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Welding industry against economic fluctuations of 2006-2012

Abstract: The article aims to determine the scale of applying welding technologies, the role of welding engineering in production and economy and the impact of economic fluctuations on the dynamics of sales in industries applying welding techniques and on the demand for welding equipment and consumables.

Keywords: welding industry analysis, production, employment, technology

Following the adopted terminology, the notion of "industry" is usually reserved for the production of one type of goods. In the case of welding engineering, the potential of industry results from the presence of joining technologies in manufacturing processes of most products and structures made of steel, non-ferrous metals and their alloys, as well as products made of plastics, composites, ceramics, multimaterials and even of wood. Such products, in the form of bridges, power systems and boilers, pipelines, vehicles, building structures, household equipment etc., are manufactured in over 100 various industries of Poland's economy.

The term of joining usually refers to three basic technologies, i.e. fusion welding, pressure welding and brazing/soldering. However, this very general division does not reflect the scale, potential and role of these technologies in production processes and economy. According to the standard PN-EN ISO 4063:2011E *Welding and Allied Processes – Nomenclature of Processes and Reference Numbers* within the three primary technologies, i.e. fusion welding, pressure welding and brazing/soldering as well as cutting and gouging as allied processes it is possible to enumerate 46 various methods and approximately 100 variants of these methods used for joining various structural materials.

Application of joining technologies and allied techniques

In spite of increasing consumption of aluminium and plastics, steel continues to remain the primary structural material, therefore the consumption of steel was adopted as the basis for the analysis of the welding industry situation. It is estimated that approximately 65% of rolled steel products (i.e. in Poland, depending on the market situation between 3.5 and 5 m tons) is used for welded structures and products made by means of, among others, welding techniques (Fig. 1).

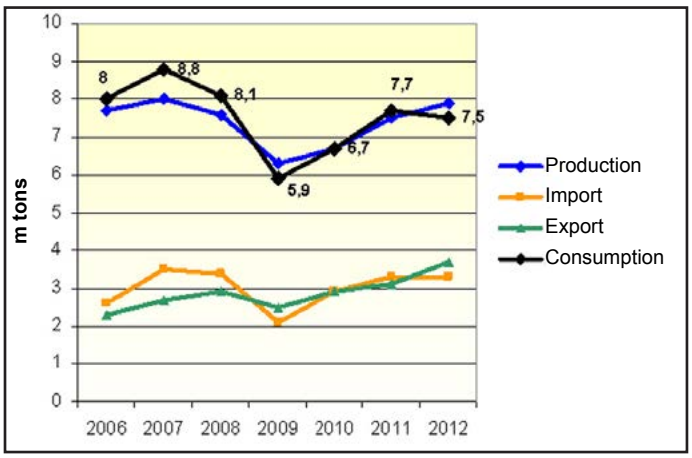

Fig. 1. Consumption of hot rolled products in Poland in 2006-2012

Figure 1 presents the impact of market fluctuations on the consumption of hot rolled products. In 2009, in comparison with the

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prosperity time of 2007, the consumption of such products dropped by 2.9 m tons, i.e. by over 36%. The period of economic revival of 2010-2011 was reflected by an increase in the consumption of the aforementioned products by approximately 1.8 m tons. The economic downturn of 2012 was not as severe as that of 2009. In comparison with the previous year the consumption fell by a mere 0.2 m tons. However, by 2012 the consumption of hot rolled products had not reached the level of 2006, i.e. the year preceding the greatest economic boom in the last decade. These changes influenced the economic situation in the welding industry.

Among 22 industrial processing sectors, 6 (being the main users of welding techniques, i.e. the production of metals, metal products, equipment and machinery, cars, trailers and semitrailers, other vehicles and electronic equipment) consume approximately 95% of rolled products (Fig. 2).

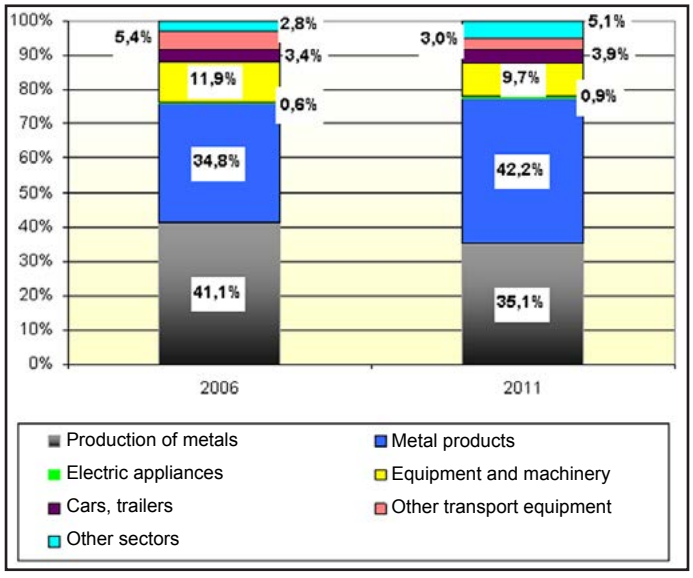

Fig. 2. Structure of hot rolled product consumption according to sectors of economy and industry in 2006 and 2011

The structure of rolled product consumption reveals that the years 2006-2011 saw a consumption increase in such sectors as metal products (by 7.4%), cars, trailers and semitrailers (by 0.5%) as well as electric appliances (by 0.3%) and a decrease in the production of metals (by 6%), equipment and machinery (by 2.2%) and of other transport equipment (2.4%). As regards the use of welding technologies, the manufacture of metal products is the most important sector of industry (Fig. 2).

The scale of welding technologies application is affected, among others, by changes in employment and number of enterprises (referred to as business entities in statistics terminology) taking place in industry sectors using welding techniques. In the years 2006-2012 the number of business entities in the sectors mentioned above rose from 7574 to 7774, i.e. by mere 200 companies. As regards employment numbers the structure of companies practically did not change. Small and medium enterprises (SME), i.e. those employing up to 250 workers make up 93% of the total number of enterprises. Only 7% of businesses are companies employing above 250 workers, i.e. companies rated as big (Fig. 3).

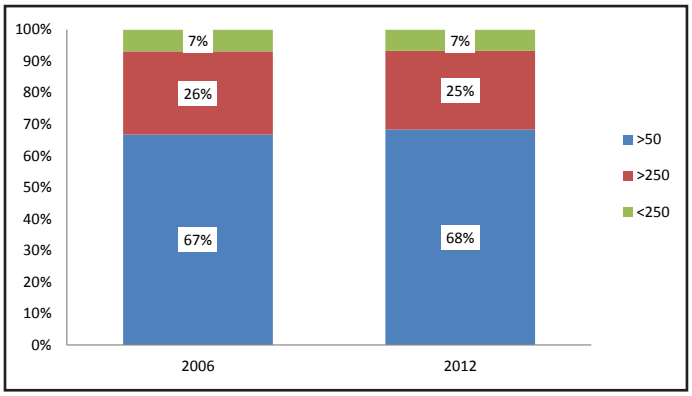

Fig. 3. Structure of business entities in welding engineering-related industry sectors according to the number of employed workers

Table 1 presents that in 2012 7774 companies were involved in the manufacture of metals, metal products, electric appliances, equipment and machinery, vehicles and transport equipment, i.e. goods requiring the use of joining technologies. This constitutes approximately ¼ of all the companies in the industrial processing sector, employing 697.5 thousand workers, i.e. 34% of the total number of workers employed in the processing industry. The manufacture of metal products is the greatest user of welding processes both in terms of the number of business entities (4426) and the scale of employment (234 thousand workers).

Table 1. Number of business entities and employment in industry sectors using welding technologies in 2012

Description	Number of entities*	Share %	Av. employment in thous.	Share %
Industrial processing in total	29 333	100	2052	100
including the manufacture in sectors using welding techniques	7774	25.5	697.5	34
• metals	metals	1.5	61.0	3.0
• metal products	metal products	15.0	234.5	11.4
• electric appliances	electric appliances	2.2	90.8	4.4
• equipment and machinery	equipment and machinery	4.9	116.5	5.7
• cars	cars	2.0	153.4	7.5
• other transport equipment	other transport equipment	0.9	41.3	2.0
Building engineering in total	236 361	100	612.8	100
• including civil engineering objects	including civil engineering objects	6.3	157.8	25.7

*Data refer to enterprises employing over 9 workers

It is problematic to estimate the number of companies using welding technologies in building industry as some companies manufacture building materials and perform building processes without using welding technologies. According to American data the share of welding in the total labour cost in building sector amounts to approximately 13% (Fig. 4).

In the building engineering sector civil engineering objects (railway tracks, bridges, railway bridges, and pipelines) are examples of building structures requiring the use of welding technologies. This production process involves over 15 thousand companies employing over 150 thousand workers, which makes up more than 25% of the total number of workers employed in the building sector. Industrial buildings, warehouses and office buildings are other structures made using welding techniques. Also broadly defined service industry offering various types of repairs, tests and training utilising welding technologies affects the potential of welding engineering sector.

It is estimated that, depending on the economic situation, welding sector directly or indirectly employs between 120 and 180 thousand workers. This number includes welders (the largest group), welding coordination and quality control workers, personnel dealing with the production, distribution and service of welding equipment and consumables, workers involved in training of welding personnel as well as welding research specialists.

Role of welding industry in production and economy

The role of welding industry in the Polish economy is indicated by many factors such as, among others, the number of enterprises involved in the production of welded goods and structures as well as the share of industry sectors using welding technologies in the production sold and in the generation of gross added value (Tables 2 and 3).

Table 2. Examples of industries using joining technologies and their share in the production sold in 2005 and 2012

Description	2005		2012	
	BN PLN	share %	BN PLN	share %
Industrial processing in total	571.6	100	985.3	100
including metal products	38.2	6.7	78.4	7.9
Building and assembling in total	82.5	100	170.6	100
including civil engineering objects	15.4	18.7	46.9	27.5

According to the data presented in Table 2, in spite of the economic downturn, in the total industrial production sold the share of industry sectors closely related to welding engineering, i.e. the manufacture of metal products and civil engineering objects, increased from 6.7 to 7.9% and from 15.4 to 27.5% respectively.

The manufacture of metal products had the greatest share in the generation of gross added value, i.e. 7.8% and 7. 7% in 2006 and 2012 respectively (Table 3).

Table 3. Share of industry sectors utilising welding technologies in the generation of gross added value

Description	Share %	
	2006	2012
Industry in total	100	100
including industrial processing, including the manufacture of:	76.3	70.1
• metals	3.8	1.9
• metal products	7.8	7.7
• electric appliances	3.1	2.9
• equipment and machinery	6.0	3.7
• cars	5.2	5.7
• other transport equipment	1.8	1.5

The contribution of welding engineering in the generation of added value is diversified in individual sectors. Until today there has been no research performed relating to this issue. In spite of individual classification for given countries it is possible to use results from other countries as such data depict to what extent individual sectors of economy are related to welding engineering. According to Figure 4, in the US economy sectors, the highest share of welding engineering in the total labour costs is in heavy industry (15.97%) and in building engineering (13%).

In the case of aviation industry, electronics and automotive industry this share amounted to from 0.63 to 2.63% respectively. However, it should be emphasized that these sectors utilise the most advanced welding technologies and that progress made in structural materials and welding technologies can change such statistics. [1]

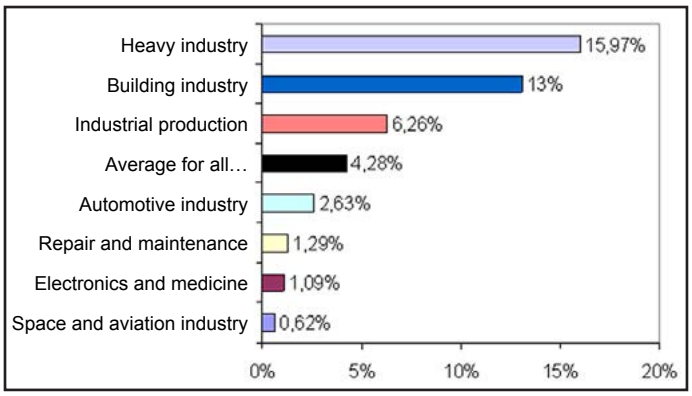

Fig. 4. Share of welding engineering in total labour costs in US economy [1]

According to research conducted in Germany, the share of welding technologies in the added value generated by "vehicle production" was 7.1%, that generated by metal structures amounted to 4.5%, and that generated by production of machinery was 1.8%. Without risking any major error such data can be referred to Polish conditions. It is estimated that, on average, 5% of gross added value generated by welding engineering-related sectors is contributed by welding technologies.[2]

Analysing the dynamics of production sold in 6 industry sectors using welding techniques leads to the conclusion that the economic downturn most significantly affected the sector named as "other transport equipment" (i.e. ships, railway and tram rolling stock etc.). Although, in comparison with 2009, this sector saw an increase in production in the years which followed, by 2012 the manufactures of equipment and machinery had failed to reach the sales volume of the base year of 2006. The sectors referred to as "manufacture of metal products" and "electric appliances", relatively slightly affected by the 2009 crisis, were in a comparatively good condition. (Fig. 5).

As opposed to other sectors of economy, if compared with 2008 in the crisis year of 2009 the production of steel structures decreased by 30 thousand tons only, i.e. less than in the next period of economic downturn of 2012, when year-to-year decrease amounted to approximately 50 thousand tons. Although the export of steel structures has not reached the most

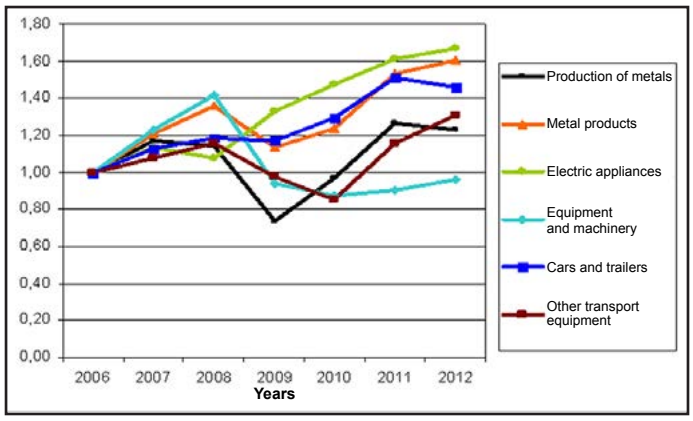

Fig. 5. Dynamics of production sold in 6 industry sectors utilising welding technologies. Year 2006 = 1

prosperous level of 2008, it is possible to observe that the sector is regaining its position in the market by successive production increase and positive price ratio of exported and imported structures in 2012. This observation is confirmed by data related to the production and export of steel structures, within which civil engineering structures, bridges, towers, masts, prefabricated steel buildings etc. are made of rolled products joined, among others, by means of welding technologies (Fig. 6 and 7).

The data presented in Figures 1, 5, 6 and 7 indicate that economic fluctuations are reflected

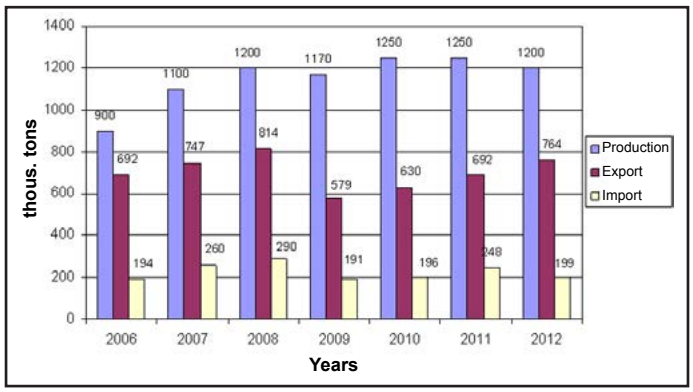

Fig.6. Production, export and import of steel structures in 2006-2012

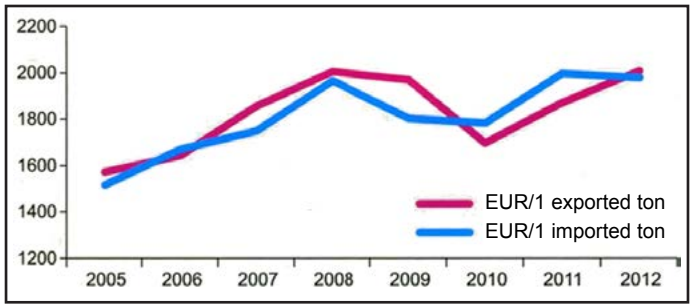

Fig. 7. Prices of exported and imported steel structures [3]

in all sectors analysed, with differences relating to their intensity and time. Quite frequently a decrease in one sector is compensated by a growth in another. For instance, the crisis which affected the production of transport equipment in 2010 was, to some extent, remedied by an increase in the sales of metal products, cars, trailers and semitrailers and of electric appliances. It is also necessary to emphasise the relatively high dynamics of the "metal products" sector, i.e. of the greatest user of welding technologies.

Relationships between the number of business entities and the value of production sold

Special attention should be paid to the relationships between the structure of companies as regards their number and the structure of production sold as such relationships indicate which companies generate the greatest value of sales. While analysing the 6 sectors as the whole, it is possible to notice, to some extent, the correctness of the Pareto principle, according to which the greatest volume of sales is generated by the smallest number of companies, where such companies are big. The value of production sold by 68% of companies employing up to 50 workers (the related data do not include companies employing up to 9 workers) makes up only 9% of the total sales of companies analysed. In turn, 7% of companies sell products, the value of which in the sales structure amounts to 70%. The value of production sold by 25% of companies employing between

Table 4. Structure of business entities in 6 sectors of industry using welding techniques according to the number of employed and to the value of production sold in 2012

Employment	Number of entities		Production sold	
	2006	2012	2006	2012
below 50*	67%	68%	9%	9%
from 51 to 250	26%	25%	21%	21%
above 250	7%	7%	70%	70%
	100%	100%	100%	100%

*Data refer to enterprises employing over 9 workers

51 and 250 workers amounts to 21%. As can be seen, the economic changes in the years 2006 – 2012 had no impact on the structure of companies in terms of employment and production sold (Table 4).

Detailed analysis of individual industry sectors related to welding engineering indicates that as regards the manufacture of metal products it is small and medium enterprises and not big companies that play a leading role as far as the value of production sold is concerned. In 2006 and 2012 the share of such companies in the volume of sales amounted to 66 and 64% respectively. In the years analysed an increase in the sales share for big companies from 34 to 36% and a decrease in the share related to the number of companies from 4 to 3% indicates a slight increase in production concentration in big companies (Table 5).

The sector referred to as "the manufacture of metal products" is one of the greatest users of welding technologies as well as of welding equipment, consumables and all types of services related to the production of welded structures and products (e.g. NDT, examination etc.).

Impact of economic fluctuations on the market of welding equipment and consumables

The fluctuations in economy were reflected in the production, export, import and demand for welding equipment and consumables. The economic downturn of 2009 affected mostly the national manufacturers of welding equipment and components, the production sold of which in 2009 fell in comparison with 2007-2008 by approximately 50%. A smaller, approximately 30% decrease affected the so-called market of welding equipment and components (production – export + import) as companies purchased both domestic and imported equipment (Fig. 8).

While comparing data presented in Figures 5 and 8 it is possible to notice that the sales dynamics in the sectors of industry utilising welding techniques does not directly translate to the dynamics of demand for welding equipment. As opposed to the slump of 2009, indicated by a significant decrease in demand, the economic upturn was not reflected in the dynamics of equipment purchase.

In fear of sales fall companies in the years which followed did not invest in new welding equipment. Consequently, the equipment market value of 2012 was lower by approximately 28% than that of 2006. For domestic manufacturers, a smaller demand for welding equipment was compensated by an

Table 5. Structure of production sold and the number of business entities in individual industry sectors related to welding engineering

Sector		SME		Big companies	
		Share %			
		2006	2012	2006	2012
Production of metals	Production sold	14	20	86	80
	Number of entities	85	89	15	11
Manufacture of metal products	Production sold	66	64	34	36
	Number of entities	96	97	4	3
Production of equipment and machinery	Production sold	42	49	58	51
	Number of entities	94	94	6	6
Production of electric appliances	Production sold	30	22	70	78
	Number of entities	89	88	11	12
Production of cars	Production sold	12	9	88	91
	Number of entities	86	77	14	23
Production of other transport equipment	Production sold	22	26	78	74
	Number of entities	85	85	15	15

increase in export, which in 2012 exceeded that of 2006 two times. In the years 2006 – 2012 the import of welding equipment remained stable, with fluctuations not exceeding 18% (Fig. 8).

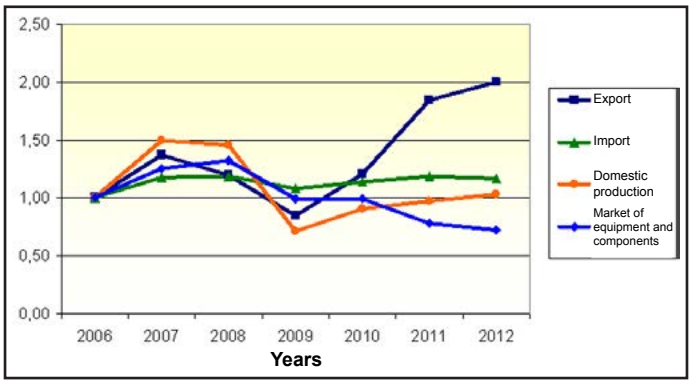

Fig. 8. Dynamics of production, import, export and market of welding equipment (market = production + export - import). Year 2006 = 1

The dynamics of electrode market shows that after 2010 the production and export of covered electrodes suffered from a decline. An increase in import did not compensate for such falls. As a result, the consumption of electrodes in 2012 was approximately 50% lower than that of 2006. The decrease in electrode consumption results from the number and types of welded structures (less welding on assembly due to investment reductions) as well as from the general tendency to replace MMA welding with welding utilising solid wire electrodes or flux-cored wires (Fig. 9).

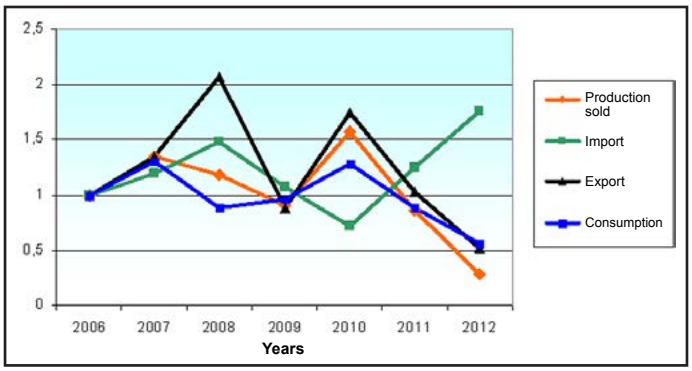

Fig. 9. Dynamics of covered electrode market according to mass. Year 2006 = 1

The market of flux-cored wires reacted to economic downturn both in 2009 and 2012. However, the increase in production and export as well as the growing tendency of flux-cored wire consumption in the years 2009 –2012 should be viewed with optimism (Fig. 10).

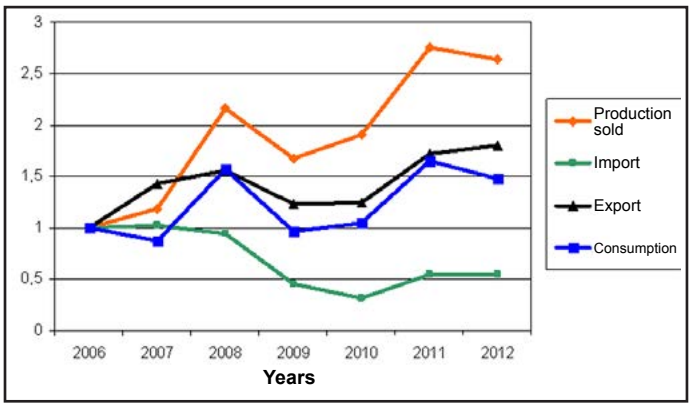

Fig. 10. Dynamics of flux-cored wire market according to mass. Year 2006 = 1

The diagrams presenting the data related to the market of covered electrodes and flux-cored wires indicate that in the period of economic fluctuations entrepreneurs respond to demand for welding consumables otherwise than they do in terms of welding equipment. An economic downturn-triggered decrease in demand for welding consumables was not as deep as that related to welding equipment. Enterprises do not need to invest in new equipment, yet they have to purchase wires and electrodes to joint elements making a commissioned and designed structure.

In the future the use of welding consumables may not indicate the scale of welding technologies application as modern methods such as laser welding, electron beam welding etc. enable joining elements without using welding consumables.

Summary

Welding engineering, due to its scale, significantly affects the national economy. More than 40 various welding methods and approximately 100 variants of these methods find applications in the production of welded structures and in the manufacture of welded products in over 100 industries of the Polish economy. Industrial processing includes 24 industry sectors out of which 6 (i.e. the manufacture of metals,

metal products, equipment and machinery, cars, trailers and semitrailers, other transport equipment and electric appliances) consume approximately 95% of rolled products. These products are processed into finished goods using, among others, welding technologies in approximately 8 thousand companies representing industry and building engineering. It is estimated that, depending on the economic situation, welding sector employs between 120 and 180 thousand workers.

Conclusions

1. The market fluctuations of 2006-2012 were reflected in the welding industry; their indicators being, among others, changes in the consumption of rolled products, number and structure of companies using welding techniques, value of production sold and that of production added as well as demand for welding equipment and consumables.

2. In the crisis year of 2009 the consumption of rolled products processed into finished goods by means of, among others, welding techniques fell by 36% in comparison with 2007. In spite of the economic revival of 2010-2011 the consumption did not reach the base level of 2006. The reason for this was another economic downturn of 2012.

3. In the years 2006-2012 the consumption of rolled products rose in 3 out of 6 economic sectors, i.e. in the manufacture of metal products from 34.8% to 42,2%, in the production of cars from 3.4% to 3.9% and in the production of electric appliances from 0.6% to 0.9%. These sectors are characterised by greater resistance to economic fluctuations and by high sales growth dynamics.

4. The manufacture of metal products and the production cars, trailers and semitrailers have the greatest, among 6 sectors analysed, share in the gross added value generation structure. In 2012 this share amounted to 7.7% and 5.7% respectively.

5. In 2006-2012 the number of business entities in 6 industry sectors grew by 200. In terms of employment the structure of companies did not change. Small and medium enterprises (employing up to 250 workers) made up 93%, whereas big companies (with employment exceeding 250 workers) constituted 7% of the total number of companies.

6. As regards the manufacture of metal products (as opposed to other sectors analysed), it is SMEs, and not the big companies, that played the leading role in the size of production sold. The share of SMEs in the sales structure amounted to 66 and 64% in 2006 and 2012 respectively.

7. The periods of economic downturn particularly severely affected the demand for welding equipment. As regards welding engineering the sales dynamics increase in 6 most important industry sectors did not translate to growing demand for welding equipment. In 2012 the value of welding equipment market did not reach the level of 2006.

8. The dynamics of flux-cored wire consumption is on the increase. The consumption of covered electrodes is fluctuating, yet a falling tendency can be observed.

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