Energy and Environment

Analyses

Trade and electricity intensity of the "Production of drop forging parts" (NACE 25.50 5) as well as the “Production of powder metallurgic products” (NACE 25.50 5) in the EU

Study on behalf of the Industrieverband Massivumformung e.V. (IMU) and the Fachverband Pulvermetallurgie e.V. (FPM)

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Executive summary

According to the EU Commission, companies can only benefit from cost relief pertaining to the expansion of renewable energies (in Germany, the EEG (Renewable Energy Act) contribution) and compliant with State Aid Law in future, if certain minimum requirements with respect to the electricity cost and trade intensity of the industry are fulfilled. This has been explained in the Guidelines on State Aid for Environmental Protection and Energy 2014-2020.

Based on principle as well as data-related difficulties, the required indicators "trade and electricity cost intensity" at a European level can neither be determined for the sector NACE 25.50 ("Production of forging, pressing, stamping and roll forming of metal as well as powder metallurgic products") nor for its subsectors, as several items of data at Eurostat are not available in the required disaggregated form. As a consequence, the Economic Sector NACE 25.50 and/or its subsectors were not considered in the State Aid Guidelines, i.e. not listed in Annexure 3 and/or 5.

This study closes the existing data gaps with statistical information of the affected technical associations (Industrieverband Massivumformung e.V. (German Forging Association) and Fachverband Pulvermetallurgie e.V. (Technical Association for Powder Metallurgy)) as well as with projections based on official data. These empirical audits suggest that the economic sectors "Production of drop forging parts" and "Production of powder metallurgic products" have to be included in the list of Annexure 3 of the State Aid Guidelines in the context of an addendum, as their trade as well as electricity cost intensity exceed the threshold of 10%.

Against this backdrop, the study shows that the production of drop forging parts (NACE 25.50 2) and the production of powder metallurgic products (NACE 25.50 5) in Europe fall under the category of electricity-intensive industries. On average, the electricity cost component of these industries in gross value added (to factor costs) exceeds the threshold of 10% for the years 2009 to 2013. The electricity cost intensity for the production of drop forging parts amounts to 13.2%; that of powder metallurgic mouldings lies at 14.3% (Ø 2009 to 2013).

On the other hand, the component of electricity costs in gross value added for the primary economic sector "Production of forging, pressing, stamping and roll forming of metal and powder metallurgic products" (NACE 25.50) with a value of 7.4 % (average 2009 to 2013) lies significantly below the threshold required by the EU Commission.

At the same time, the market in which the companies of the sector "Production of forging, pressing, stamping and roll forming of metal and powder metallurgic products" are active is characterised by high competitiveness. As a measure for assessing the degree of competition, the trade intensity is typically consulted (ratio from sum of exports and imports, i.e. the trade volume and the entire domestic range, or the production plus the imports).

The trade intensity with EU third countries of the economic sectors examined here lies significantly above 20% for the industry in total (NACE 25.50). On the level of the subsectors "Production of drop forging parts" (NACE 25.50 2), a trade intensity of more than 12% is calculated; for the "Production of powder metallurgic products" (NACE 25.50 5), the trade intensity is calculated at more than 57 %.

As a conclusion, it can be determined that the electricity intensive subsectors "Production of drop forging parts" as well as the "Production of powder metallurgic products" fulfil the prerequisites provided for the State Aid Guidelines for the Annexure 3 list (trade intensity > 10%, electricity cost intensity > 10%). In order to avoid competitive disadvantages for these economic sectors in the course of expanding renewable energies, the above-mentioned industries need to be included in the exemptions of the "Special Equalisation Scheme" according to § 64 of EEG 2014 in Germany.

Regardless of the empirical result, the study ultimately raises the question as to whether the production of drop-forged as well as powder metallurgic components should also qualify for partial relief of the costs for expanding renewable energies in order to avoid an undesirable distortion of competition.[1] This issue should not be considered merely on the basis of the close substitution relations to the end products of the foundry industry (which has qualified for the list of industrial branches entitled to receive grants).

[1] Please refer to footnote 84 of the EU -Guidelines on State Aid for Environmental Protection and Energy 2014-2020.

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1. Definition of Tasks

On 9 April 2014, the European Commission adopted the Guidelines on State Aid for Environmental Protection and Energy 2014-2020. The new State Aid regulations play a decisive role in the reformation of the EEG, particularly with respect to the specific interpretation of the relief based on the Special Equalisation Scheme (§§ 63 cont. EEG 2014), which is granted to electricity intensive operations in Germany to preserve international competitiveness.

Three criteria form the prerequisites for the availment of the Special Equalisation Scheme (§§ 63 cont. EEG 2014):

- the purchased and self-consumed power of an applying company at one delivery point during the last financial year amounts to at least 1 GWh/a and
- the ratio of the electricity costs to the gross value added of a company during the last financial year amounts to at least 16% (limit in calendar year 2015 and/or 17% for calendar year 2016), or this ratio must amount to at least 20% in a company from an industry appearing in list 2 of Annexure 4 and
- the applying company operates a certified energy management system (ISO 50001; EMAS), if the absolute electricity consumption exceeds 5 GWh/a.

If the specified threshold values are achieved, an EEG contribution scaled and reduced according to the electricity consumption and the electricity cost intensity can be claimed. This scaling as well as the lowering of the initial threshold values was introduced in the context of EEG 2012. Both came into force during the limit year 2013.

According to the intention of the EU, relief for electricity intensive operations (in Germany, this is by way of the Special Equalisation Scheme of the EEG) will in future only be granted to sectors which are exposed to special international competitive pressure. A standardised process is consulted to assess the competitive situation, which refers to two indicators, namely the trade and electricity intensity.

According to the opinion of the EU Commission, companies can only benefit in future from relief of the EEG contribution in compliance with State Aid Law if they either

- belong to one of the 68 sectors identified ex-ante and listed in Annex 3 of the Directive (sectors displaying a trade intensity of >10% and an electro intensity of >10%)

- or belong to one of the 152 sectors likewise identified ex-ante and listed in Annexure 5 of the Guidelines (sectors with a trade intensity at EU level with third countries greater than 4%), which at the same time demonstrate an electricity intensity (component of electricity costs based on the full EEG contribution rate in the gross value added) of at least 20% at a corporate level.[2]

A reduced (EEG) contribution ratio of at least 15% of the standard applies for companies complying with these conditions.

In order to protect the competitiveness of electricity intensive companies in light of the planned dynamic expansion of renewable energies, the Member States can further limit the contribution rate, if required. Specifically, the Guideline envisages that the payment of the contribution to finance the expansion of renewable energy is principally limited to

- a maximum amount of 4% of gross value added as well as
- to an amount of 0.5% of the gross value added for companies whose electricity intensity exceeds a value of 20%.

The Guideline also envisages a temporary and hardship provision.[3] However, this temporary regulation is not an ideal solution for supported companies, as it particularly lacks any form of long-term planning. Furthermore, new market participants cannot profit from this regulation.

One important prerequisite to even be included as an economic sector in one of the lists which has been defined ex-ante is obviously the availability of statistical data to

[2] According to the EU Commission, the same competitive risk exists for sectors exhibiting a trade intensity of at least 4% and an electricity intensity greater than 20%, or a lower electricity intensity of at least 7% as well as a greater trade intensity of at least 80%. Please refer here to European Commission (2014), page 14, footnote 89.

[3] Accordingly, based on the above- mentioned criteria (following the commencement of the Guideline), the EEG contribution can be limited to 20% of the standard rate for companies which previously benefitted from industry privileges. See EU Commission (2014), page 48 (No. 198).

calculate the trade and electricity intensity at EU level. The official determination of data for individual sectors is principally based on the classification of economic sectors, edition 2008 (NACE 2008).[4] The lists of economic sectors in Annexure 3 and/or Annexure 5 of the Guidelines relevant for qualification record on the level of three and/or four digit sectors of the economic sector systematic. Further breakdowns, e.g. on the level of five or seven digit sectors, are not specified in the Annexure of the Guideline.

However, when interpreting the lists, it must be observed that significant data gaps already exist for some four digit sectors, thereby rendering calculation of the energy costs for the gross value added as well as the trade intensity with third countries at EU level impossible using official statistics alone. Against this backdrop, it may be assumed that electricity intensive economic sectors in international competition are not specified in the Annexure lists of the Guideline because there is a lack of statistical data at EU level. The lack of sufficiently detailed, official basic data alone should not represent a criterion for exclusion for contribution relief in terms of the Guideline for companies entitled to claim.

The economic sector "Production of forging, pressing, stamping and roll forming of metal as well as powder metallurgic products" (NACE 25.50) clusters companies of the metal-processing industry which form products made of steel, non-ferrous metals or alloys by either forging or bending and/or manufacture using powder metallurgy. The forming processes carried out in this economic sector characterised on the one hand by the heating of raw material as well as by the application of mechanical forces (pressing, pulling, punching, bending etc.) on the other. The processes are electricity and/or energy intensive to a greater or lesser degree depending on their scope, complexity and the material characteristics of the component. Neither the sector "Production of forging, pressing, stamping and roll forming of metal as well as powder metallurgic products" as a whole nor its subsectors are specified in the Annexure 3 list or in the

[4] The economic sector systematic was established in the course of generating the NACE Ordinance and serves to standardise the statistical assessments of the EU. Furthermore, the PRODCOM Ordinance, which not only requires a uniform product classification for the product statistics, but also compliance with certain quality standards, also applies to the production industry.

additional Annexure 5 list of the Guideline. In future, companies of this economic sector would therefore be excluded from claiming the relief, granted to electricity intensive operations for preserving their competitiveness.

In order to scientifically assess issues regarding the calculation of trade intensity and the significance of the electricity cost component in the gross value added for the sector "Production of forging, pressing, stamping and roll forming of metal as well as powder metallurgic products" (NACE 25.50) as a whole and the especially electricity intensive sectors "Production of drop forging parts" (NACE 25.50 2) and "Production of powder metallurgic products" (NACE 25.50 5) in particular, the Industrieverband Massivumformung e.V. (IMU) and the Fachverband Pulvermetallurgie e.V. (FPM) have awarded a research project. The purpose of the project is to use existing statistical data to quantify the electricity cost intensity and the trade intensity for the above-mentioned sectors at EU level for the period between 2009 and 2013 (more recent data for 2014 is not yet available). The EEFA-Institute GmbH & Co. KG presents a research report pertaining to this research project.

2. The Economic Sector "Production of forging, pressing, stamping components" (NACE 25.50)

2.1. Economic Significance

The economic sector "Production of forging, pressing, stamping components" (NACE 25.50) is one of the smaller industries in Europe, with a 0.8% share in the production of the processing industry. According to Eurostat, the 12,443 companies active in this economic sector achieved a turnover of 57.6 billion euros (share in turnover of processing industry: 0.76%) in 2012. 288,000 people or 0.93% of the employees in the processing industry work in this sector.

The economic sector includes the production of:

- open-die forged parts and cold extrusion parts made of steel and non-ferrous metals,
- drop forging parts made of steel and non-ferrous metals,
- sheet metal parts made of steel and non-ferrous metals, as well as
- powder metallurgic products made of steel powder or non-ferrous metal powders.

2.2. Description of Selected Production Processes

Contrary to other more homogeneous industries, the sector is characterised by a broadly diversified product mix and numerous, partially complex production processes. Even though the economic sector as a whole may not be classified as electricity intensive (according to the gross value added compared to factor costs, the average electricity costs of the years 2009 to 2013 achieve a component of 7.4%), it contains individual industries and/or production processes which are extremely electricity intensive.

Electricity intensive process sequences can be found particularly in the production of drop forging parts (NACE 25.50 2) as well as in the production of powder metallurgic products (NACE 25.50 5). These production operations , the production processes of which shall be described briefly below for the purpose of clarification.

The drop forge technique is characterised by high process productivity as well as by the special strength properties of the produced components. Drop forged components are predominately used for safety-relevant applications with high dynamic stress, in the motor vehicle industry (engine, transmission or chassis components). The industry is also a typical supply industry and/or closely associated with the economic development in the vehicle manufacturing sector. The sustained transfer of the German vehicle manufacture to international locations has already led to an associated growth in exports and intensification of global competition.

Drop forging is a pressure forming process (massive forming), whereby the billet is completely or partially formed between two dies (sometimes in several work cycles). Simply put, the tool hereby transfers its negative form onto the billet.

Massive forming of steel materials is typically performed at a temperature of approx. 1,200°C (whereby the billet can also be partially heated). Various processes are available to heat the billet to the necessary forming temperature. Heating by means of electricity is common. A distinction is made between conductive and inductive processes.

Conventional processes use convection heating generated in chamber furnaces or by means of gas burners (heat transmission / radiation). Alternatively, conductive heating using high-frequency electricity is employed to bring the billet to the desired forming temperature. In case of inductive heating, an inductor, which is traversed by low or medium frequent alternating current, generates an alternating magnetic current. This induces eddy currents in the electrically conductive blank, thereby directly heating the material.

Advantages of inductive heating include the avoidance of contamination, e.g. through surface contact with hot gases, the possibility of partially heating the work-piece, as well as a good process integration.

In contrast to all other heating processes, the efficiency factor of inductive heat is extremely high, as only the workpiece itself is heated and/or radiation and convection losses of hot systems components are largely minimised. Somewhere between 400 and 500 kWh are required to heat one ton of steel to a forming temperature of 1,200°C by way of electrical, inductive heating. By comparison, the chamber furnace uses 1,200 kWh/t and a gas burner as much as between 2,000 and 2,500 kWh/t to reach the same forming temperature.[5]

Powder metallurgic products are made using metallurgical (ultra-fine) powder (pure metals or alloys), which are compressed in moulds (presses) and sintered at high temperatures to form finished parts. Mechanical, chemical and electrolytic processes are used in manufacturing the powder. Electrically / hydraulically operated compression tools are employed to compress the powder (and/or its alloy combinations) under high pressure to form green compacts. Subsequent sintering provides the green compact with its strength properties. During the process, the powder grains form a solid connection at their contact surfaces by way of diffusion of the metal atoms at temperatures of between 1,100 and 1,300°C. The sintering process is carried out in electrically heated continuous or vacuum furnaces. Powder metallurgic mouldings are often used in the motor vehicle manufacture, in medical technology, as well as in the tool, mining and aviation industries.

[5] See Systems technology Skorna, inductive forge heating, Internet: http://www.induktionserwaermung.de/html/schmieden.html (Date of issue 24.11.2014)

3. Definitions, Data Situation and Method

The objective of this study is to quantify the indicators of trade and electricity intensity in terms of the EU Commission Guideline for State Aid for Environmental Protection and Energy for 2010 to 2014 for the sector "Production of forging, pressing, stamping and roll forming of metal and powder metallurgic products" (NACE 25.50), as well as the subsectors "Production of drop forging parts" (NACE 25.50 2) and "Production of powder metallurgic products" (NACE 25.50 5) at EU level. In order to achieve this objective, the definitions of both indicators are explained briefly in the following paragraph. Subsequently, the available database for the empirical calculation of the trade and electricity intensity is examined in detail.

3.1. Definition: Trade intensity with Third Countries

Trade intensity belongs to the group of ex-post-indicators which attempts to empirically record the competition intensity of an industry by way of foreign trade data. It is defined as the ratio from the sum of exports and imports (trade volume) and the entire offer in the domestic market, i.e. the domestic production plus imports:

$$(1)\ Trade\ intensity = \frac{Value\ of\ imports + \text{Value of } exports}{Production\ value + \text{Value of } imports}$$

In principle, the trade intensity indicator can be calculated based on monetary volume or, if sufficient statistical information is available, with the aid of physical amounts (e.g. in million tons). Monetary volume provides the advantage that differences in the value added intensity can be considered in the "trade intensity" indicator. Trade intensity assumes values between zero and one. A value of zero hereby indicates no foreign trade and a value of one indicates no domestic production.

The trade intensity of an economic sector with third countries at EU level results from the exclusive consideration of foreign trade with regions outside of the EU (EU - extra) in formula (1) and/or placed in relation to the production of the industry within the EU.

3.2. Definition: Electricity intensity

In the Guidelines for State Aid for Environmental Protection and Energy, the European Commission has also specified energy intensity as a further criterion. The criterion of electricity intensity in terms of the Guideline does not - as the name initially suggests - describe an indicator which places the application of electrical power (MWh) in relation to an economic reference value, such as the gross production value (in €) (specific energy consumption in MWh/€ gross production).

Electricity intensity rather indicates the share of electricity costs of a company or sector (in €) in the gross value added (to factor costs).[6] Electricity intensity in terms of the Guideline is principally calculated as follows:

$$(2)\ Electricity\ intensity = \frac{Electricity\ consumption\ (MWh) \times Electricity\ price(\frac{€}{MWh})}{Gross\ value\ added\ at\ factor\ costs\ (€)} \times 100$$

Gross value added comprises the total produced goods and services evaluated at market prices minus all primary performances incorporated in the production. It is thus the value added to the primary performances by processing or refinement.

Deducting the amount of other indirect taxes minus subsidies for ongoing production from the gross value added would result in gross value added in relation to factor costs.

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.[7]

3.3. Data-bases for the EU

The brief illustration of the criteria (trade and electricity intensity) which qualify companies and/or sectors for the availment of privileges and/or relief of costs for the expansion of renewable energies already reveals that the empirical implementation of the concept at EU level requires an extensive and reliable database.

Data for the EU is principally provided by the Statistical Office of the European Union (Eurostat). However, the data of Eurostat contains gaps in some deeply integrated economic sectors, such as the sector of "Production of forging, pressing, stamping and

[6] For more detail please refer to European Commission, Guidelines on State Aid for Environmental Protection and Energy 2014-2020, Annexure 4.

[7] Regarding the definition of gross value added, see Statistisches Bundesamt (Publisher), Kostenstruktur der Unternehmen des Verarbeitenden Gewerbe sowie des Bergbaus und der Gewinnung von Steinen und Erden (Cost structure of companies in the processing industry as well as mining and extraction of rocks and soils)-(Fachserie 4, Reihe 4.3 (Series 4, Part 4.3)-)

roll forming of metal as well as powder metallurgic products" (NACE 25.50) and the sector's subgroups "Production of drop forging parts" (NACE 25.50 2) and "Production of powder metallurgic products" (NACE 25.50 5). This initially makes calculating the component of electricity costs in the gross value added as well as the trade intensity with third countries at EU level seemingly impossible (see Table 1).

Table 1: Data availability for calculating the trade intensity

Name of Sector	NACE no.	Production	Export	Import
Production of forging, pressing, stamping and roll forming of metal as well as powder metallurgic products	25.50	EU	-[1)]	-
among those				
Production of drop forging parts	25.50.2	EU	-[2)]	-[2)]
Production of powder metallurgic products	25.50.5	EU	-[2)]	-[2)]

1)Turnover abroad (outside euro-zone) available for Germany: Destatis FS4R411.
2) Source: Destatis and Eurostat.

Particularly quantifying trade intensity with third countries involves empirical problems for the primary economic sector "Production of forging, pressing, stamping and roll forming of metal as well as powder metallurgic products". This is due to the fact that European foreign trade statistics contain no data regarding the import or export of this economic sector. Despite clear production characteristics of the "Production of forging, pressing, stamping and roll forming of metal and powder metallurgic products" sector, foreign trade is not discernible in the statistics. The reason for this is that the international classification for foreign trade is based on product categories (and not on processes).

The PRODCOM statistics of Eurostat (sold annually) are generally available to calculate the trade intensity of economic sectors. These statistics link the production values of all economic sectors up to the level of subsectors with the associated foreign trade data (import and export). However, this statistical compilation reveals significant gaps in case of some sectors.

These data gaps affect the "Production of forging, pressing, stamping and roll forming of metal as well as powder metallurgic products" sector (NACE 25.50), as well as the industries contained therein. As a consequence, trade intensity cannot be calculated

directly for the sector NACE 25.50 as a whole or its sub-industries based on the official data.

However, the names of the product groups in the foreign trade statistics allow identification of work pieces due to additions in the descriptions, such as "drop forged" or "sintered", which can be entirely or partially associated with the two sub-sectors "Production of drop forging parts" and "Production of powder metallurgic products".

However, this approach is only possible for the "Production of drop forging parts" and the "Production of powder metallurgic products", as these components can be identified relatively reliably in the foreign trade statistics on the basis of the characteristics "drop forged" and/or "sintered", which are allocated to these sectors. Similarly clear descriptions cannot be found for other sub-industries of the economic sector NACE 25.50, such as "sheet metal forming" or "roll forming". For this reason, the trade intensity of the entire sector cannot be derived "bottom up" from the production and/or foreign trade statistics.

Empirical information regarding the share of electricity costs in the gross value added ("electricity cost intensity") is also not possible at EU level, as the Statistical Office of the European Union does not publish data regarding the energy consumption or energy costs of the economic sectors in question.

As the only official data source, reliable information regarding the energy consumption and the gross value added for the four-digit sectors "Production of forging, pressing, stamping and roll forming of metal as well as powder metallurgic products" for Germany can be raised from the records[8] of the German Federal Statistical Office, thus allowing the calculation of specific energy consumption. The database of Eurostat[9]

[8] Official data regarding energy consumption is provided by Destatis (Publisher), Establishment of the energy consumption for the sectors mining and extraction of rocks and soils as well as the processing industry, Statistic No. 060, Wiesbaden.

[9] Eurostat, Electricity prices for industrial consumers, as at 2007 –– biannual data, group ID: 2 000 MWh - 20 000 MWh, without VAT taxes and levies eligible for reimbursement.

provides the industrial electricity price, which makes it possible to calculate energy costs.

Table 2: Data availability for calculating electro-intensity

Name of Sector name	NACE no.	Electricity consump-tion	Price/-costs of electricity	Gross value added
Production of forging, pressing, stamping parts, etc.	25.50	-[1)]	EU	EU
among those				
Production of drop forging	25.50.2	-[2)]	-[2)]	-
Production of powder metallurgic products	25.50.5	-[3)]	-[3)]	-

1) Available for Germany: Destatis
2) Available for Germany: Wirtschaftsverband Stahl- und Metallverarbeitung (trade association for steel and metal processing) (WSM).
3) Fachverband Pulvermetallurgie e.V. (technical association for powder metallurgy) (FPM), European Powder Metallurgy Association (EPMA).

The official statistics do not provide information on the energy consumption or the gross value added for the "Production of drop forging parts" and the "Production of powder metallurgic products" sections. For the EU as a whole, detailed data for these economic sectors (NACE 25.50 2 and 25.50 5) are only available for selected partial aspects. Detailed statistical information regarding the power consumptions in European companies is available for powder metallurgy to close this data gap. Information regarding specific electricity consumption in German companies is available in the drop forging sector (see Table 2).

3.4. Method

Against the backdrop of the comparatively fragmented database described above, this study aims to complete the data by way of plausibility considerations in order to determine the indicators "trade intensity" and "electricity intensity" demanded by the Guideline for the economic sectors "Production of forging, pressing, stamping and roll forming of metal as well as powder metallurgic products", "Production of drop forged parts" and "Production of powder metallurgic products" at EU level.

The available information and parameters (electricity consumption and/or derived electricity intensity for Germany, data from relevant technical associations regarding specific electricity consumption in Germany and the EU, the relation of gross value added to

production of Eurostat etc.) represent the most important starting point for all considerations on completing the database basis at EU level.

This approach reveals the very scattered and sparse amount of data, in order to calculate from it the trade and electricity intensity and to verify the extent to which companies in the "Production of forging, pressing, stamping and roll forming of metal as well as powder metallurgic products" sector are qualified to use the privilege regulations of the Guideline.

Assessing incomplete data is naturally always associated with uncertainties. In view of this, the assessments presented in this study can provide important indirect references for the direction and extent of the development of the electricity and trade intensity in the economic sectors "Production of forging, pressing, stamping and roll forming of metal as well as powder metallurgic products", "Production of drop forged parts" and "Production of powder metallurgic products" at EU level.

Assessments and plausibility considerations cannot replace the availability of reliable data on a mid- or long-term basis, however. In order to cope with the constantly increasing quantitative requirements in future, the improvement and/or detailing of the official statistics, particularly at EU level, is essential. Statistics from relevant technical associations provide a further option for improving the data situation, as long as suitable association structures are established, also at EU level.

In future, the European Commission could and/or should allow alternative (possibly company-specific and/or based on individual cases) verification procedures for special industry sectors, which are not able to reliably verify whether or not they fulfil the criteria to be accepted into the industry lists of the Guidelines on State Aid for Environmental Protection and Energy due to lack of statistical data.

4. Empirical Results

4.1. Trade Intensity

Relevant data (imports, exports as well as production) must be available to calculate the criterion for making use of the relief regulations - the trade intensity of a sector with EU third countries - specified by the EU Commission.

Eurostat, together with PRODCOM, provides very detailed information regarding production for the sectors "Production of forging, pressing, stamping and roll forming of metal as well as powder metallurgic products" as well as the industries contained therein, namely "Production of drop forging parts" and "Production of powder metallurgic products". The available information regarding production is based on monetary volumes (in 1,000 €)) and currently extends to the year 2013.

Furthermore, information regarding foreign trade is required to empirically determine trade intensity. However, the sectors "Production of forging, pressing, stamping and roll forming of metal as well as powder metallurgic products" (NACE 25.50) and the industries contained therein, namely "Production of drop forging parts" and "Production of powder metallurgic products" cannot be readily and/or unequivocally associated with relevant product groups of foreign trade statistics.[10]

However, the lack of statistical information alone (and subsequently no empirical possibility to determine the trade intensity indicator at EU level from the statistics) is not an indication that the companies and operations of the "Production of forging, pressing, stamping and roll forming of metal as well as powder metallurgic products" (NACE 25.50) sector are not subject to intensive international competition.

[10] Information numbers can generally be clearly allocated to certain product numbers (see German Federal Statistical Office (2013)). However, this comparison, among others, is missing for sector NACE 25.50 as well as its subsectors.

Table 3: Trade intensity of the "Production of drop forging parts and the production of powder metallurgic products"

in million € and %

	2009	2010	2011	2012	2013	Ø 2009 to 2013
Production of drop forging parts (25.50 2)						
Production EU 28	7 333	9 541	11 860	11 594	11 658	10 397
Import	552	939	835	1 051	1 070	580
Export (EU extra)	581	700	828	878	817	761
Trade intensity	12.7	11.8	11.2	12.7	12.7	12.2 %
Production of powder metallurgic products (NACE 25.50 5)						
Production EU 28	1 597	2 063	2 348	2 150	2 196	2 071
Import	433	658	786	822	811	702
Export (EU extra)	552	939	835	1 051	1 070	889
Trade intensity	48.5	58.7	51.7	63.0	62.6	57.4 %

Source: Own calculation according to Eurostat

However, product groups can be allocated "manually" for the sectors "Production of drop forging parts" and "Production of powder metallurgic products" based on the name supplements in the product group foreign trade statistics. Based on the name supplements "drop forged" and "sintered", the relevant products can be identified and allocated to the two sectors.[11] Based on this allocation, a trade intensity can thus be

[11] According to the information of the Wirtschaftsverband Stahl- und Metallverarbeitung e.V. (WSM), not all products classified as "sintered" in the foreign trade statistics are entirely manufactured in a powder metallurgic manner. For this reason, a value added component of approx. 30% is assumed in coordination with the information of the association which is allocated to the sector "Production of powder metallurgic products".

calculated for these two sectors, which achieves 12.2% (Production of drop forging parts, NACE 25.50 2) and 57.4% (Production of powder metallurgic products NACE 25.50 5) (see Table 3).

However, this approach is not possible for all subsections of the economic sector NACE 25.50. For this reason, it is necessary to select an alternative evaluation approach for the derivation ofto derive trade intensity for the primary sector "Production of forging, pressing, stamping and roll forming of metal and powder metallurgic products".

In this regard, an official source provides initial information regarding foreign trade - at least for Germany - for the economic sector "Production of forging, pressing, stamping and roll forming of metal and powder metallurgic products" (NACE 25.50). In Series 4, Part 4.1.1 (Employment and turnover of processing industry operations), the German Federal Statistical Office publishes the export ratio for the entire economic sector (NACE 25.50) (based on turnover) on an annual basis. International turnover (export) in the statistic is additionally subdivided according to turnover with the euro-zone and turnover with the remaining countries.

Based on this data (which is not available in this form at EU level), it is at least possible to calculate a first rough parameter for the trade intensity of the economic sector "Production of forging, pressing, stamping and roll forming of metal and powder metallurgic products" for Germany with the aid of production and export, which equates to the export ratio. Since the imports are incorporated in the numerator as well as the denominator of the "trade intensity" parameters, the trade intensity would turn out greater than or equal to the value without consideration of the imports, even if the imports were taken into account (which, however, are not statistically available). In this respect, the approach outlined here is a careful estimation of the trade intensity in Germany.

Based on these aspects, the trade intensity for the entire sector NACE 25.50 for Germany results in an average value of 29.95% for the years between 2009 and 2013. According to the information of the German Federal Statistical Office, the export ratio of the sector "Production of forging, pressing, stamping and roll forming of metal and powder metallurgic products" (NACE 25.50) with countries outside of the euro-zone averaged 10.54% for the years 2009 to 2013 (approximately equates at least to the trade intensity of Germany with EU countries outside of the euro-zone).

Here, it should be considered that foreign trade with countries outside of the EU zone partially includes exports into EU countries outside of the euro-zone. The euro-zone currently consists of 18 of the 28 EU member states (status: December 2014). The foreign trade of sector NACE 25.50 with EU regions outside of the EU zone is not

expected to exceed a value of 34%. This assumption is at least supported by Germany's entire foreign trade in the EU, which applies to the euro-zone with a component of 66% (average for the years 2009 to 2013). German exports for the economic sector NACE 25.50 were corrected downward in this factor in order to also take into consideration the exports into EU countries outside of the EU zone.

Trade intensity for Europe can only be derived step by step based on this these statistics –– supported by the existing data in Germany. For this purpose, it is initially assumed that only German companies (after all, 40% of the product value of sector NACE 25.50 in EU 28 apply to these companies) export into EU countries. It is furthermore presumed that there are no imports of the sector in the EU 28. Subject to these aspects (production of sector NACE 25.50 for the EU, exports of the sector only from Germany, no imports), a trade intensity is revealed for sector NACE 25.50 for EU 28 of at least 2.88 % (see Table 4).

Table 4: Trade intensity "Production of forging, pressing, stamping and roll forming of metal and powder metallurgic products" (NACE 25.50) outside of EU 28 – without imports and exports remaining EU countries

in million € and %

	2009	2010	2011	2012	2013	Ø 2009 to 2013
Production EU 28	34 602	40 470	47 608	45 869	45 733	42 856
Import [1)]	-	-	-	-	-	-
Export Germany (EU-extra) [2)]	825	1 157	1 306	1 363	1 521	1 234
Export remaining EU (EU-extra)	-	-	-	-	-	-
Trade intensity (EU extra)	2.4	2.9	2.7	3.0	3, 3	2.9

Source: Own calculation according to Eurostat and Destatis FS4R411, [1)] Import data not available. [2)] Export data is only available for Germany and comprises all exports outside of the euro-zone. In order to only consider exports in EU countries outside of the eurozone when calculating the trade intensity, the exports in countries outside of the eurozone were corrected downward by the factor which equates to the export component in EU zones for all economic sectors. This component amounted to an average of 66.4% for the years 2009 to 2013.

However, it is quite probable that not only German, but also other companies of this economic sector with a registered office in foreign EU countries exported goods into

EU foreign countries. Similarly, companies and operations of sector NACE 25.50 with a registered office outside of the EU, will deliver their goods to Europe (import).

In order to close the outlined gaps of the imports/exports of the other EU countries for the sector NACE 25.50, a relatively simple approach was selected. This involved transferring the upgraded information of foreign trade obtained for the two sectors (NACE 25.50 2 and 25.50 5) to the total primary sector. Specifically, the following assumptions were made:

- Exports: On average during the years 2009 to 2013, German companies of both industries exported goods at a value of 543 million euros into countries outside of Europe; the sum of exported goods of all EU 28 countries amounted to a value of 1.650 million euros. If one transfers this ratio to the entire sector, goods at a value of 3.760 million euros were exported from the EU and/or goods at a value of 2.526 million euros from the remaining EU without Germany.

- Imports: If one summarises the imports and exports (EU extra) of both sectors, the level of their imports averages approx. 22% lower than their exports for the years 2009 to 2013. If one transfers this ratio to the entire sector, the imports for the entire sector amounted to 2.920 million euros (2009 to 2013).

Taking into account the estimated imports and exports of the remaining EU countries, a purely calculative trade intensity is derived for EU 28 of amounting to 14.59% for the years 2009 to 2013 (see Table 5).

Table 5: Trade intensity sector "Production of forging, pressing, stamping and roll forming of metal and powder metallurgic products" (NACE 25.50) EU 28 – incl. imports and exports remaining EU countries

in million € and %

	2009	2010	2011	2012	2013	Ø 2009 to 2013
Production EU 28	34 602	40 470	47 608	45 869	45 733	42 856
Import	2 026	2 631	2 911	3 207	3 823	2 920
Export Germany	825	1 157	1 306	1 363	1 521	1 234
Export remaining EU	1 925	2 632	2 277	2 742	3 052	2 526
Trade intensity (EU extra)	13.0	14.9	12.9	14.9	16.9	14.6

Source: Own calculation according to Eurostat and Destatis FS4R411.

4.2. Electricity (Cost) Intensity

In order to calculate the electricity cost intensity in the sector "Production of forging, pressing, stamping and roll forming of metal and powder metallurgic products" (NACE 25.50) and the industries contained therein at EU level, it is necessary to initially determine the electricity costs. The electricity costs of a sector can be calculated by multiplying the physical electricity consumption of the sector with the relevant existing electricity price.[12]

[12] Official statistics do not provide direct information regarding the electricity costs of individual sectors for either Germany or at EU level. Only the total energy costs are specified in the cost structure records of the German Federal Statistical Office (Series 4, Part 4.3: Cost structure of companies in the processing industry as well as mining and extraction of rocks and soils) for individual economic sectors in Germany. Similar facts apply for detailed corporate statistics -such as those published by EUROSTAT at EU level - which also only represent energy costs as a total.

$$(3)\ SK_i(€) = VES_i(kWh) \times \frac{PS_i\left(\frac{c}{kWh}\right)}{100}$$

with: SK_i: electricity costs, in €, VES_i: absolute electricity consumption, in kWh and PS_i: electricity price in c/kWh.

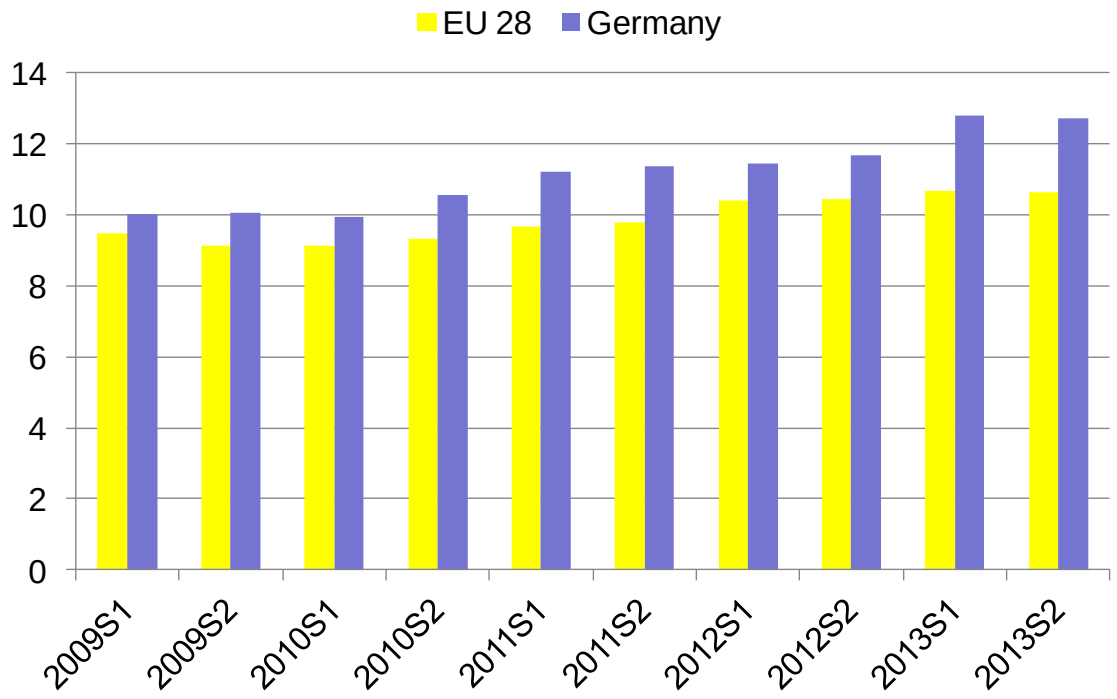
Industrial electricity prices (accurate, sector-specific price information is not available), such as published by Eurostat, form the basis for the calculation of electricity costs at EU level. The Eurostat records regarding industrial electricity prices distinguish between various supply cases, which are based on the quantity of the company's electricity consumption.

Companies and operations in the economic sector "Production of forging, pressing, stamping and roll forming of metal and powder metallurgic products" (NACE 25.50) consumed approx. 5,724 GWh of electrical power in Germany during the year 2013. According to the statements of the German Federal Statistical Office, this energy consumption was spread over 884 reporting units. Assuming, in view of the lack of accurate information, that each company active in the sector "Production of forging, pressing, stamping and roll forming of metal and powder metallurgic products" (NACE 25.50) possesses one supply and/or connection port for power from the public network and is identical to the reporting units of the German Federal Statistical Office, this would result in an energy consumption per supply point for the entire sector (in Germany) of 6,476 MWh/a for 2013. Looking at the average of the years between 2009 and 2013, the calculative energy consumption per operation and/or supply point in the sector "Production of forging, pressing, stamping and roll forming of metal and powder metallurgic products" (NACE 25.50) amounts to 4,225 MWh/a.

Eurostat specifies an electricity price for all member states of the European Union for this consumption case (2,000 to 20,000 MWh/a, without VAT as well as taxes and levies eligible for reimbursement) (see Chart 1).

Chart 1: Industrial electricity price in Europe and Germany

1st six months 2009 to 2nd six months 2013, in c/kWh*)



Source: Eurostat. *) without VAT and taxes and levies eligible for reimbursement.

However, electricity consumption of the sectors analysed here cannot be derived from the official data of Eurostat. Official statistics only provide time series regarding energy consumption for Germany and only for the primary economic sector "Production of forging, pressing, stamping and roll forming of metal and powder metallurgic products" (NACE 25.50). Conclusions regarding energy consumption of the sectors "Production of drop forging parts" (NACE 25.50 2) as well as "Production of powder metallurgic products" (NACE 25.50 5) can be derived from statistics of the association for the EU and Germany.

Due to the largely data-related difficulties in obtaining the absolute energy consumption of the investigated sectors directly from official statistics of Eurostat, it has to be calculated from the available information. For this purpose, the identified data gaps are initially closed with estimations based on available data regarding the specific energy consumption of the sectors in the EU (and Germany) during the individual years. Subsequently, the specific energy consumption obtained in this manner is linked to the available data pertaining to production at EU level (in 1,000 €) in order to obtain the absolute energy consumption.

Reliable data regarding energy consumption in Germany as well as the EU with respect to energy deployment in the mass production of powder metallurgic mouldings is available from records collated by the association. In 2012, the specific energy consumption in the EU amounted to approx. 377 kWh/1,000 € gross production value. At an average price of 12,297 €/t for powder metallurgic mouldings, this resulted in a specific energy consumption of 45 kWh per kg finished component. This value coincides with the information published in the scientific literature, which indicates a specific energy consumption of 5 kWh/kg for powder metallurgic production (this value includes approx. 0.5 kWh/kg of fossil energy for gassing).[13]

According to the Fachverband Pulvermetallurgie e.V. (FPM, technical association for powder metallurgy), the specific deployment of electrical energy for the production of powder metallurgic components in Germany lies between 6% and 11% below the values observed for the EU as a whole. According to the information of the association statistics, this results in an average specific electricity consumption for Germany of 345 kWh/1000 € gross production value for the years 2009 to 2013. This energy deployment lies at 9.5% below the European reference value.

According to the information of the Industrieverband Massivumformung e.V. (IMU, German Forging Association), the production of drop forging parts in Germany currently (2013) requires the deployment of 657 kWh of electrical energy per ton of product, which equates to a specific energy consumption of 320 kWh/1000 € with reference to the monetary production.

Furthermore, the energy consumption per ton of production (and/or per 1000 € gross production) for the entire economic sector NACE 25.50 in Germany can be obtained from the official statistics for the years 2009 to 2013. According to this information, the specific energy consumption during the period 2009 to 2013 fluctuated - without any uniform trend - between 173 and 184 kWh/1,000 € gross production. A rapid increase of the specific energy consumption for the "Production of forging, pressing,

[13] For details see Kruzhanov, K.; Arnhold, V. and Ernst, E., Energy deployment in mass production of powder metallurgic mouldings.

stamping and roll forming of metal and powder metallurgic products" (NACE 25.50) to 302 kWh can be observed during the year under review (2013).

Based on this information, a complete table of specific energy consumptions in the economic sectors investigated here (NACE 25.50, NACE 25.50 2 and NACE 25.50 5) for the period 2009 to 2013 can essentially be estimated subject to two aspects:

- the change in the specific energy consumption at the level of both sectors "Production of drop forging parts" as well as "Production of powder metallurgic mouldings" follows the observed trend at the primary level of "Production of forging, pressing, stamping and roll forming of metal and powder metallurgic products" (NACE 25.50);

- the observed efficiency difference with respect to deployment of electrical energy between Germany and the EU as a whole in the economic sector "Production of powder metallurgic products" (NACE 25.50 5) can be transferred to the "Production of drop forging parts" (NACE 25.50 2) as well as the primary sector "Production of forging, pressing, stamping and roll forming of metal and powder metallurgic products" (NACE 25.50).

Table 6 summarises the specific energy consumption of the individual sectors for the years 2009 to 2013, as determined based on the above-mentioned aspects.

Table 6: Specific energy consumption in economic sectors NACE 25.50, NACE 25.50 2 and NACE 25.50 5 at EU level

in kWh/1000 € gross production value

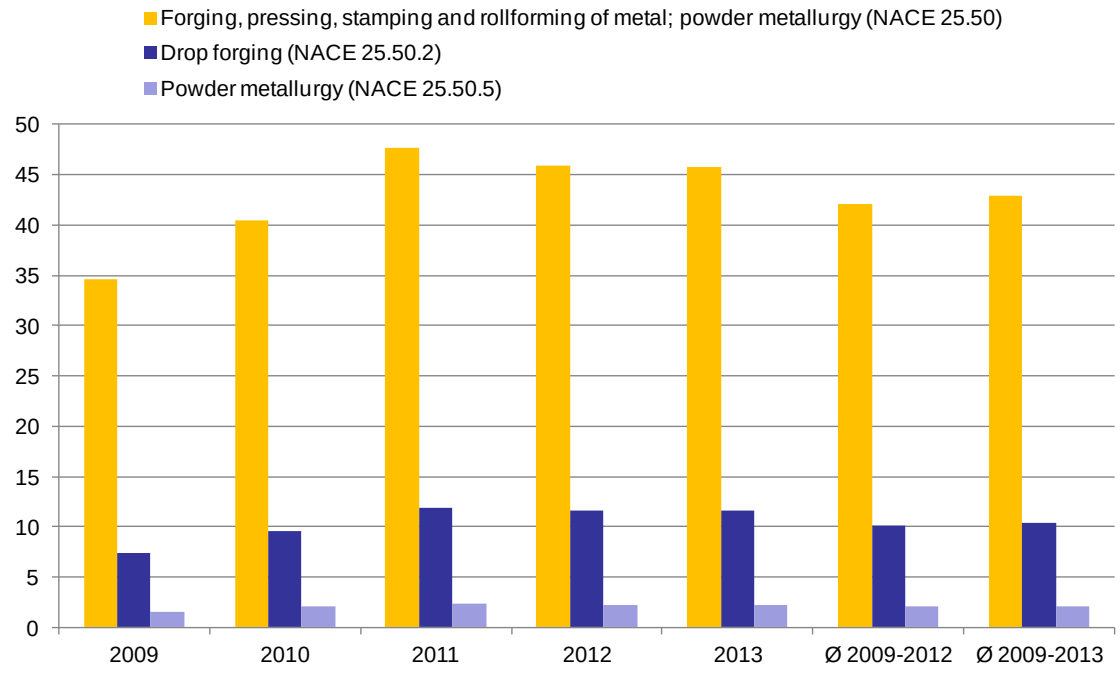
	2009	2010	2011	2012	2013	Ø2009 -2012	Ø2009 -2013
Production of forging, pressing, stamping parts, etc. (NACE 25.50)	189.0	198.7	191.4	204.0	335.5	196.1	225.9
Production of drop forging parts (NACE 25.50 2)	350.8	369.0	339.0	338.2	354.9	348.0	349.6
Production of powder metallurgic products (NACE 25.50 5)	379.6	399.3	366.8	365.9	384.0	377.3	378.7

Source: Own calculations according to DESTATIS and information of the Industrieverband Massivumformung e.V. (IMU) as well as the Fachverband Pulvermetallurgie e.V. (FPM)

As an annual average during the years 2009 to 2013, the companies of the economic sector NACE 25.50 ("Production of forging, pressing, stamping and roll forming of metal and powder metallurgic products") produced in the EU to a total value of €42.8 billion. Approximately one quarter of the production value (24.3 % and/or €10.4 billion) is based on the production of drop forging parts. By contrast, the production of powder metallurgic products represents a relatively small section (€2.1 billion and/or 4.8 % of the entire production value of sector NACE 25.50 are based on the production of powder metallurgic mouldings) – (for details, see Chart 2).

Chart 2: Production of drop forging parts, powder metallurgic products as well as forging, pressing, stamping parts in total in Europe

2009 to 2013, in billion €



Source: Own calculations according to Eurostat

This basic structure is only roughly reflected in the calculated energy consumption of the EU. The reason for this is the fact that both sectors, i.e. the "Production of drop forging parts" (NACE 25.50 2) as well as the "Production of powder metallurgic products" (NACE 25.50 5), have an above-average electricity intensity when compared to the entire sector. The two sectors therefore have a disproportionate share in the entire energy consumption of the economic sector (Ø 2009 to 2013: 9.7 TWh) with 37.5 % (energy consumption NACE 25.50.2 on Ø 2009 to 2013: 3.6 TWh) and/or 8.1 % (energy consumption NACE 25.50.5 on Ø 2009 to 2013: 0.8 TWh) (see Table 7).

Table 7: Energy consumption in economic sectors NACE 25.50, NACE 25.50 2 and NACE 25.50 5 at EU level

in TWh

	2009	2010	2011	2012	2013	Ø2009 -2012	Ø2009 -2013
Production of forging, press-ing, stamping parts, etc. (NACE 25.50)	6.539	8.042	9.111	9.359	15.346	8.263	9.679
Production of drop forging parts (NACE 25.50 2)	2.573	3.521	4.021	3.92	4.137	3.509	3.635
Production of powder metal-lurgic products (NACE 25.50 5)	0.606	0.824	0.861	0.787	0.843	0.769	0.784

Source: Own calculations according to DESTATIS, EUROSTAT and information of the Industrieverband Massivumformung e.V. (IMU) as well as the Fachverband Pulvermetallurgie e.V. (FPM), European Powder Metallurgy Association (EPMA)

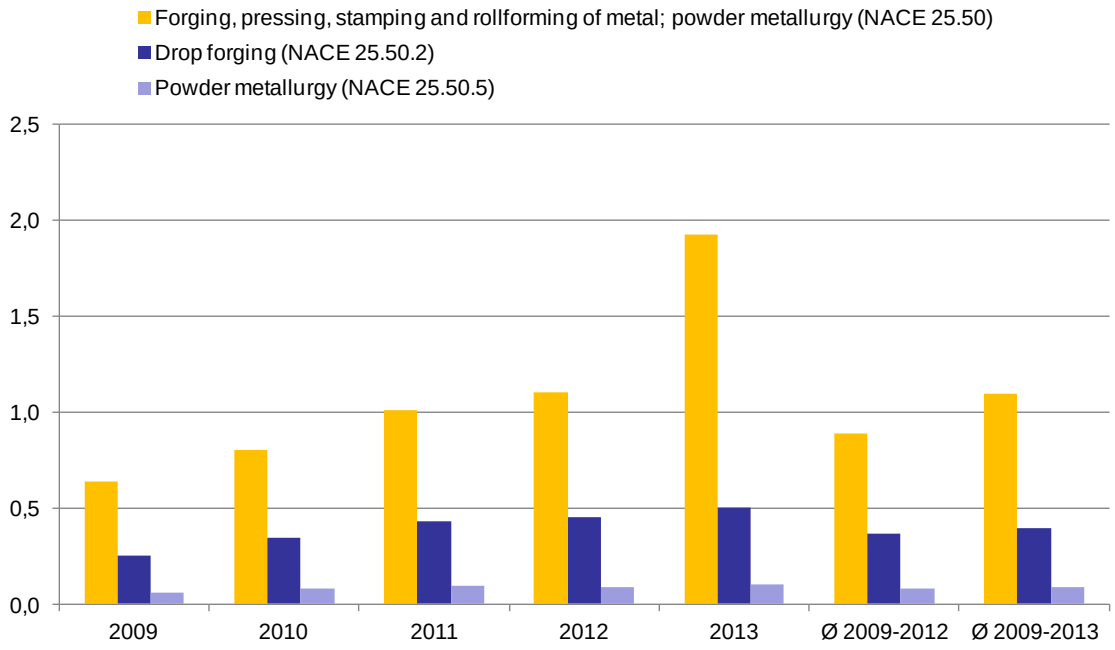
The calculated electricity consumption and the electricity prices for the industry published by Eurostat (assuming the full EEG contribution rate for German companies) result in the calculative electricity costs for the sectors "Production of drop forging parts" (NACE 25.50 2), "Production of powder metallurgic products (NACE 25.50 5) as well as the "Production of forging, pressing, stamping and roll forming of metal and powder metallurgic products" (NACE 25.50) at EU level.

Chart 3 summarises the development of electricity costs in the specified economic sectors. Electricity costs of almost €1.1 billion were incurred on average in sector NACE 25.50 during the years 2009 to 2013. The electricity costs for the production of drop forging parts amount to almost €0.4 billion; for the production of powder metallurgic mouldings this figure lies at €85 million. Electricity costs increased significantly

despite continuous efficiency improvements during the period between 2009 and 2013. This is essentially due to the development of electricity prices for industrial consumers.[14]

Chart 3: Electricity costs of economic sectors NACE 25.50, NACE 25.50 2 and NACE 25.50 5 at EU level

2009 to 2013, in billion €



Source: Own calculations according to DESTATIS, Eurostat and WSM

[14] The increase in electricity costs in 2013 is furthermore explained by the rapid increase in the specific energy consumption in the sector "Production of forging, pressing, stamping and roll forming of metal and powder metallurgic products" (NACE 25.50). Research regarding the energy consumption (statistic no. 060) for Germany depicts this increase in energy consumption in sector NACE 25.50 in this manner. The extent to which this observed increase in the (specific) energy consumption is merely a one-off or whether this trend will continue can only be clarified conclusively during the coming years upon the presentation of final official energy deployment data for Germany.

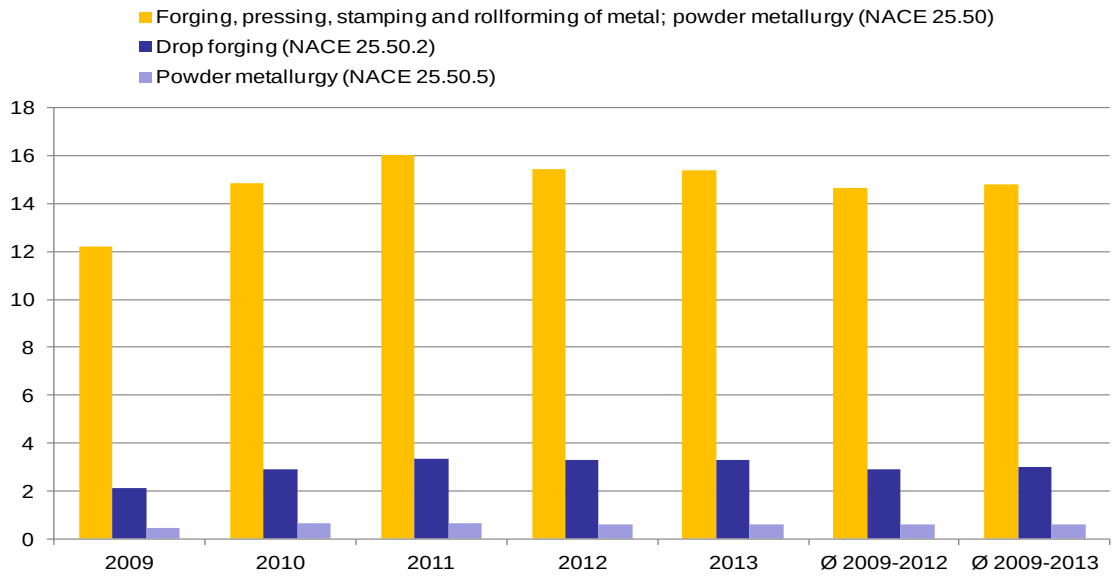
As a summarised indicator, this information allows electricity (cost) intensity to be derived in terms of the Guideline, by putting into perspective the determined energy costs of the relevant sector with respect to the gross value added (to factor costs). As far as individual industries are concerned, the gross value added (to factor costs) is available at EU level up to the level of four digit sectors. This differentiation therefore only permits the utilisation of the gross value added (to factor cost) from the official European statistics as reference value for the electricity costs for the total sector "Production of forging, pressing, stamping and roll forming of metal and powder metallurgic products" (NACE 25.50).

Due to this data gap, the gross value added (to factor costs) has to be estimated for both industries (NACE 25.50 2 and NACE 25.50 5) at EU level with the aid of existing statistical information.

In order to achieve this objective, the strategically secured ratio between the gross value added to production value (both information at EU level originally exists in a database of Eurostat) of the primary total sector "Production of forging, pressing, stamping and roll forming of metal and powder metallurgic products" (NACE 25.50) was transferred in this study to the economic sectors contained in the primary sector, namely "Production of drop forging parts" (NACE 25.50 2) and "Production of powder metallurgic products" (NACE 25.50 5). Germany (cf. Chart 4).

Chart 4: Gross value added (to factor costs) of economic sectors NACE 25.50, NACE 25.50 2 and NACE 25.50 5 at EU level

2009 to 2013, in billion €



Source: Own calculations according to Eurostat

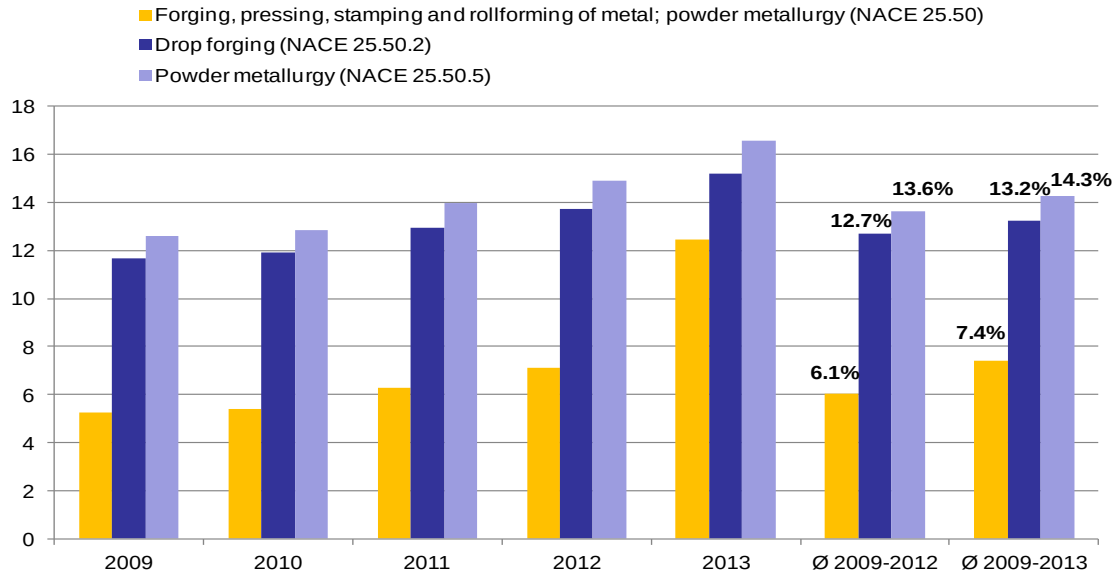
According to the information from Eurostat, the ratio between gross value added to gross production value in the sector "Production of drop forging parts" (NACE 25.50 2) varied between 33.7% and 36.7% in the period from 2009 to 2013. The average value for the years 2009 to 2013 was approx. 34.5%.

Based on these aspects, the economic sector "Production of drop forging parts" (NACE 25.50 2) achieved a gross value added of almost € 3 billion (Ø2009-2013); the "Production of powder metallurgic products" (NACE 25.50 5) achieved €0.6 billion. In comparison: Eurostat indicates an average annual gross value added of €14.8 billion for the entire economic sector "Production of forging, pressing, stamping and roll forming of metal and powder metallurgic products" for the same period (see Chart 4).

By summarising the estimations and calculations, the electricity intensity indicator at EU level reveals the following: The component of electricity costs in gross value added (to factor costs) achieves a total value of 7.4 % (Ø 2009 to 2013) in the sector "Production of forging, pressing, stamping and roll forming of metal and powder metallurgic products" (NACE 25.50). In the sector "Production of drop forging parts", a component of 13.2% is revealed - also respectively considering the full EEG contribution rate for companies from Germany. For the "Production of powder metallurgic products" (NACE 25.50 5), the figure lies at 14.3 %.

Chart 5: Share of electricity costs in the gross value added to factor costs in Europe

2009 to 2013, Ø 2009 to 2012 and Ø 2009 to 2013, shares in %



Source: Own calculations according to DESTATIS, Eurostat and WSM

*) Electricity costs without privileges, i.e. under the assumption of the full EEG contribution rate for German drop forges and/or powder metallurgic operations

Table 8: Share of electricity costs in gross value added to factor costs in sectors NACE 25.50, 25.50.2 and 25.50.5 at EU level

in %

	2009	2010	2011	2012	2013	Ø2009 -2012	Ø2009 -2013
Production of forging, press-ing, stamping parts, etc. (NACE 25.50)	5.23	5.41	6.28	7.12	12.47	6.06	7.40
Production of drop forging parts (NACE 25.50 2)	11.68	11.94	12.95	13.72	15.18	12.68	13.23
Production of powder metal-lurgic products (NACE 25.50.5)	12.61	12.84	13.96	14.90	16.57	13.64	14.25

Source: Own calculations according to DESTATIS, EUROSTAT and information of the Industrieverband Massivumformung e.V. (IMU) as well as the Fachverband Pulvermetallurgie e.V. (FPM)

The observations of alternative average periods (e.g. 2009 to 2012 -– without the peak values in specific electricity consumption) provide little change in the overall picture. On the whole, it can be stated that both sectors "Production of drop forging parts" (NACE 25.50 2) as well as "Production of powder metallurgic products" (NACE 25.50 5) clearly exceed the threshold of 10% electricity cost intensity required in the State Aid Guidelines by values of between 13 to 14%. By contrast, the entire economic sector "Production of forging, pressing, stamping and roll forming of metal as well as powder metallurgic products" (NACE 25.50) with its many different sectors lies below the required threshold value by approx. 2.5%.

5. Substitution Competition

According to the opinion of the EU Commission, additional costs due to the expansion of renewable energies (in Germany EEG contribution) in economic sectors confronted with a trade intensity of above 10% and a simultaneous electricity (cost) intensity of more than 10% pose significant risks for competitiveness (a similar risk exists for other constellations with the indicators trade and electricity cost intensity, e.g. lesser trade intensity of <10% but >4% and electricity costs above 20% as well as trade intensity of >80% and electricity cost intensity of at least 7 %).

The economic sectors "Production of drop forging parts" (NACE 25.50.2) and "Production of powder metallurgic products" (NACE 25.50.5) examined in this study fulfil the empirical criteria (trade intensity and electricity cost intensity >10%) and - for this reason alone - have to be included in the lists of sectors eligible for subsidies (Annexure 3 of the Guidelines).

A further argument supporting their inclusion is, that the production procedures in this sector are economically similar and that, to a significant extent, end products are generated which are eligible for subsidies on the basis of metal products from other economic sectors, which are already included in the list of sectors eligible for subsidies.

Numerous components produced from steel or other metals can be generated by forging, pressing, stamping, sintering (powder metallurgy) or casting (economic sector of "Steel, light metal and non-ferrous metal foundry"; NACE 24.51 to NACE 24.54).

For example, drop forged crankshafts exhibit special strength properties. The production of forged shafts is also very cost intensive, so that these crankshafts were predominately used in large numbers in the past, i.e. in the mass production of vehicles. Today, innovative materials and new production processes have led to cast crankshafts exhibiting almost the same strength properties as forged ones. This is supported by the fact that they can be produced relatively cost efficiently, so that cast crankshafts are partially replacing forged shafts in engine and/or motor vehicle production.

Similar constellations apply for gearbox parts, synchronizer rings or planet carriers, which can be produced in various ways, such as by means of a powder metallurgic process (pressing or sintering of metal powder) or by pressing, forging and casting.

Examples and detailed explanations clarifying the intensive technological competition of the sectors examined here with respect to the sectors already listed as qualifying for relief of the EEG contribution are contained in the **Annexure.**

All this shows that solely examining the "trade and electricity intensity" indicators as an assessment benchmark for cost relief from the EEG standard allocation is not sufficient to prevent unfair competition. The risk of unfair competition will always exist when some economic sectors can qualify for the privilege according to the Guidelines on State Aid for Environmental Protection and Energy yet other sectors generating similar goods and/or goods eligible for subsidies cannot apply due to gaps in official statistics.

The majority of the products manufactured by the sectors "Production of drop forging parts" (NACE 25.50 2) and "Production of powder metallurgic products" (NACE 25.50 5) can be substituted by cast mouldings and/or structural elements (foundry sector (NACE 24.51 to NACE 24.54)). As the economic sector "Foundry" has qualified for

the privilege, the exclusion of the sectors "Production of drop forging parts" (NACE 25.50 2) and "Production of powder metallurgic products" (NACE 25.50 5) from the partial relief of the EEG contribution inevitably leads to unfair competition, which is not the intention of the EU Guidelines on State Aid for Environmental Protection and Energy.

6. Summary and Recommendation for Action

According to the intention of the EU, relief for electricity intensive operations (in Germany by way of the Special Equalisation Scheme of the EEG) will in future only be granted to sectors which are exposed to special **international competitive pressure**. A standardised process is consulted to assess the competitive situation, which refers to two ex-post indicators, namely the **trade and electricity intensity**.

Specifically, the **Guideline of the European Commission for State Aid for Environmental Protection and Energy for 2014 to 2020** provides that, in future, companies can only benefit from relief of the EEG contribution compliant with State Aid law if they either

- belong to one of the 68 sectors identified ex-ante and listed in Annexure 3 of the Guideline (sectors showing a trade intensity of > 10 % and an electricity intensity of > 10%)

- or belong to one of the 152 sectors likewise identified ex-ante and listed in Annexure 5 of the Guidelines (sectors with a **trade intensity at EU level with third countries greater than 4%)**, whereby the individual company simultaneously demonstrates an electricity intensity (component of electricity costs based on the full EEG contribution rate in the gross value added) of at least 20%.

One important prerequisite to even be included as an economic sector in one of the lists defined ex-ante is the **availability of statistical data** to calculate the trade and electricity intensity at EU level. However, significant data gaps already exist for some sectors, which render the calculation of the energy costs for the gross value added as well as the trade intensity with third countries at EU level impossible with the aid of the official statistics alone.

The economic sector "Production of forging, pressing, stamping and roll forming of metal as well as powder metallurgic products" (NACE 25.50) clusters companies which form products made of steel, non-ferrous metals or metal alloys by way of different

technical processes (pressing, forging, etc.) into structural elements. The production processes in this economic sector are very heterogeneous with respect to their electricity intensity. Particularly the two sectors "Production of drop forging parts" (NACE 25.50 2) and "Production of powder metallurgic products" (NACE 25.50 5), whose production processes require forming temperatures of approx. 1200°C have to be considered as extremely electricity intensive.

Due to the **lack of detailed, official databases**, the sector "Production of forging, pressing, stamping and roll forming of metal as well as powder metallurgic products" is **not** included in the **list of Annexure 3** or the **additional list of Annexure 5** of the Guideline. In future, companies of this economic sector will therefore be excluded from the privileges which are granted to electricity intensive operations for preserving their competitiveness. The **restricted availability** of sector-related, statistical data (based on NACE four and six digit companies) should **not** represent a **criterion for exclusion** from relief.

On behalf of the Industrieverband Massivumformung e.V. (IMU) and the Fachverband Pulvermetallurgie e.V. (FPM), the EEFA-Forschungsinstitut has examined the database in detail in the context of a **study** and substituted missing information with plausible estimations based on available statistical data (e.g. those available for Germany). In addition, specific information from the technical associations of the sectors "Production of forging, pressing, stamping and roll forming of metal as well as powder metallurgic products" (Industrieverband Massivumformung e.V. (IMU) and the Fachverband Pulvermetallurgie e.V. (FPM)) were used to quantify the **electricity cost intensity** and the **trade intensity** for the entire sector (NACE 25.50) as well as for drop forging and powder metallurgy, in particular, at EU level for the period between 2009 and 2013.

Electricity cost intensity:

To calculate the denominator of the "electricity cost intensity" (electricity costs) parameter, the **specific electricity consumption** (in kWh/1000 € gross production value) for Europe was determined for the sectors “Production of drop forging parts” (NACE 25.50 2) and “Production of powder metallurgic products” (NACE 25.50 5) based on detailed statistics from the technical associations. In order to arrive at the specific electricity consumption for the entire sector “Production of forging, pressing, stamping and roll forming of metal as well as powder metallurgic products” (NACE 25.50), reference was made to the specific electricity consumption of the sector for Germany (calculated on the basis of official data). In addition, in order to arrive at the specific electricity consumption of sector NACE 25.50 in the EU based on this data, the **better electricity efficiency** of German companies – in comparison with the EU average – was considered (the efficiency subsidy of German companies compared to

European companies can be determined based on the association statistics for the sub-sectors).

With the aid of the **electricity price** paid by companies consuming on average between 2,000 and 20,000 MWh (according to EUROSTAT) as well as the production values (PRODCOM statistics), it was ultimately possible to arrive at the **electricity costs** of the entire sector (NACE 25.50) as well as both sectors contained therein (NACE 25.50 2 und NACE 25.50 5).

The **gross value added** (to factor costs) for the determination of the electricity cost component at EU level was obtained from the detailed corporate statistics of EUROSTAT (for sector NACE 25.50). The gross value added for the two sectors (NACE 25.50 2 and 25.50 5) had to be estimated based on the production values as well as the observed structures of the primary sector.

With the aid of this database, the calculations show that the **electricity intensity** (component of electricity cost in gross value added to factor costs) in the sector "Production of forging, pressing, stamping and roll forming of metal as well as powder metallurgic products" in Europe reaches a value of 7.4 % (Ø 2009-2013); **the reference value for the "Production of drop forging parts" is 13.2%; the value for powder metallurgy lies at 14.3%**.

Trade intensity:

The direct calculation of the **trade intensity** of the total sector "Production of forging, pressing, stamping and roll forming of metal as well as powder metallurgic products" is not possible due to a lack of data (and/or a lack of allocation of production) pertaining to foreign trade at EU level.

However, the text descriptions of the product groups in the foreign trade statistics allow the identification of "drop forged" as well as "sintered" workpieces. In this manner, it is possible to identify goods and/or product groups in the foreign trade statistics which can be allocated to the two sectors "Production of drop forging parts" and "Production of powder metallurgic products". Together with the relevant information regarding production, it is possible to calculate the trade intensities of the two sectors.

The trade intensity for the primary sector "Production of forging, pressing, stamping and roll forming of metal as well as powder metallurgic products" is calculated based on the turnover (German companies of the sector) outside of the eurozone (according to Series 4, Part 4.1.1) as well as the added estimation of foreign trade (EU extras) of the remaining European countries.

Table 8: Result: Trade intensity and electricity intensity

Average 2009 to 2013, in %

	Electricity intensity (Electricity costs / BWS to factor costs)	Trade intensity (EU-extra trade)
	Europe	Europe
25.50	7.4	14.6
25.50 2	13.2	12.2
25.50 5	14.3	57.4

Source: Own calculations according to EUROSTAT, Industrieverband Massivumformung e.V. (IMU), Fachverband Pulvermetallurgie e.V. (FPM), EPMA, Destatis

According to these calculations, "Production of drop forging parts" (NACE 25.50 2) achieves an average **trade intensity with EU third countries to the amount of 12.2%;** the value for "Production of powder metallurgic products" (NACE 25.50 5) lies at **57.4%** for the years 2009 to 2013. A trade intensity of 14.6% is calculated for the entire sector "Production of forging, pressing, stamping and roll forming of metal as well as powder metallurgic products" (NACE 25.50) for the same period.

Recommendation for Action:

As this analysis has shown, the companies of the sectors "Production of drop forging parts" (NACE 25.50 2) and "Production of powder metallurgic products" (NACE 25.50 5) in Europe belong to the electricity intensive sectors; their component of electricity costs in relation to gross value added considerably exceeds the threshold of 10 %. The component of electricity costs in gross value added for the primary economic sector "Production of forging, pressing, stamping and roll forming of metal and powder metallurgic products" (NACE 25.50) achieves a value of 7.4 % (average 2009 to 2013) and lies significantly below the threshold required by the EU Commission.

On the other hand, the market in which the companies of the sector "Production of forging, pressing, stamping and roll forming of metal and powder metallurgic products" are active is characterised by a high degree of competition. The trade intensity with EU third countries lies significantly above the threshold of 10% for the "Production of drop forging parts", the "Production of powder metallurgic products" as well as the entire economic sector "Production of forging, pressing, stamping and roll forming of metal as well as powder metallurgic products" at EU level.

In summary, it is evident that the primary four digit sector does not fulfil the criteria of the State Aid Guidelines to be included in the Annexure 3 list. However, the companies of the sectors "Production of drop forging parts" as well as "Production of powder metallurgic products" would be exposed to a significantly increased risk of losing their competitiveness if they were excluded from the privilege regulations.

As these two sectors exhibit trade intensity greater than 10% as well as electricity intensity greater than 10%, they should be included in the group of sectors identified ex-ante as eligible for subsidies (Annexure 3 of the Guidelines) in the context of a subsequent listing.

This step is supported by an additional important argument which is independent of the empirical findings outlined in this study: The majority of the products manufactured by the sectors "Production of drop forging parts" (NACE 25.50 2) and "Production of powder metallurgic products" (NACE 25.50 5) can be **substituted** by cast mouldings and/or structural elements (foundry sector (WZ 24.51 to WZ 24.54)). As the economic sector "Foundry" has qualified for the privilege, the exclusion of the sectors "Production of drop forging parts" (NACE 25.50 2) and "Production of powder metallurgic products" (NACE 25.50 5) inevitably leads to **unfair competition**, which is not the intention of the EU Guidelines on State Aid for Environmental Protection and Energy.

7. Literature Index

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8. Annexure - Substitution Risks

Forging and Powder Metallurgy in Technological Competition with Cast Materials

1. Preliminary Notes

There are numerous processes for producing ready-for-assembly or near-net-shape parts using non-machining methods. Many of these, however, render subsequent machining of functional surfaces necessary, e.g. for achieving the required surface quality or dimensional tolerances.* In so far as the production methods are equal in fulfilling the required function, the decision to opt for a particular process is almost always made based on the part price. Material, design details and production processes are inextricably linked in this selection process, and the necessary effort involved in the slow and thus costly subsequent machining operations is often a decisive factor when awarding contracts. The wealth of material, design and production facets which needs to be considered makes any attempt at a comparison inadequate, as only a few aspects may ever be taken into account.

2. Forming Processes and Materials

Diagram D1 shows which materials may be worked using which forming processes. Many processes demand special material compositions, such as high silicon contents in aluminium and ferrous materials in order to improve castability, or spheroidized cementite in pearlite steels, so that the materials may be extruded or fineblanked. Furthermore, many materials, such as steels, are heat treated following forming. Suitability for the various heat treatment operations can also be influenced by the production process. In the case of carbon steels, hot extrusion offers a compromise between tool failure and tool wear. Nickel-based super alloys are mostly used for investment casting; in many cases, they are also suited to metal injection moulding. In very high-temperature-resistant tools, these alloys are often forged. Cast iron is primarily processed by means of sand or die casting; functional surfaces are subsequently machined, as the level of geometrical accuracy is generally insufficient. The typical cast aluminium alloys are suitable for all casting processes. They may also be used in spray compacting, although this process is not usually employed for producing shaped parts. Recently, some aluminium and magnesium alloys have been processed into shaped parts by means of forging or pressure die casting in the semi-solid state. Bronzes, brasses and copper-nickel-based alloys are worked into shaped parts not only by means of pressure die casting, which is still feasible with low melting brasses, but also using practical-

ly every production process. Hard magnetic substances need to be partially cast and partially processed using powder metallurgical operations.

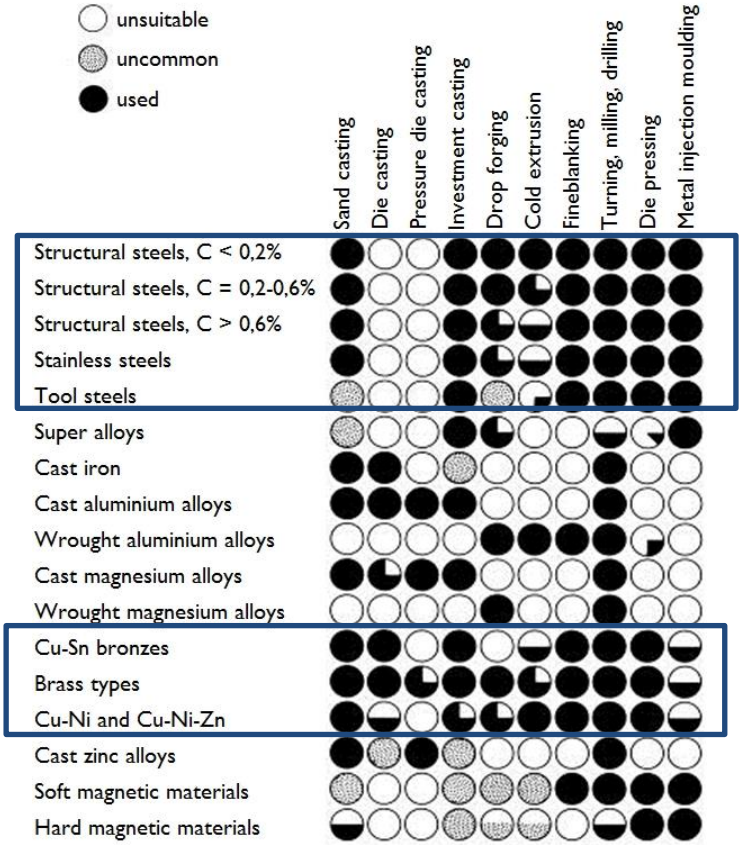

Diagram D1: Suitability of various forming processes for different materials

Starting with the same or similar chemical composition, different production processes also provide different properties. Thus, the property profile of a shaped part cannot be separated from the production method.

All production processes provide possibilities for accommodating special requirements, which need to be discussed with the manufacturers. In all forming processes, the costs for the raw material are part of the calculation. If the mechanical properties are sufficient and the part can be produced by casting without considerable subsequent machining, cast iron is almost unbeatable in terms of low cost. However, in many cases, material costs are not the only decision criteria.

3. Casting – Forging – Powder Metallurgy

Casting is the most flexible process in terms of shaping technology and with respect to the range of materials which can be used. Undercuts and complex hollow spaces as well as three-dimensional spiralling parts are possible. Special processes allow directionally solidified parts and monocrystalline materials to be produced. As with all other casting processes, it is not possible to cast sharp corners and edges. However, radii of up to approximately 0.4 mm can be achieved even with steels which do not readily fill a cavity. Melts with lower surface tension fill a cavity more precisely. In steel, it is difficult to produce holes and slots below 2 mm or wall thicknesses below approximately 1 mm. The surface qualities which may be attained are often already sufficient for low functional requirements. However, for most requirements, functional surfaces require subsequent machining.

The term forging encompasses a range of various hot forging processes using open or closed dies. Drop forging with flash is the most frequently used process. For mass-produced parts with moderate geometrical complexity, very high productivity rates may be achieved through automation. Tooling efforts are comparatively low and may often be adapted flexibly to the annual volume, so that costs in downstream work processes may be reduced effectively. Forging is thus suitable for everything from very low volumes to huge mass production. Among all near-net-shape parts, forged components have the best combination of strength and toughness for a given material. By means of controlled cooling from the forging heat together with the choice of material, it is possible to fulfil all microstructural requirements – from hardened or annealed to normalised – without additional heat treatment. Some limiting design properties must be mentioned which are laid down for forged parts in DIN 7523, Part 2. For die removal, die drafts are necessary. As in pressure die casting, these die drafts need to have a greater inclination on the inner contours than on the outer contours. Sharp edges or corners may only be forged with calibrating operations; normal closed-die forging requires radii, fillets and rounded edges.

Powder metallurgical shaped parts following the die pressing process have good radial geometrical tolerances. However, these are dependent on the basic strength of the materials used. Many geometry elements may be designed without being tied to rotationally symmetric contours, rendering powder metallurgical shaped parts far superior to extruded parts in this respect, although they do not attain the strength of parts produced by extrusion. The diverse forming possibilities of sophisticated casting processes cannot be attained. By contrast, die-pressed parts have much greater precision and reproducibilty as well as often being far superior with respect to strength. As die draughts are not needed in most cases, functional surfaces which may be shaped by dies and mandrels thus require no subsequent machining. Productivity is high, yet considerable tool costs render small serial production unfeasible. In the case of die press-

ing, the competitive edge when it comes to cost often only becomes visible in large serial production and by carrying out value analyses. Particularly worthy of mention are die-pressed sintered parts with their porosity, oil storage capacity for self-lubricating plain bearings or the possibility of producing material combinations (e.g. cemented carbide) not possible by conventional means. Using powder injection moulding, a great variety of materials – and not only metallic ones – may be formed. The forming flexibility is fully comparable to that of plastic shaped parts and investment castings, the only difference being that the starting material is a powder in a (viscous) injection mass. The fine powder used leads to an outstanding surface quality. Due to considerable shrinkage during sintering, the dimensional scatter is only marginally better than that of investment casting.

4. Substitution Examples

Some examples will serve to show that there are often several solutions for the same or related tasks. If all of them fulfil their function equally well, it is important to weigh them up against each other from a technical and economic point of view. Fig. F1 highlights the possible methods for producing planet carriers. Here, a sintered part is shown which is joined with a hot forged steel part by means of surface riveting (GKN Sinter Metals, Hirschvogel Umformtechnik). The forged part is also produced with a ready-for-assembly parking gear. Here, there are many different sophisticated, award-winning designs from GKN Sinter Metals, Borg Warner, Sumitomo Electric, Hitachi Powdered Metals, Toyota, Stackpole and other manufacturers. In other designs, forged parts are joined by means of electron beam welding, or fineblanked and forged parts are joined by riveting. There are also planet carriers made of malleable cast iron which need to be machined on all functional surfaces.

Fig. F1: Examples of planet carriers: Sintered part and forged part joined by surface riveting. (GKN Sinter Metals, Hirschvogel Umformtechnik)

Synchronizer rings may be produced in a completely different way. Conventionally, synchronizer rings for car transmissions are forged from a highly wear-resistant special brass. Depending on the application and required strength, there are geometrically similar solutions. These include synchroniser rings made from porous sintered steel of high strength, or those produced by means of fineblanking, powder forging, precision forging, orbital forging, and cold forging. They may also be made from spheroidal graphite cast iron or even be produced as an investment cast component. Fig. F2 shows a fineblanked cast version compared with a sintered part produced by powder metallurgy.

Fig. F2: Die-pressed (GKN Sinter Metals) and fineblanked cast synchronizer ring (Feintool Lyss)

There are numerous other examples of alternative production processes, for example for manufacturing connecting rods. These include drop forging, powder forging and sand casting (Fig. F3).

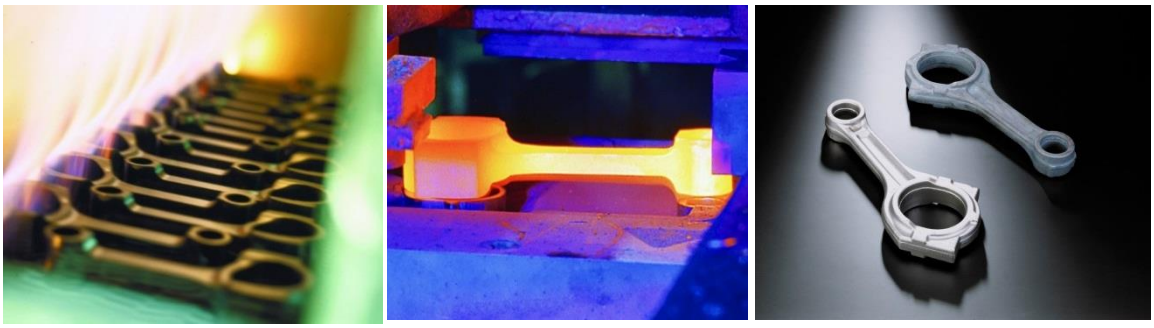

Fig. F3: Cast connecting rod with heat treatment versus forged connecting rod

Furthermore, more recent ferritic cast iron materials (e.g. under the brand SiboDur**) score over forged materials with higher tensile and fatigue strengths as well as better

elongation. This is leading to VW and Audi increasingly replacing wheel carriers with cast types. The monopoly enjoyed by forged crankshafts to date is also being challenged by higher strength ferritic cast materials with local roller burnishing (e.g. in the 1.9 l diesel engine). Depending on the refinement of individual alloying elements, such as silicon, material properties may be adapted in these cast products for crash-relevant parts, chassis parts, commercial vehicle wheel hubs or pistons, thereby supplanting conventional forged parts in terms of price.

Many shift fingers are produced as powder metallurgical shaped parts and by means of investment casting. Gearshift forks are die pressed, forged from steel or die cast from copper-based alloys. Tilt and rocker arms are cast, forged or die pressed/sintered (see

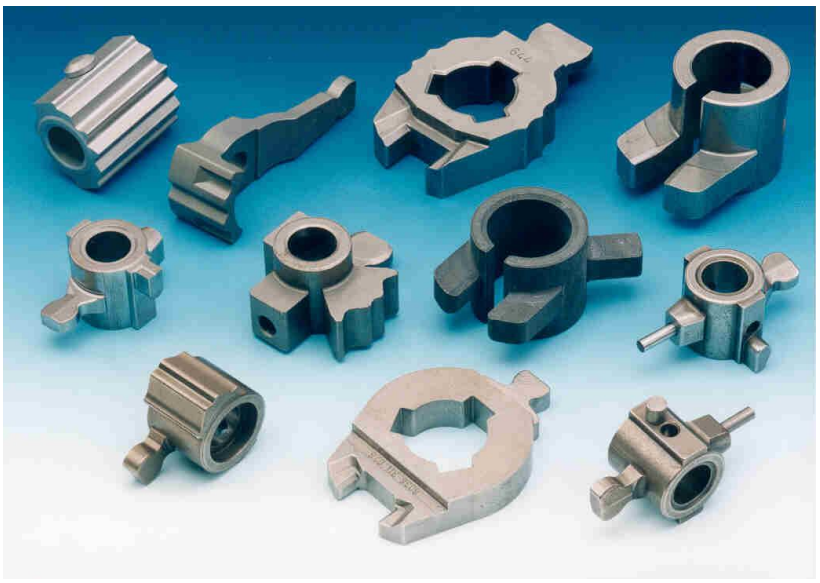

Fig. F4).

Fig. F4: Gearshift forks and tilt arms (cast, forged, sintered)

The right process in each case must be derived from the technical and economic requirements. There are also alternatives to powder metallurgical metal injection moulding (MIM) in the form of investment or die casting, particularly in the case of moderate or low volumes. Fig. F5 shows, for example, two die cast roller levers made of high-strength aluminium bronze with an overmoulded steel bolt which undergoes induction hardening in the cast state.

Fig. F5: Die cast roller levers with overmoulded steel bolt instead of a powder metallurgical MIM part

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* cf. Paul Beiss, Tagungsband Hagener Symposium 2006, ISBN 3-9807736-9-8, pp.69-95; VDI-Wissensforum; Einbaufertige und endkonturnahe Formteile (Ready-for-assembly and near-net-shape formed parts); Seminarunterlagen (Seminar papers); VDI, Düsseldorf 2005; Assinter-Paper; Competitiveness of Sintered Components, Guide to Technological Alternatives; Turin, 1996

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