross value added to production, etc.)

This approach accesses the very scattered and not-fully-available data, in order to calculate the trade and electro-intensity and to check the extent to which companies in the "surface refinement and heat treatment" sector (including contract hardening plants) fulfil the EEAG's criteria.

Obviously, any estimation of missing data is always associated with uncertainty. As such, the estimates presented in this study may provide important indirect evidence for the direction and extent of the development of the electro- and trade intensity in the "surface refinement and heat treatment" sector and for "contract hardening plants" at an EU level.

In the medium and long term, estimates and plausibility considerations do not replace the non-availability of official data. In order to meet the ever-increasing quantitative requirements in the future, an improvement or detailing of the official statistics is essential, in particular at EU level. Association statistics are another way to improve the data situation, provided appropriate association structures have also been established at EU level.

For specific industrial sectors which, due to a lack of statistical data, cannot prove that they fulfil the criteria for inclusion in the list of industries qualifying for environmental and energy aid, the Commission should in the future also allow alternative (perhaps on a company-specific or individual-case basis) methods of verification, harmonised on a European level.

4. Empirical results

4.1. Trade intensity

To calculate the criterion set by the European Commission for inclusion in Annex 3 – the trade intensity of a sector – the corresponding data (imports, exports and production) must be present. Since the "contract hardening plant" (NACE 25.61 21) sector and the overarching four-digit sector "surface refinement and heat treatment" (NACE 25.61) have no corresponding products in the foreign trade statistics, the official statistics do not provide the relevant import and export values (cf. Section 3.3).

Because of the data gaps outlined, the trade intensity with non-EU Member States can therefore also not be directly calculated in the manner envisaged by the EU Commission. A lack of statistical information alone is not an indication that companies and companies in the "contract hardening plant" sector (or the overall NACE 25.61 sector) are not subject to intense competition with other countries.

Against this background, the criterion of "trade intensity" for "contract hardening plants" or the "surface refinement and heat treatment" sector in Germany must be analysed. Firstly, the available data for Germany is better than that at the European level; furthermore, the empirical findings for Germany can provide important information on the magnitude of trade intensity in other European regions.

4.1.1. Trade intensity for Germany

4.1.1.1. Direct determination of trade intensity from the official statistics

For Germany, the official statistics provide profoundly broken-down information in its collection of production statistics for "surface refinement and heat treatment" sector within the "production in the manufacturing sector and for mining and quarrying and earth" (Series 4 Volume 3.1). The information available on production is based on reported monetary aggregates (in €000s) and currently go as far as the financial year 2019 (physical production quantities, in 1,000 tonnes, are not available for the NACE 25.61 sector).

In addition, in order to determine trade intensity empirically, information on foreign trade is required. Series 4, Volume 4.1.1 (Beschäftigung und Umsatz der Betriebe des Verarbeitenden Gewerbes - employment and turnover of enterprises in the manufacturing sector) is the only source of statistics on foreign trade for the "surface refinement and heat treatment" sector in Germany. In this annual publication, the Federal Statistical Office gives the export share (in terms of sales) for the whole economic sector (NACE 25.61). Statistics on revenue from abroad (exports) are also broken down according to sales to the euro zone and sales to other countries.

Using data on production and exports, an indicator showing the trade intensity, and which corresponds to the export share, can be calculated. Since imports are incorporated in both the numerator and denominator for the trade intensity indicator, the latter – if consideration is taken of the statistically unavailable imports – can be only greater than or equal to the trade intensity indicator without regard to imports. In this respect, the approach outlined here gives a conservative estimate of the trade intensity for the "surface refinement and heat treatment" sector in Germany.

Table 3: Trade intensity for the "surface refinement and heat treatment" sector (NACE 25.61) in Germany

in €m and %

	2010	2012	2014	2016	2018	Ø 2010-2018
Production	5 669	6 378	7 114	7 485	8195	7047
Import [1)]		-	-	-		
Export	1 330	1 546	1 985	2 077	2301	1868
Trade intensity	23.5	24.2	27.9	27.8	28.1	26.3

Source: Own calculation according to Destatis, FS4R31 and FS4R411, [1)] Import data not available.

Under these premises, the overall average value for trade intensity for the NACE 25.61 sector in Germany for the years 2010 to 2018 is 26.3 % (see Table 3). The average export share of the "surface refinement and heat treatment" sector (NACE 25.61) with non-European countries was, according to the Federal Statistical Office, for the years 2010 to 2018, 10.2 % (approximately equivalent to at least the trade intensity with non-EU Member States).

4.1.1.2. Indirect determination of trade intensity from customer trade intensity

The gaps in the data – which have already been mentioned several times and which are considerable in parts, especially in terms of the statistics for Europe – mean that it is sensible to approach a calculation of "trade intensity" for the "surface refinement and heat treatment" sector in an alternative way. In this respect, the trade intensity indicator must no longer be directly determined from the available data for the sector in question (NACE 25.61), but indirectly from the competitive situation of downstream economic activities (customer base). Surface refinement and heat treatment are outsourced process steps, which have been integrated into other industrial sectors to some extent. Many of these other industrial sectors perform hardening (for example) at their own works in in-house hardening shops, whilst simultaneously using contract hardening plants (e.g. in the case of operating bottlenecks).

The key advantage to this approach is that the "surface refinement and heat treatment" sector's customers are mainly industries such as the automotive sector, the tool industry, mechanical engineering, etc., for which the trade intensity indicator with non-EU Member States can be determined statistically both for Germany and Europe.

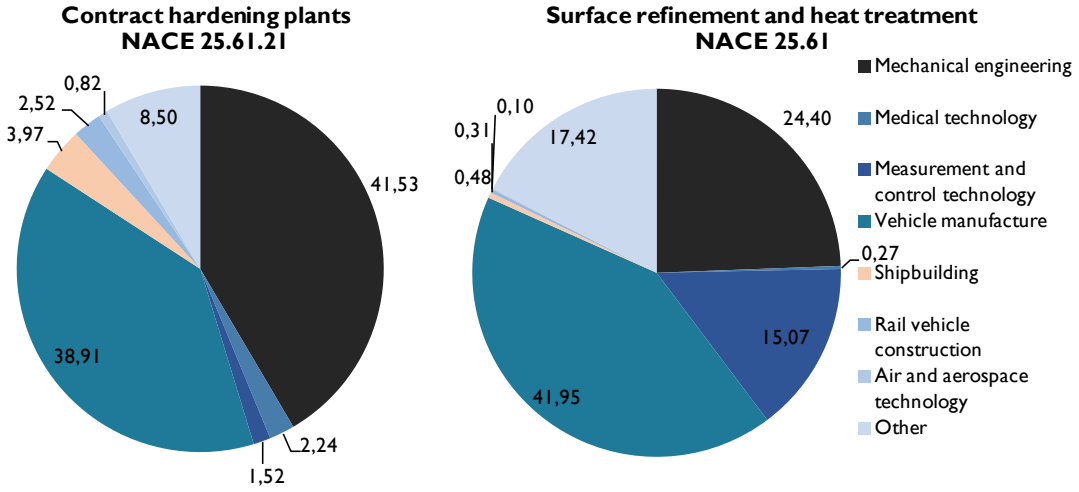
To illustrate the intensity of competition in the sector, trade intensity can be calculated using alternative approaches, based on empirical data for the sectors upstream and downstream of the hardening shop industry (or NACE 25.61 21).

Therefore, to estimate trade intensity in the "surface refinement and heat treatment" sector and for "contract hardening plants", the weighted average of the empirically determined trade intensities of the downstream industries and/or of the customer base is used. It is obvious that in order to empirically implement this computational cycle, the customer base or sales structure of the entire sector (NACE 25.61) and of "contract hardening plants" must be known in detail.

The Industrieverband Härtetechnik eV (IHT) and Zentralverband Oberflächentechnik eV (ZVO) have been able to provide extensive information about the customer base (for the years 2010 to 2018) in Germany. Both of these industry associations represent the entire customer base in the "surface refinement and heat treatment" sector.

Chart 1: Germany: Customer base for sectors NACE 25.61 and NACE 25.61 21

Average for the years 2010 to 2018, in %



Source: EEFA calculations based on IHT and ZVO information.

According to the specified industry associations, customers from the mechanical engineering and vehicle manufacturing sectors requested the most heat-treatment work from contract hardening plants in Germany, averaging 41.53 % and 38.14 % respectively for the years 2010 to 2018.

The customer base of the entire "surface refinement and heat treatment" sector differs from this market structure only to a small extent, its sales focus likewise being in these two sectors (see Chart 1).[10]

When weighted according to the respective customer base of the sectors, trade intensities of 108.34 % and 111.21 % respectively are evident for the "contract hardening plant" and "surface refinement and heat treatment" sectors.

4.1.2. Trade intensity for the EU

At the European level there is no reliable data regarding the customer base and the sales markets of the companies in the "surface refinement and heat treatment" sector. In order to calculate trade intensities with non-EU Member States for NACE sector 25.61 despite this – as provided in the European Commission Guidelines on State aid for environmental protection and energy 2010-2014 – the available information on the customer base on an EU level must first be conveyed.

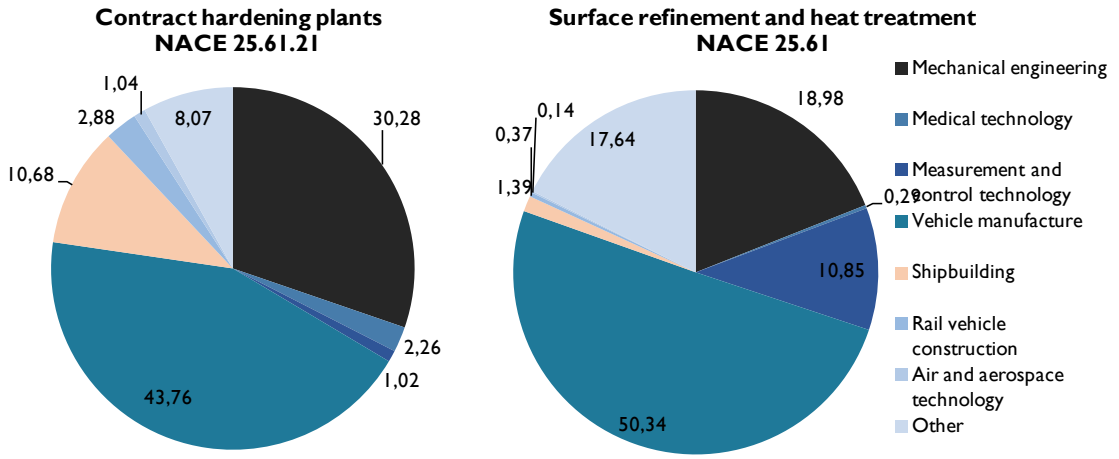
It is evident that the economic structures in Germany are essentially different from those in the EU. If one takes a simple explanatory approach, assuming that the proportion of the process steps for surface engineering and hardening are technologically identical for a homogeneous sector (e.g. mechanical engineering) in Germany and Europe, then a new customer base for Europe can be derived from the information computationally available, based on the empirically observed economic or sectoral structure in Europe and on the known importance of the heat treatment and surface coating process steps in Germany.

In concrete terms, in order to derive the European customer structure from the German one (which is already known), a calculation is first made of the contribution or share (of intermediate consumption) contributed by the "contract hardening plant" and "surface refinement and heat treatment" sectors to the total production of the respective downstream economic activities in Germany (mechanical engineering, medical technology, etc.) If it is assumed that the demand from the respective sectors (mechanical engineering, medical technology, etc.) for services from the "contract hardening plant" and "surface refinement and heat treatment" sectors at an EU level is the same proportion as in Germany, then the result is a new customer structure for the

[10] To calculate the customer base of the entire sector NACE 25.61, a weighted average customer base was calculated in accordance with the relevant production values from the data of the two associations, IHT and ZVO, regarding their specific customer bases.

Chart 2: Europe: Customer base for sectors NACE 25.61 and NACE 25.61 21

Average for the years 2010 to 2018, in %



Source: Own calculation according to IHT, ZVO and Eurostat information.

sectors "contract hardening plant" and "surface refinement and heat treatment" sectors in Europe (see Chart 2).

The conversion of the customer structure outlined takes account of the fact that, for example, the "mechanical engineering" sector in Germany has an economically stronger contribution than is generally the case in other parts of Europe. As a result, the "mechanical engineering" sector in Germany induces a noticeably higher demand than in Europe for the "contract hardening plant" and "surface refinement and heat treatment" sectors.

Accordingly, the "mechanical engineering" sector, for example, in Europe provides around 30.28% of the customer structure for "contract hardening plant" – which is noticeably below the corresponding proportion for Germany (41.53%).

Using the thus-identified customer structure of the sectors downstream of the "contract hardening plant" and "surface refinement and heat treatment" sectors, a calculation can now be made without any major problems – due to the lack of gaps in data on imports, exports and production provided by the Statistical Office of the European Commission (Eurostat) – of the trade intensities at an EU level. Table 4 summarises the production, imports and exports (based in each case on trade with countries outside Europe) and the trade intensity of the downstream sectors in Europe. It is apparent that the trade intensities of the downstream sectors, weighted by the customer base for the "contract hardening plant" sector at European level, result in a trade intensity of 71.63 %. A trade intensity with third countries of 71.61 % results for the "surface refinement and heat treatment" sector as a whole.

Table 4: Europe: Production, imports, exports and trade intensities for customer sectors

Average 2010 to 2018, in €m and %

	Production	Imports (outside EU)	Exports (outside EU)	Trade intensity
Mechanical engineering	473 849	97 574	240 435	102.12
Medical technology	12 300	6 370	11 982	274.40
Measurement and control technology	56 676	27 681	38 579	144.74
Vehicle manufacture	648 530	64 528	177 381	45.16
Shipbuilding	19 188	1 958	4 460	38.46
Rail vehicle construction	20 604	1 401	4 124	30.90
Air and aerospace technology	82 866	58 151	86 894	267.99
Other	681 747	313 399	215 678	67.88
EU: weighted trade intensity NACE 25.61 21				71.63
EU: weighted trade intensity NACE 25.61				71.61

Source: Own calculations based on Eurostat

4.2. Electro-intensity

4.2.1. Electro-intensity for Germany

The electricity costs for the "surface refinement and heat treatment" economic sector can be calculated from electricity consumption (which is continued in the official survey on the energy use of operations involved in mining and in quarrying stone and earth and of the manufacturing sector), by linking the physical consumption of electricity with its price. If more specific information is not available, the electricity price used could be the average industrial electricity price published by the Federal Association of Energy and Water Industries (BDEW) (see Section 3.3). In this study, an electricity price specific to the sector was used to calculate electricity costs (assuming the payment of the full EEG surcharge rate), which was provided by the Industrieverband Härtetechnik eV (IHT).

To determine a figure for electro-intensity within the meaning of the Directive for the "surface refinement and heat treatment" sector as a whole, official data on gross value added can be used. Both the gross value added and gross value added at factor cost are available in the form of official data (Destatis, cost-structure survey) up to the four-digit NACE level.

As a result, the gross value added (at factor cost) had to be derived from the statistical data for the six-digit "contract hardening plant" sector. The relevant data links official statistics (for production and cost structure in the manufacturing sectors) with the Industrieverband Härtetechnik's cost structure surveys. Specifically, the estimate of the gross value added is calculated (at factor cost) for NACE 25.61 21 (contract hardening plants) by deducting the following from the official gross production value (Destatis, Series 4 Volume 3.1) for the sector:

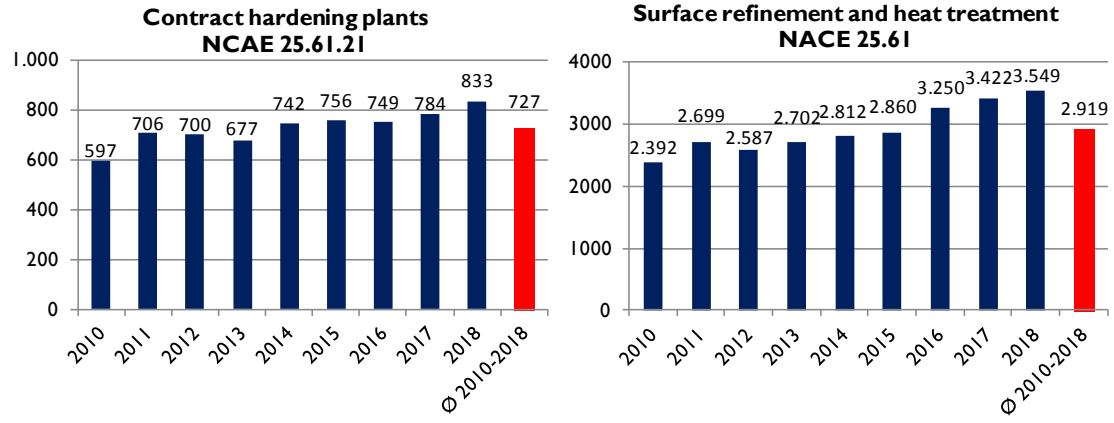
- the consumption of raw, auxiliary and operating materials, (from the cost structure survey by Industrieverband Härtetechnik)
- the use of trading goods (official cost structure statistics)
- the cost of contract work done by other companies (official cost structure statistics)
- the cost of other industrial/manual services (only external services) / temporary workers (official cost structure statistics)
- rents and leases (official cost structure statistics)
- other costs (official cost structure statistics) and
- other indirect taxes (less indirect subsidies) (official cost structure statistics).

In order to be able to use the information from the official cost structure survey to calculate the gross value added in the "contract hardening plant" sector, the additional assumption had to be made that the percentage cost shares of these items in the gross production value was identical to that of the overarching economic sector, NACE 25.61 ("surface refinement and heat treatment").[11] The thus-calculated gross value added at factor cost is €2 919 million on average for the years 2010 to 2018 for the "surface refinement and heat treatment" sector in Germany, and €727 million for contract hardening plants (see Chart 3).

[11] The cost structure survey by the Federal Statistical Office does not report on the six-digit economic sector 25.61 21 ("contract hardening plants").

Chart 3: Germany: Gross value added at factor cost

2010 to 2018, ave. 2010 to 2018, in €m



Source: Own calculations based on Eurostat.

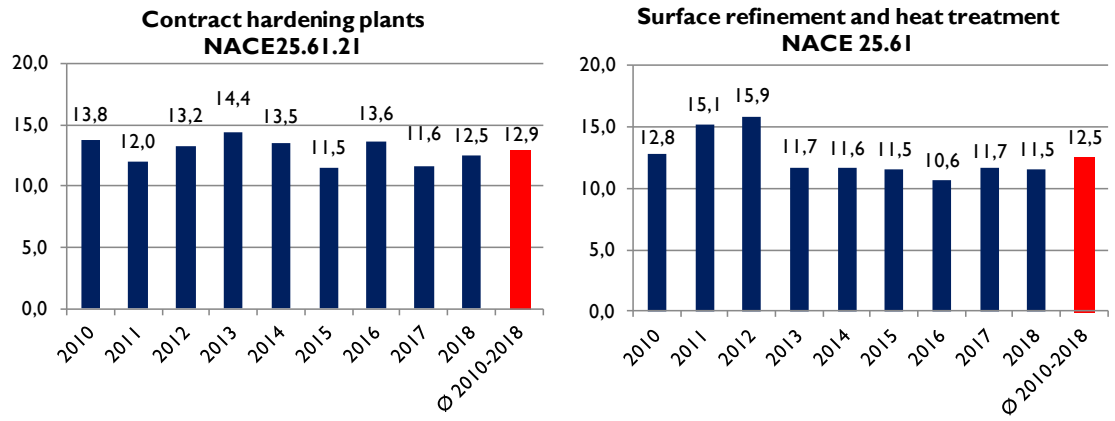
In contrast, the cost of electricity or electricity consumption for the "contract hardening plant" (NACE 25.61 21) sector cannot be derived from the official data. Conclusions on the electricity consumption of contract hardening plants and the associated electricity costs can be drawn from the cost structure analysis of the Industrieverband Härtetechnik. As part of the association's internal survey, information on the proportion of energy costs within sales (for those companies belonging to the Association) and the proportion of electricity costs within energy costs (by dividing the cost of electricity by the price paid by a sector for the purchase of electrical energy, one arrives at a figure for physical electricity consumption).

When interpreting the figures from the aforementioned Association statistics, it should be noted that the Industrieverband Härtetechnik eV, does not represent all companies in the sector, nor are they all included in its collected statistics (degree of organisation, participation in the survey). To eliminate this effect, only those percentages for energy and electricity costs were used from the Association's statistics, in order to calculate the absolute electricity costs with the help of the figures for sales or gross production value of the sector as a whole, as given in the official statistics.

To calculate the electro-intensity within the meaning of the Directive, the indicator "proportion of electricity costs in gross value added (at factor cost)" must take account of the fictitious costs that would be incurred by the elimination of preferential treatment through the EEG surcharge.

Chart 4: Germany: Electricity cost share within gross value added at factor cost

2010 to 2018, ave. 2010 to 2018, proportion in %



Source: Own calculations based on IHT, Destatis, BDEW, electricity costs without preferential treatment.

The thus-calculated electro-intensity as a proportion of electricity costs (without EEG preferential treatment) within gross value added at factor cost is 12.5 % on average for the years 2010 to 2018 for the "surface refinement and heat treatment" sector in Germany on, and 12.9 % on average for contract hardening plants (see Chart 4).[12]

In the previous section, the electricity costs of the "surface refinement and heat treatment" sector of "contract hardening plants" were calculated for Germany for the years 2010-2018 from the official data available and from the Association's internal data, and related to gross value added (electro-intensity). Of course, the treatment of the data for physical electricity consumption of these sectors also needed to be embedded into this section. From this figure for absolute electricity consumption (in kWh), the specific use of electrical energy (kWh/€1000 gross production) can be calculated by dividing the total use by production (in €000s) for each economic sector.

4.2.2. Electro-(cost-)intensity for the EU

For Europe, the official statistics do not provide reliable data on the cost of electricity in the "surface refinement and heat treatment" and "contract hardening plant" sectors nor on physical electricity consumption. With all due caution, data on electricity costs at EU level can be ascertained under the assumption that the average electro-efficiency

[12] Given this electro-cost intensity, it is understood that in 2014, 177 companies in the sector "surface refinement and heat treatment" (NACE 25.61) benefited in Germany, as a result of their application, from the special equalisation scheme pursuant to Section 40 et seq. EEG, cf. BAFA (2014).

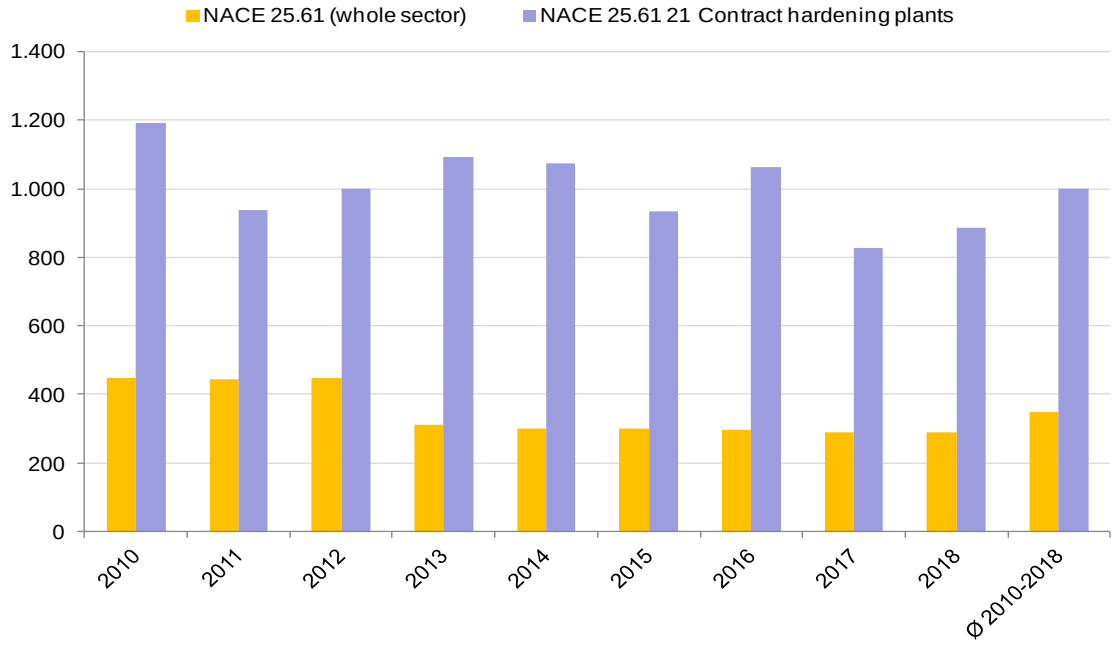
(or specific electricity consumption) in Europe is approximately that of the state of the art in Germany (cf. Chart 5).

Under these assumptions, the cost of electricity can be calculated both for the sector "surface refinement and heat treatment" and for "contract hardening plants" at an EU level by multiplying the statistically validated production values (Prodcom), the respective specific electricity consumption (Germany) and the price of electricity in the EU.

In the present study, the starting point for the calculation of electricity costs at an EU level is industrial electricity prices, as published by Eurostat. The Eurostat survey on industrial electricity prices distinguishes between a number of types of delivery. If it is assumed, due to the absence of precise information, that each operation in the "surface refinement and heat treatment" sector is equipped with a delivery or connection point for electricity from the mains grid, the electricity consumption of one delivery point (averaged across the whole sector in Germany) is calculated as 6307 MWh per year (average 2010 to 2018). For contract hardening plants the respective value is 6756 MWh per year.

Chart 5: Specific electricity consumption for the surface refinement and heat treat sector (NACE 25.61) and for "contract hardening plants" in Germany

2010 to 2018, ave. 2010 to 2018, in kWh/€1000 of gross production value



Source: Own calculations based on IHT, Destatis and BDEW.

For this type of delivery (2000-20000 MWh per year, exclusive of VAT and eligible taxes and duties), the average electricity price for the years 2010 to 2018 (according

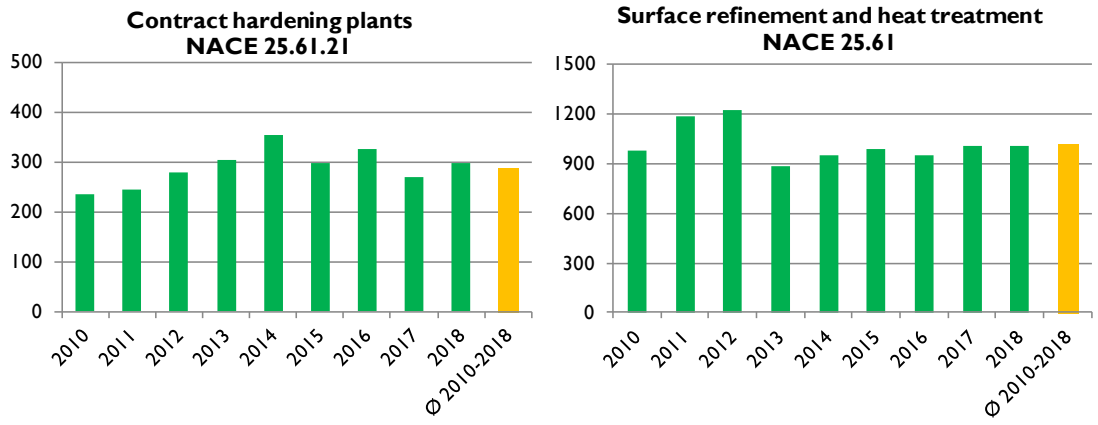
to Eurostat figures) is about 10% below the industry electricity price in Germany over the same period. In analogy to the procedure in the previous section, the Eurostat industrial electricity price for the case outlined was recalculated under the premise of the payment of the full EEG surcharge rate for German companies.

Based on the thus-modified electricity price for the industry, as well as the electricity consumption calculated, a calculation is made of electricity costs for the "surface refinement and heat treatment" and "contract hardening plant" economic sectors at the EU level (cf. Chart 6).

The electro-intensity at an EU level, within the meaning of the Directive, can be determined as a summary indicator. Figures for gross value added (at factor cost) is – as regards individual sectors – are available at an EU level up to a four-digit NACE level. This differentiation allows the gross value added (at factor cost) from the official European statistics to thus be used only as a benchmark for the cost of electricity for the "surface refinement and heat treatment" sector as a whole.

Chart 6: Electricity costs for the "surface refinement and heat treat sector" and for "contract hardening plants" in Europe

2010 to 2018, ave. 2010 to 2018, in €m



Source: Own calculations based on Eurostat.

Because of this gap in the data, the gross value added by contract hardening plants at an EU level must be estimated – with the help of the existing statistical information.

As mentioned above, the gross production value of the "contract hardening plant" economic sector (production value: €2 234 million on average for the years 2010 to 2018, Eurostat) – which is, in principle, statistically significant on an EU level – can be adjusted by the corresponding quantities states above. The issue is aggravated at the EU level, in that Eurostat does not publish a cost structure survey differentiated by economic activity.

For this reason, there are only two ways to calculate the gross value added by "contract hardening plants" at an EU level:

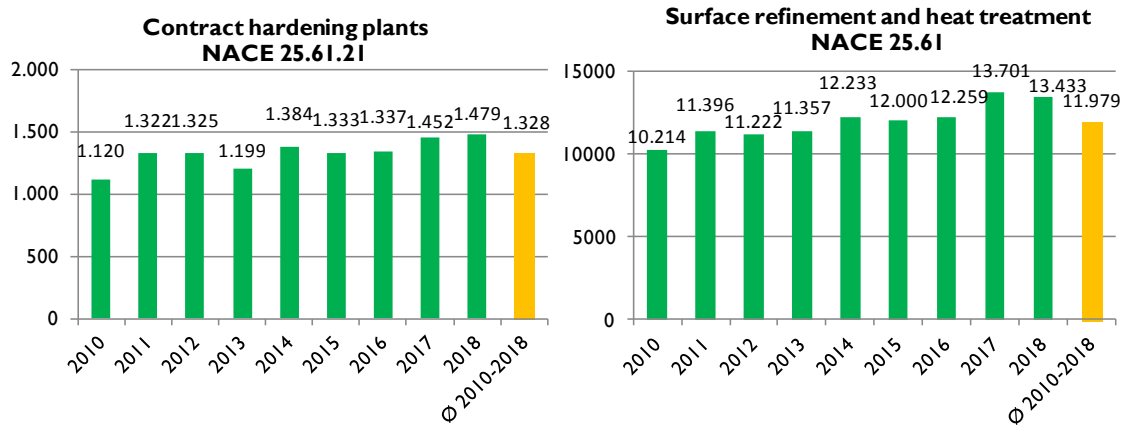
- Transferring the cost structure identified for Germany in the sector "contract hardening plant" to a European level, and the calculation of the gross value added from the production value (Eurostat) of the sector: The ratio of the gross value added at factor cost in the sector "contract hardening plant" to gross production value in Germany is approx. 60% (average value for the years 2010 to 2018).

- by assigning the statistically validated ratio of gross value added to the value of production (both pieces of EU-level information are available on the Eurostat database) of the overall sector "surface refinement and heat treatment" to the subordinate "contract hardening plant" economic sector. Using this method, the ratio of gross value added to gross production value averages approximately 47 % for the years 2010 to 2018.

As a result of these considerations, it should be noted that – due to legal and structural differences in EU Member States – both energy costs and other cost structures of the sector "contract hardening plants" probably differ from region to region. It is also questionable as to the extent to which the "surface refinement and heat treatment" sector in Europe as a whole has similar or identical structures of intermediate products, such as the subsector "contract hardening plants". It follows that both approaches appear to be less than optimal and/or that they are associated with uncertainties can be ultimately overcome only by an improvement in statistical data basis.

Chart 7: Europe: Gross value added at factor cost

2010 to 2018, ave. 2010 to 2018, in €m



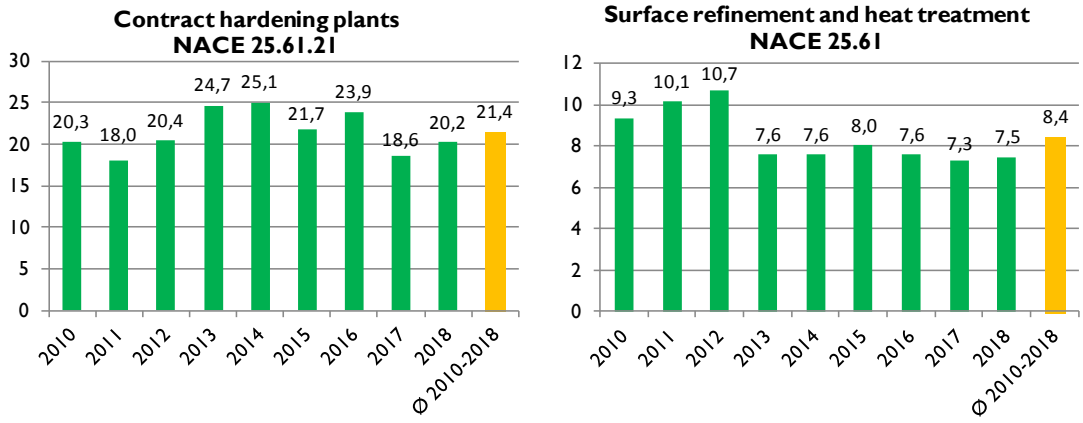
Source: Own calculations based on Eurostat.

Below, the "more moderate" estimation approach is selected in light of these statistical uncertainties, and the ratio of gross value added to production value – as communicated for contract hardening plants in Germany – is assigned to the conditions in Europe. It is obvious that this approach leads to a higher estimate of the gross value added at factor cost for contract hardening plants in Europe. Consequently, the electro-intensity of European contract hardening plants tends to be underestimated in this study, compared to alternative estimation method. The thus-calculated gross value added at factor cost is €11 979 million on average for the years 2010 to 2018 for the "surface refinement and heat treatment" sector in Germany, and €1 328 million for contract hardening plants (see Chart 7).

In summarising the assumptions and calculations, the electro-intensity indicator at an EU level reveals the following picture: the proportion of electricity costs within gross value added (at factor cost) in the sector "surface refinement and heat treatment" is 8.4 % (average for 2010 to 2018); for the contract hardening plants – in each case, taking into account the full EEG surcharge rate for companies from Germany – a ratio of 21.4 % can be seen (cf. Chart 8).

Chart 8: EU: Proportion of electricity costs within gross value added at factor cost

2010 to 2018, ave. 2010 to 2018, proportion in %



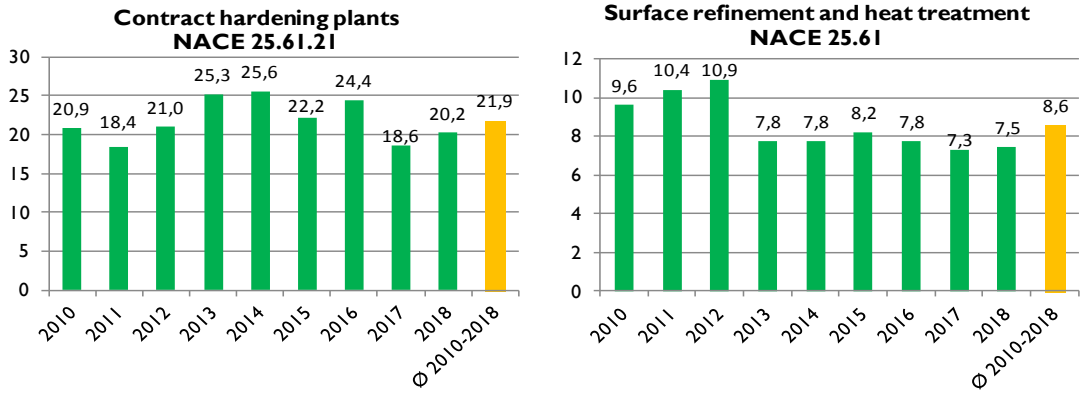
Source: Own calculations based on Eurostat, *) electricity costs without preferential treatment, i.e. assuming full EEG surcharge rate for European contract hardening plants or companies.

The previous calculations of electro-intensity in the "contract hardening plant" and "surface refinement and heat treatment" sectors assumed that the electro-efficiency in Germany corresponds to the average state of the art in the EU. If an alternative scenario is assumed – that the electro-efficiency of modern industrial furnaces in the German surface refinement and heat treatment sector is 3% higher than the EU average, then the proportion of electricity costs within gross value added increases for the

entire sector (NACE 25.61) to 8.6% (average 2010 to 2018) and for contract hardening plants to 21.9% (cf. Chart 9).

Chart 9: EU: Proportion of electricity costs within gross value added at factor cost

2010 to 2018, average 2010 to 2018, proportion in % *)



Source: Own calculations based on Eurostat, *) electricity costs without preferential treatment, i.e. assuming full EEG surcharge rate for European contract hardening plants or companies, as well as a 3%-higher electro-efficiency in Germany compared to the EU average.

5. Summary and recommended action

With the revision of the **European Commission Guidelines on State aid for environmental protection and energy** in 2021, the EU intends that relief for energy-intensive companies (which in Germany occurs through the EEG special equalisation scheme) will only be granted to sectors that are particularly exposed to **international competition**. To assess the competitive situation, a standardised procedure is used, based on two ex-post indicators: **trade intensity and electro-intensity**.

The currently valid **European Commission Guidelines on State aid for environmental protection and energy 2014-2020** provide that companies may be eligible for relief from the costs of producing renewable energies, either if they

- belong to one of the 68 ex ante identified sectors listed in Annex 3 of the Directive and demonstrate an electro-cost intensity of at least 20 %. (Identical risks to competitiveness exist in sectors which have a trade intensity ≥10% and an electro-intensity ≥10% at EU level, a low trade intensity, but of at least 4% where there is a markedly higher electro-intensity ≥80%, or where there is a very high trade intensity ≥80% with a low electro-intensity ≥7%)

- or belong to the 152 likewise ex ante identified sectors, listed in Annex 5 of the Guidelines (sectors with a **trade intensity on an EU level with third countries of >4%**), and where the individual company has an electro-cost intensity (ratio of electricity costs based on the full EE production costs to gross value added of at least 20%).

In the opinion of the EU Commission, there is also the same competitive risk for sectors which have a **high trade intensity > 80%** and a **low electro-cost intensity > 7%**.

In the "surface refinement and heat treatment" economic sector (NACE 25.61), there is a combination of companies from the metalworking industry, who either refine iron and steel products by depositing metallic and non-metallic coatings or harden them by heat treatment or tempering ("contract hardening plants" NACE 25.61 21). The production processes (electrolysis, electroplating, anodising, etc. and hardening by heat

treatment) encountered in this economic sector are very **electro-intensive**.

Due to **a lack of detailed, official data bases**, the "surface refinement and heat treatment" sector is **not listed in Annex 3** nor **in the additional Annex 5** of the current Guidelines. The **limited availability** of sector-related, statistical data (at the four- and six-digit NACE level) must not be an **exclusion criterion** for sectors or companies which are trade and electro-intensive for relief from the cost of production of renewable energy.

On behalf of the Industrieverband Härtetechnik eV (IHT), the EEFA research institute has shed more accurate light on the data base as part of a **study**, and has supplemented the lacking information with plausible estimates based on existing statistical data (for Germany and the EU). In addition, specific information of the trade associations within the "surface refinement and heat treatment" sector (Industrieverband Härtetechnik eV and Zentralverband Oberflächentechnik eV) were used in order to quantify the **electro-cost-intensity** and the **trade intensity** for the sector overall (NACE 25.61), and for contract hardening plants in particular, at EU level for the period from 2010 to 2018.

Electro-cost intensity:

The electro-cost intensity (for Germany) is determined from the **IHT's cost structure analysis**. Using this data and the **electricity price** paid by contract hardening plants in Germany, the **electricity consumption** (MWh) and/or the specific electricity consumption (kWh/€1000 gross production) can be calculated. Subsequently, using the electricity price at the EU level and the production values (PRODCOM statistics), the cost of electricity for the overall sector (NACE 25.61) and for contract hardening plants in the EU can be calculated.

The **gross value added** (at factor cost) – used to determine the electricity cost proportion at EU level – is then estimated or calculated from Eurostat data (for NACE sector 25.61). The starting point in this respect is the data available on the gross production value of the economic activity as well as data on the energy and electricity costs and the cost structure surveys.

The calculations show that the **electro-intensity** (proportion of energy costs within gross value added at factor cost) in the "surface refinement and heat treatment" sector in **Germany** reached 12.5 % (average 2010-2018); for "contract hardening plants", the respective figure was 12.9 %.

At an **EU level**, the proportion of **electricity costs** within gross value added (at factor cost) for the "surface refinement and heat treatment" sector was 8.4 % (average 2010 to 2018). For the **contract hardening plant** sector, the EU-level **electricity**

cost proportion was 21.4 %, taking into account the full EEG surcharge rate for German companies.

Trade intensity:

The direct calculation of **trade intensity** is not possible due to lack of data on foreign trade at an EU level. Surface refinement and heat treatment are **outsourced process steps**, which have been integrated into other industrial sectors to some extent. Many of these other industrial sectors perform hardening (for example) at their own works in in-house **hardening shops**, whilst simultaneously using contract hardening plants (e.g. in the case of operating bottlenecks). The trade intensity is therefore given as a **weighted average** of the empirically determined trade intensities of those **sectors** which the sectors "surface refinement and heat treatment" (NACE 25.61) and **contract hardening plants** count as their **customers**. The data on the customer base in Germany was provided by the Industrieverband Härtetechnik eV (IHT) and the Zentralverband Oberflächentechnik eV (ZVO) and refer exclusively to Germany. Taking into account the different **economic structures** in Germany and Europe, a **European customer base** was calculated from this data – under the assumption that the proportion of process steps for surface engineering and hardening was always the same for a homogeneous sector (e.g. mechanical engineering) in Germany and Europe.

In terms of the trade intensity of "contract hardening plants" with third countries on an EU level, the specific **EU-level customer base** gives rise (in purely mathematical terms) to a weighted trade intensity of the customer sectors of 71.63 % (average 2010-2018). At the NACE four-digit level, the "surface refinement and heat treatment" sector (NACE 25.61) has a trade intensity with non-EU Member States of 714.61 % on average for the years 2010 to 2018 (cf. Table 5).

Table 5: Result: Trade and electro-intensity

Average 2010 to 2018, in %

	Electro-intensity (electricity costs/ gross value added at factor cost)	Trade intensity (based on trade outside the EU in each case)
	Europe	Europe
25.61 21	21.4	71.63
25.61	8.4	71.61

Source: own calculations based on IHT, Destatis and BDEW.

Recommended action:

In conclusion, the present analysis shows that the **companies in the "contract hardening plant" sector (NACE 25.61 21)** are among the **most energy-**

intensive industries in Europe. **The proportion of electricity costs within the gross value added appreciably exceeds the 10% threshold.** The upper hierarchical level of "surface refinement and heat treatment" (NACE 25.61) has a proportion of electricity costs which is under 10%, although it is constantly above 7%.

On top of that, the market in which "contract hardening plants" and "surface refinement and heat treatment" companies operate is characterised by a particularly high density of competition. The reason for the intense international competition is, on the one hand, the geographical distribution of hardening shops and surface-coating operations in Europe and the immediately surrounding regions, and on the other the simple and cost-effective ways of promptly transporting the goods for heat treatment or surface coating to appropriate locations outside Europe. The **EU trade intensity** with third countries, which is derived from the customer base of the economic sector, is **above 70 %** on an EU level, both for "contract hardening plants" and for the "surface refinement and heat treatment" **industry as a whole**.

In summary, the results indicate that "surface refinement and heat treatment" **companies are exposed to an increased risk of losing their ability to compete with non-European competitors**, should they have to **bear the costs of producing renewable energy in full**. Both the sector "contract hardening plants" (NACE 25.61 21) as well as the upper hierarchical sector of "surface refinement and heat treatment" (NACE 25.61) can together be identified as electricity-intensive industries facing strong international competition from non-EU countries if **sectors are not included in the list of ex ante identified sectors eligible for relief**. The forthcoming revision of the EEAG should be the latest that such inclusion should be applied.

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