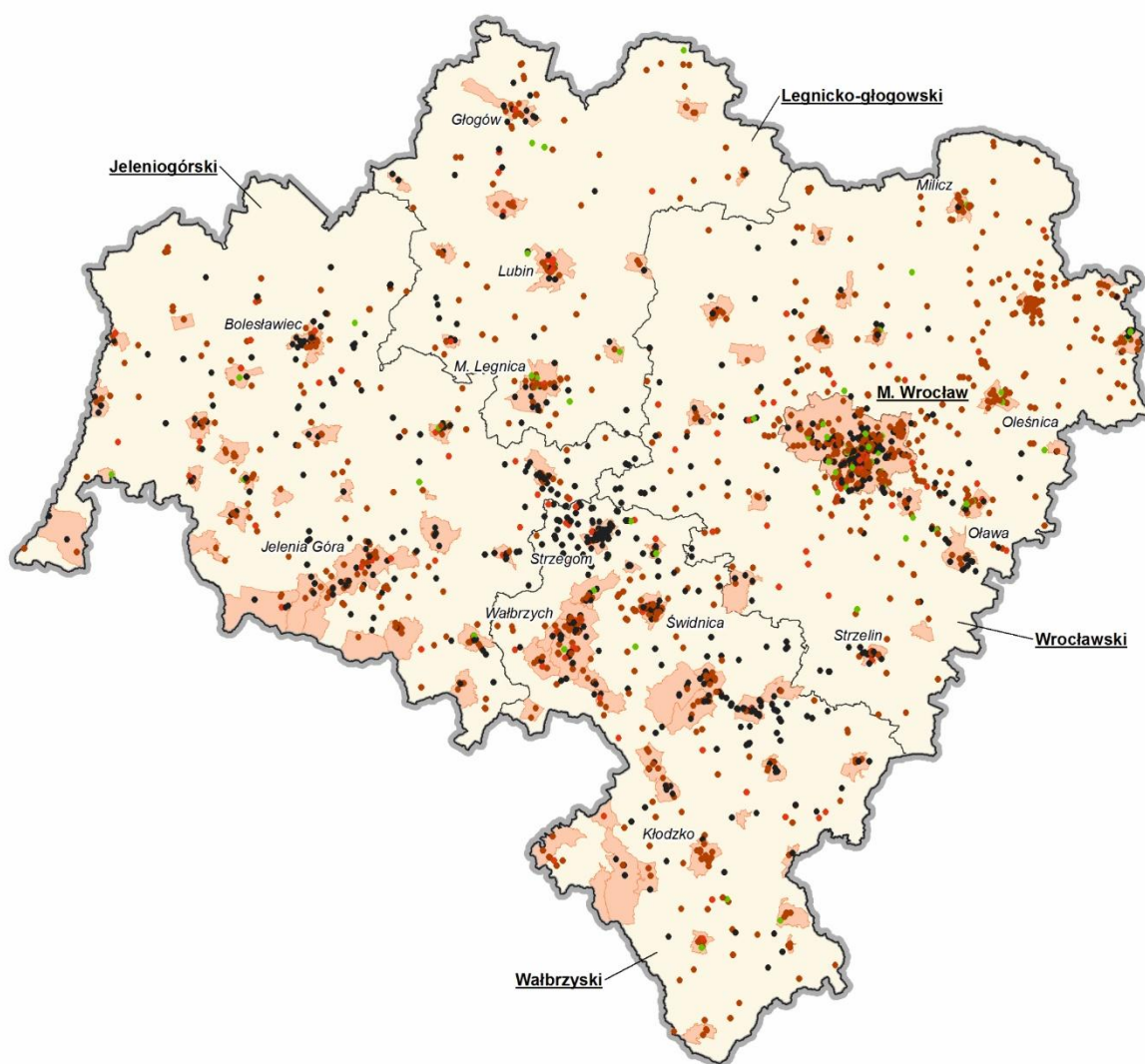


Diagnoza oraz trendy rozwojowe dolnośląskiej inteligentnej specjalizacji surowce naturalne i wtórne

RAPORT KOŃCOWY



ekovert Łukasz Szkudlarek
na zlecenie
Urzędu Marszałkowskiego Województwa Dolnośląskiego



Mapa zamieszczona na okładce przedstawia lokalizację przedsiębiorstw poszczególnych podbranż DIS surowce naturalne i wtórne

Zespół autorów:

Prof. Andrzej Solecki

Mgr inż. Łukasz Szkudlarek

Mgr inż. Wiktoria Ryng-Duczmal

Mgr Waldemar Bernatowicz

Mgr Anna Jagiełło

Mgr Iwona Filipowska

Mgr Damian Marciniak

Eksperti branżowi:

Dr inż. Stanisław Ślusarczyk – Politechnika Wroclawska

Dr hab. inż. Jacek Szczepiński - Poltegor Instytut

Dr inż. Katarzyna Tokarczyk - Dorociak - Uniwersytet Przyrodniczy we Wrocławiu

Dr inż. Gabriel Czachor - Uniwersytet Przyrodniczy we Wrocławiu

Mgr inż. Jacek Major - Koordynator Klastra Kamieniarskiego

Mgr inż. Krzysztof Skolak – Prezes fundacji Bazalt

inż. Michał Firlej – właściciel firmy StoneConsulting

Table of contents

TABLE OF CONTENTS	3
1. ABSTRACT.....	7
2. OBJECTIVE OF THE STUDY AND ADOPTION OF METHODOLOGY.....	9
2.1. OBJECTIVE OF THE STUDY	9
2.2. INITIAL ASSUMPTIONS	9
2.3. RESEARCH METHODOLOGY	10
3. CHARACTERISTICS OF THE INDUSTRY.....	14
3.1. SUB-INDUSTRIES OF DIS NATURAL AND SECONDARY RAW MATERIALS AGAINST POLAND, EUROPE AND THE WORLD.....	14
3.1.1. MINING AND PROCESSING OF MINERAL RESOURCES SUB-INDUSTRIES.....	14
3.1.2. RECOVERY AND RECULTIVATION SUB-INDUSTRY	43
3.1.3. WOOD PROCESSING SUB-INDUSTRY	45
3.1.4. ADVANCED MATERIALS SUB-INDUSTRY	50
3.1.5. IDENTIFICATION OF KEY FACTORS AND BARRIERS TO THE DEVELOPMENT OF THE INDUSTRY;.....	51
3.1.6. ANALYSIS OF COMPETITIVENESS RELATIVE TO THE REMAINING PART OF POLAND AND THE EUROPEAN UNION	53
3.2. ECONOMIC POTENTIAL.....	55
3.2.1. NUMBER AND LOCATION OF COMPANIES AND EMPLOYMENT STATUS	56
3.2.2. THE INNOVATIVE POTENTIAL OF THE REGION	63
3.2.3. EXPORT OF GOODS AND SERVICES.....	70
3.2.4. ANALYSIS OF FORECASTS AND DEVELOPMENT TRENDS IN SUB-AREAS OF THE SPECIALISATION OF THE NATURAL AND SECONDARY RAW MATERIALS;	73
3.3. IDENTIFICATION OF THE DEVELOPMENT NICHES IN THE SPECIALISATION SUB-AREAS	78
4. INSTITUTIONS SUPPORTING THE INDUSTRIES	82
4.1. SCIENTIFIC AND RESEARCH UNITS OPERATING IN THE NATURAL AND SECONDARY RAW MATERIALS SECTOR... 82	
4.1.1. DESCRIPTION OF UNITS	82
1.1.1. RESEARCH AND FINANCING OF RESEARCH	86
1.1.2. COOPERATION WITH ENTREPRENEURS AND FACTORS THAT INHIBIT AND ENCOURAGE COOPERATION BETWEEN ENTREPRENEURS AND SCIENTIFIC RESEARCH UNITS	87
1.2. CLUSTERS.....	88
1.1.1. DESCRIPTION OF EXISTING CLUSTERS AND THEIR STATUS.....	88
1.1.2. FINANCING OF CLUSTERS	91



1.1.3. IDENTIFICATION OF PROBLEMS.....	91
1.2. ANALYSIS OF THE EFFECTIVENESS OF PUBLIC INTERVENTION	91
1.2.1. THE USE OF BUSINESS SUPPORT BY SMART SPECIALIZATIONS.....	92
1.2.2. INTEREST IN SUPPORT IN THE CURRENT PERSPECTIVE	97
1.2.3.	99
1.2.4. INDICATION OF POSSIBLE SUPPORT SCHEMES	100
2. INNOVATION POTENTIAL IN THE INDUSTRY	105
2.1. TYPES OF INNOVATION AND THEIR RANGE	105
2.2. EXPENSES OF ENTERPRISES FOR RESEARCH AND DEVELOPMENT	109
2.3. EMPLOYEE POTENTIAL	111
2.4. PATENTS AND TRADEMARKS	113
2.5. FINANCING INNOVATION BY ENTREPRENEURS.....	115
2.6. PLANS FOR THE DEVELOPMENT OF INNOVATIVE PRODUCTS AND SERVICES	116
3. IDENTIFICATION OF FACTORS OF SMART SPECIALISATION SECTOR OF NATURAL AND SECONDARY RAW MATERIALS	120
3.1. EVALUATION OF THE IMPACT ON THE DEVELOPMENT OF THE ENTITIES OPERATING IN THE NATURAL RESOURCES INDUSTRY	120
3.2. IDENTIFICATION OF THE MICRO- AND MACRO-ENVIRONMENT FACTORS BASED ON THE CATI RESEARCH	130
3.3. INTERCONNECTION OF THE FACTORS - THE CROSS ANALYSIS OF THE IMPACTS	131
3.4. SWOT ANALYSIS	135
3.4.1. STRENGTHS.....	136
3.4.2. WEAKNESSES	137
3.4.3. OPPORTUNITIES	139
3.4.4. THREATS	140
3.4.5. SUMMARY OF THE SWOT ANALYSIS FOR THE MOST LIKELY SCENARIO	142
3.4.6. SUMMARY OF OTHER ADOPTED SCENARIOS.....	144
4. SIGNIFICANT CONCLUSIONS FROM THE RESEARCH	146
5. WYKAZ TABEL, RYSUNKÓW I WYKRESÓW.....	151
6. LITERATURA	155
ZAŁĄCZNIK 1. WYBRANE WYNIKI BADANIA CATI	157
ZAŁĄCZNIK 2. PKD WYBRANYCH PODBRANŻ WYTYPOWANYCH DO BADANIA CATI	187



**ZAŁĄCZNIK 3. WSKAZANIE UWZGLĘDNIENIA W TEKŚCIE ROZWIĘCIA POSZCZEGÓLNYCH
PROBLEMÓW BADAWCZYCH190**

LIST OF ABBREVIATIONS:

BDOO	Database of general geographic objects
BGSMPiŚ	Balance of mineral resources management in Poland and the world
BZK	Balance of mineral resources in Poland
CODGIG	Central center of geodetic and cartographic documentation
DAWG	Lower Silesian Agency for Economic Cooperation
DIS	Lower Silesian Smart Specialization
FAO	United Nations Food and Agriculture Organization
GUS	Central Statistical Office
INB	Research Institutions
IT/ICT	Information technology / information and communication technologies
OSM	Open Street Map
PIG	State Geological Institute
PKD	Polish Classification of Activities 2007
PRG	State register of borders and units of territorial divisions in the country
RDOŚ	Regional Directorate for Environmental Protection
RPO WD	Regional Operational Program of the Lower Silesian Region
USGS	United States Geological Survey

1. ABSTRACT

The natural and secondary raw materials industry is one of the six key development areas of the Lower Silesian Region. Due to the fact that in the economic structure of the region, the mining and raw materials sector definitely distinguishes Lower Silesia against the background of other Polish regions and also the potential for development of this sector was recognized as Lower Silesia Smart Specialisations (Polish: DIS).

This is justified in terms of extraction of rock raw materials (in the years 2001-2012 the largest in the country extraction of broken stones and secondary rocks, second place in the country in terms of extraction of gravel and sand, high position in the field of clay extraction). The DIS sector also included the wood sector (due to the region's great woodlands and the potential of the paper and furniture industries). Furthermore, the subject of smart specialisation includes advanced materials, which is connected with the fact that Lower Silesia is an important national research and development centre in this field.

In the process of implementation of the “Regional Innovation Strategy for Lower Silesian Region for the years 2011-2020” and the “Strategic Frames for Smart Specialisation in Lower Silesia”, the Marshal Office of the Lower Silesian Region (UMWD) monitors and updates the mentioned documents. Diagnostic and trend researches are carried out for this purpose.

The main research areas included in the analysis were: the diagnosis of Lower Silesia intelligence and the identification of trends and development niches. The results of the analyses included, inter alia: description of the main determinants of economic development, characteristics and history of the industry, assessment of the development of entities, evaluation of the level of innovativeness, macro- and micro-analysis, analysis of key factors and barriers to the development of the industry, analysis of effectiveness of public intervention. Then one searched for answers to the question of which support schemes would increase the competitiveness and innovation of DIS companies in the natural and secondary sectors the most effectively.

In the research, a variety of synthesis methods and data sources are applied. The following research techniques were used: desk research, individual in-depth interviews, telephone interviews, spatial analysis (GIS), scenario analysis (SWOT analysis), panel of external industry experts, cross-impact analysis. The secondary data research and information obtained during CATI and IDI surveys covered the period from 2000.

Due to the large differences between the various sectors covered by the DIS Natural and secondary raw materials, the research was divided into the following sub-sectors: mining, mineral processing, wood processing, recovery and reclamation, advanced materials. As far as possible, they were analysed and described separately.

The carried out analyses of statistical data obtained from the carried out interviews with entrepreneurs gathered during the panel of experts allowed to formulate conclusions which implementation should contribute to increase the competitiveness and innovativeness of companies with DIS Natural and secondary raw materials.

One identified **large thematic diversity of all branches of the economy within DIS Natural and secondary raw materials**. DIS currently involves a large range of diverse sectors between which there is no relationship of technology and materials, there are differences in the needs of individual companies. This hinders the effective support management. Consideration should be given to distinguishing individual specialities for the wood sub-sector and for advanced materials, as well as natural and secondary raw materials and machines producers included in DIS.

Attention was drawn to the **insufficient promotion** of DIS industry, natural and secondary raw materials and companies, as well as related events and the need for greater **support for exports at the national level**.

A significant barrier to the development is **Lack of appropriate courses of education in some sub-sectors of specialisation in the region of Lower Silesia at all levels**. This applies to secondary and higher education in the wood and stone industries. It was recognised that it is important to develop the regional strategy to promote education and training. Education deficiencies are connected to **poor availability of workers at all levels of specialisation**. The results of this research confirm large problems of entrepreneurs in obtaining specialised workers.

The research showed that DIS Natural and secondary raw materials involves **Relatively low scale of new innovations**. This is mainly due to the fact that Lower Silesia companies are still in the development stage in the field of machines and new technologies, and their first step is to implement innovations in the company scale. Only the alignment of the development opportunities will allow Lower Silesia companies to implement international innovations.

Another obtained and presented conclusion is **low interest in conducting business research and development**. Only the “operations” and “raw materials processing” sub-industries have entrepreneurs (low number) who invest in carrying out research and development. This significantly influence on a low number of patent applications.

One of the recommendations is to create a real platform for cooperation between representatives of the region, research institutions and entrepreneurs, as well as support and promote raw materials coming from the region (strongly underlined competition risk with cheaper imported raw materials and lack of clear guidelines on the application of the project documentation, indicating the use of natural resources of the regional origin).

The report also outlines recommendations for improving the efficiency of public funds to increase the innovation performance of DIS Natural and secondary raw materials. They relate to inter alia: the differentiation of support forms depending on the size of the company, starting of competitions for the development strategies of IOB for particular industries, reduction of interest rates and extension of the repayment period of repayable financial instruments as well as consideration of regional innovation loans, developing vouchers for innovations.

2. OBJECTIVE OF THE STUDY AND ADOPTION OF METHODOLOGY

2.1. Objective of the study

The main objective of the study is to acquire knowledge for the process of monitoring and updating the "Regional Innovation Strategy for the Lower Silesian Region 2011-2020" (RSI WD 2011-2020) and the "Strategic Framework for Smart Specialization in Lower Silesia" in the field of diagnosis and development trends of the "natural and secondary raw materials" Lower Silesia Smart Specialization.

2.2. Initial assumptions

The region's economic structure undoubtedly distinguishes Lower Silesia against the background of the remaining Polish voivodships - the mining and raw materials sector. By analyzing the volume of rock raw materials in the years 2001-2012, Lower Silesian Region occupies the first place among all voivodships in Poland with the largest extraction of broken stones, side rocks and the production of regular elements and the second place in the extraction of gravel and sand. They are the basic raw material in road and rail construction as well as in cubature construction. Lower Silesian Region's mining is also dominant in mining of clay raw materials of construction ceramics, stoneware ceramic clay, refractory aluminum, whitewash and kaolin raw materials. Between 2001 and 2012 it was the only operator in the country of quartzite shale, slate, bentonite, feldspar, refractory quartzite, quartzite. It is worth emphasizing that 95% of all resources in the magmatic and metamorphic fields are located in Lower Silesia. The region is also rich in thermal and healing waters, including unique radon sources, used in the spa and balneology. Lower Silesia is also a strong research center for advanced materials and nanotechnology.

In addition, regional wood is used, among others. in the paper and furniture industry. It is worth adding that the forests in the Lower Silesia region cover an area of about 540 thousand. ha and the area of all forests of Lower Silesia in relation to the total area of the region (i.e. the forest of the region) is nearly 29%. This value corresponds to the average for the whole country.

In view of the above, the natural and secondary raw materials industry was identified as one of the six key development areas of the Lower Silesian Region, identified as Lower Silesian smart specializations. In addition to identifying areas of smart specialization that is an ex-ante condition for the First Priority Axis of ROP WD 2014-2020, this study is part of monitoring and updating areas of smart specialization as part of the financing of the expertise and analysis necessary for the functioning of the ROP WD 2014-2020.

One of the important elements influencing this study was the fact that Lower Silesian smart specialization of natural and secondary raw materials has a very wide range. Its composition outside the area of acquisition, processing and utilization of natural (mineral) and secondary raw materials is further enhanced by the sectors dealing with advanced materials (nanotechnology, composites) and wood extraction and processing.

Such a wide range of disciplines found in DIS, both natural and secondary, which, in addition, have no technological, material and economic linkage, have led to difficulties in carrying out the study. Specific recommendations for the whole DIS could not be identified because of its diversity and specific factors, sometimes quite different depending on the particular DIS subgroup.

It should be added that in the document "Strategic Framework for Smart Specialization in Lower Silesia" indicated the strengths and weaknesses of DIS and the opportunities and threats to its development. However, all these factors relate to the extractive industry and to the processing of mineral resources without the other two sub-areas of specialization.

In addition, during the IDI studies conducted by the Advanced Materials and Woodworking Industry, there was a great deal of confusion regarding the link between their industry and the DIS and natural resources.

Mining and processing of raw materials mainly depends on raw materials that are non-renewable and their location is independent of the human. The wood processing industry depends on the availability of raw materials such as wood, which is located in greater or lesser extent throughout Poland, its sources are renewable and the location and scale of the acquisition depend on the will of man. The advanced manufacturing and processing industry, in turn, is dependent on the availability of advanced know-how, the availability of qualified staff, and the research infrastructure - and there are no localization or raw material limitations. Advanced materials such as composites, nanostructures, micropowders can be formed both from the processing of mineral raw materials and plastics such as polymers. Both mineral mining and timber extraction and the use of advanced materials are based on completely different external conditions. They require different technologies, completely different human resources (ie human resources), they are characterized by different recipients. In principle it is difficult to find common elements that would affect the legitimacy of placing them within one smart specialization .

One of the key conclusions of the preparation phase of the study is that the differences between the DIS and natural resources industries are so large that they can not be considered together. In view of the above, the Report attempts, as far as possible, to describe them separately.

For the purpose of this study, the division of DIS into subculture was assumed:

- Mining (in operation),
- processing of mineral raw materials,
- wood processing,
- recovery and reclamation,
- advanced materials.

The detailed breakdown of enterprises into individual sub-branches is included in Annex 2.

2.3. Research methodology

The main goal of the study is to acquire knowledge for the monitoring and updating process of the "Regional Innovation Strategy of the Lower Silesian Voivodship for the years 2011-2020" (RSI WD 2011-2020) and "Strategic Framework for Smart Specializations of Lower Silesia" in the diagnosis and development trends of the Lower Silesian smart specialization "natural and secondary raw materials".

The goal was to seek answers to research problems in the research areas listed below:

I. Diagnosis of Lower Silesian smart specialization - natural and secondary raw materials.

1. The main determinants of economic development of Lower Silesia and characteristics of smart specialization sector - natural and secondary raw materials (e.g. total export value per one employee PLN, share of revenues from sales of innovative products for export in total revenues of industrial companies, gross value added per 1 employee in thous. PLN), average share of innovative companies in the total number of companies, share of revenues from sales of innovative products to the market in total revenues of industrial companies, value of the internal R&D expenditure as % of the GDP, share of the R&D expenditure financed by the companies sector in expenditures on the R&D activity in total, participation of the R&D in the working population, patents granted to national inventions per 1 million inhabitants, percentage of companies cooperating in the field of innovative activity in general innovative companies, concentration of companies involved in the natural and secondary raw materials (also by location factor), scientific potential (location factor for patents granted), number and quality of clusters in the field of specialization);
2. The history of the Lower Silesian industry against the background of the history of industry development in Poland and Europe (2000-2016);
3. Assessment of the development status of the entities of Lower Silesian smart specialization, the natural and secondary raw materials industry in the context of Poland and the European Union on a global scale;
4. Assessment of the innovation level of companies representing the “natural and secondary raw materials” industry, including the specification of:
 - 4.1. Types of innovation in the companies in the past 10 years and their range;
 - 4.2. Companies expenses in the R&D;
 - 4.3. Size and characteristics of employment, including the employment of high-end professionals (also by location factor);
 - 4.4. Internationalization of the companies in the “natural and secondary raw materials” sector including size, dynamics and concentration of exports (also by location factor);
 - 4.5. Intellectual property protection activities, number of patents and trademarks (submitted, registered);
 - 4.6. Scope and methods of financing innovation by the companies;
 - 4.7. Business plans for the development of innovative products and services;
 - 4.8. Analysis of micro- and macro-environment factors;
5. Analysis of the key factors for the success of innovative industry development in the region;
6. Analysis of the competitive position of the industry in relation to Poland and regions of the European Union;
7. Analysis of the attractiveness of the industry development for Lower Silesia;
8. Analysis of the R&D institutions “Natural and secondary raw materials” (size and status of the research and development units operating in the studied area in Lower Silesia, human resources, achievements and scientific position, offer for the companies in the industry, transfer of knowledge and technology to the industry, cooperation between the companies in the industry and the research and development units, identification of new areas of business cooperation with the R&D sector);
9. Analysis of key factors and barriers to the development of the industry;
10. Analysis of the effectiveness of public intervention in the area of smart specialization (based on, inter alia, the percentage of the companies that increased the value of exports as a result of implemented intervention, the percentage of supported companies which showed for the first

time expenditures on the R&D as a result of the implemented intervention, the number of patents submitted as a result of intervention, the number of supported clusters, cluster initiatives and co-operation relationships, the number of applications for national programs (in terms of: innovation, R&D, internationalization, clusters), the number of the companies supported by the R&D work, the number of companies supported in the internationalization of business, the number of companies supported in the implementation of the R&D results).

11. Indication of possible support schemes for the entities of Lower Silesian smart specialization, the natural and secondary industries to increase their competitiveness and innovativeness.
12. Identification of significant industry problems in view of the impact on the state of its current level of development and competitiveness;
13. Assessment of the influence of spatial conditions on the development of entities operating in the natural raw materials sector.

II. Trends and niches of Lower Silesian smart specialization - natural and secondary raw materials.

1. Analysis of forecasts and development trends in sub-areas of the specialization of the natural and secondary raw materials in Poland and Europe;
2. Analysis of the correlation between directions of development of the industry in Lower Silesia and Poland and Europe;
3. Analysis of the factors (opportunities) that will foster the development of industry innovation
4. Analysis of the factors (threats) that will be barriers to the development of the industry innovation;
5. Identification of the development niches in the specialization subdivisions.
6. Korelacja pomiędzy zjawiskiem eksploatacji surowców naturalnych, a powstawaniem odpadów eksploatacyjnych pobudzającym potrzebę i możliwość wykorzystania surowców wtórnych (np. żelazny most, hałdy pokopalniane).

Each of the research areas was subject to analysis, which was a synthesis of various methods and data sources. Examinations of the existing data and information obtained during the CATI and IDI surveys covered the period from 2000. For the needs of the research, the following research techniques were used:

Secondary data analysis - desk research (DR) - consisted in collecting and analyzing data and programming documents related to the research area in question. An important source of secondary data turned out to be a review of literature, enabling authors to optimally use the experience gathered during previous research work for the research area. The list of data is presented in chapter 9 of the study.

Individual in-depth interviews (IDI) consisted of a conversation conducted by a qualified expert with a selected interlocutor with knowledge of the analyzed research area. The data collected in this way was of qualitative character allowing to build or verify research theses. This method allowed to obtain in-depth knowledge about the research area.

Telephone interviews (CATI - Computer Assisted Telephone Interview), in this study were the basic research method with the largest assumed size of the research sample. The goal of Telephone Computer Interviews was to obtain information from respondents helping to get answers to the survey questions. In specific cases, the same CAWI method was used as a complement to the CATI method. In this method, the participants of the survey received a link to the questionnaire on the project website prepared by the Contractor.

Spatial analysis (GIS) has been used as a tool to present and analyze the spatial diversity of the processes and phenomena studied and the spatial correlation of different levels of data.

Scenario method (trend analysis) based on SWOT analysis. Thanks to its application, it was possible to diagnose factors affecting the area of Lower Silesian specialization - natural and secondary raw materials as well as the assessment of needs and trends for the studied area, which is within the scope of at least a few problems examined. SWOT analysis determined strengths (strengths), weaknesses (weaknesses), opportunities (potential or ambient opportunities), threats (probable or existing threats in the environment).

Panels of external industry experts (EP) have been organized in such a way as to discuss and look for answers to particular research problems (problems No. 1.5, 1.9, 1.11, 2.1, 2.3, 2.4, 2.5) and ensure that experts evaluate the concept of research, the results of existing data analysis and Final report. The effect of panels of experts are reports from ongoing meetings which constitute an attachment to the final report.

Cross-analysis of impacts (KAW) which was supported by an expert panel was used to assess the interaction of numerous groups of various factors affecting the development of innovation in enterprises. By examining the existing relationships between a set of seemingly unrelated events and trends, the internal consistency of the problems analyzed was increased. Based on a cross analysis of receipts, the factors that have the greatest impact on the other, and thus on the development of innovation in the natural and secondary raw materials sector, have been selected.

3. CHARACTERISTICS OF THE INDUSTRY

Natural raw materials are the basis for the development of a significant part of the Polish, European and world industry. As it is known, the ultimate purpose of the industry is to provide consumer goods to meet the human needs. The raw material companies rarely supply consumer goods, and their final product is usually the raw material for the entire chain of companies producing final products. This frequent self-limitation causes a significant proportion of added value to be produced in the companies using final products of the raw materials industry for trade and production of consumer goods. While self-limitation is understandable for organizational reasons on a company scale, it is desirable for the region to develop highly advanced processing companies to produce consumer goods. An extreme example of such a policy (which is commonly condemned in the international forums) is the Chinese export embargo on rare earths and the desire to export only highly processed products.

Lower Silesia has a number of natural mineral resources, due to its geological structure, which enable the development of mining, mineral processing and production industries. Companies limited to mining are generally small gravel and sandy plants, as in larger plants this usually results in at least initial processing (sorting of minerals). However, these products are often sold on the local market as consumer goods. The most advanced processing of mineral resources takes place in the case of plants exploiting construction ceramics, since their final product like bricks, tiles, etc. is just a consumer good. A similar situation exists for brown coal where both the mine and Turoszów power plant belong to PGE Górnictwo i Energetyka Konwencjonalna S.A. providing electricity as a final product, which is also a consumer product to a large extent. In addition, extracted Lower Silesia natural gas after pre-processing has a large part of the status of a consumer good. The region's largest mining company, i.e. KGHM, occupies an intermediate position, because its products are not consumer goods.

3.1. Sub-industries of DIS Natural and secondary raw materials against Poland, Europe and the World

3.1.1. Mining and processing of mineral resources sub-industries

(I.2) The history of the Lower Silesia industry against the background of the history of industry development in Poland and Europe (2000-2016);

(I.3) Assessment of the development status of the Lower Silesia smart specialisation, the natural and secondary raw materials industry in the context of Poland and the European Union on a global scale;

Due to the abundance of surface deposits occurring in the Sudetes, the extraction of metals in Lower Silesia dates back to the prehistory. The first mining operations in the area of Złoty Stok were probably already carried out 4000 years ago, and the first record on the mining in the area dates from 1273. The oldest traces of extraction in the Kaczawskie Mountains of such metals as gold,

silver, lead, copper, iron, tin date back to the 5th-6th century. The organized gold extraction in the area of Złotoryja was started in the 12th century, in the time of King Bolesław Wysoki. The Silesian Piasts favoured immigration of mining professionals from Western Europe, including mainly from Germany and the areas of present Belgium.

The annexation of Silesia by Prussia at the dawn of the industrial revolution connected with the efficiency of the organization of the Prussian State led to intensive development of mining in old mining districts. However, no significant new discoveries were made during this period. It was not until after World War II that the Polish geologists (Jan Wyżykowski and Józef Zwierzycki) made the discovery resources of large copper deposits in the region of Lubin and Polkowice.

The extraction of copper, silver and associated metals (Ag, Au, Re, Se, Zn, Pb, and platinum) by Lower Silesia KGHM became one of the major sources of Polish income in the 21st century. Among these metals, Cu, Ag and Re were the most prospective for the development of smart specialisations. Therefore, more detailed data are presented for these metals. It should be noted that the omission of other metals does not mean that they cannot be the basis for the development of smart specialisations. However, the mentioned three minerals (Cu, Ag, Re) provide KGHM with a strong position on the world scale, and will decide to continue mining in the Lower Silesia mines. The gold and platinum market is heavily dominated by the enormous production of South Africa and Russia, and the Lower Silesia extraction does not have global significance.

The basis KGHM deposits are localized in the pre-Sudetes area (North-South synclinorium and Fore-Sudetes monocline). At the end of 2015, the balance resources in 15 identified deposit areas were 1976 million tonnes of deposits, including 35.57 million t Cu and 107.47 thousand tonnes of silver (BZZK 2015). The average Cu content is 1.84% and Ag52.5 g/Mg (<http://kghm.com/pl/biznes/wydobycie-i-wzbogacanie>).

In 2015, KGHM Polska Miedź S.A. extracted 31.57 million tonnes of deposits with a content of 1.52% Cu and 44.6 g/t Ag (BZZK2015), totalling 479 thousand tonnes of metallic copper (BZZK2015), from which 574.3 thousand tonnes of electrolytic copper were produced, including 420.5 thousand tonnes from own concentrates and 153.8 thousand tonnes from foreign concentrates. In addition, one produced 1 200 t Ag (<http://kghm.com/pl/biznes/produkty/metale-szlachetne#srebro>) 2 703 kg of gold and 9.17 t of rhenium, both from own deposits, as well as from foreign concentrates (BZZK2015).

According to BGSMPiS2013: copper deposit is accompanied by a whole range of precious metals: Ag, Au, As, Pb, Zn, Ni, V, Mo, Se, Re, platinum group, among which, the following are recovered: Ag, Au, Pb, Se, Ni in the form of sulphate, palladium and platinum sludge, metallic rhenium and ammonium perrhenate. At the end of 2013, the resources of these elements amounted to: Ag - 103182 t, Pb - 1548600 t, Co - 121500 t, Ni - 56380 t, V - 139110 t, Mo - 68710 t, Zn - 320290 t. The resources of rhenium, selenium and platinum were not estimated.

According BZZK2015, the following are recovered from the national deposits: Ag, Au, Ni, Pb, Pt-Pd, sulphuric acid is an additional by-product. The recovery of silver is the most important for the economy. According to the information of KGHM Polska Miedź S.A. quoted in BZZK2015 in 2015, one produced the following from copper deposits extracted by the company: 1 283 tonnes of silver, 431



kg of gold, 29 thousand tonnes of lead, 2.97 thousand tonnes of nickel, 86.98 t of selenium, 137 kg of Pt-Pd concentrate, sulphuric acid and copper sulphate.

The world production of refined copper from the second half of the 20th century shows a steady upward trend. The basis of this growth involves traditional mining, although since the eighties of the last century, the electrochemical method SX/EW has been more and more important, consisting in chemical leaching and subsequent refining by electrolysis. A part of this product is obtained from the secondary sources (recycling).

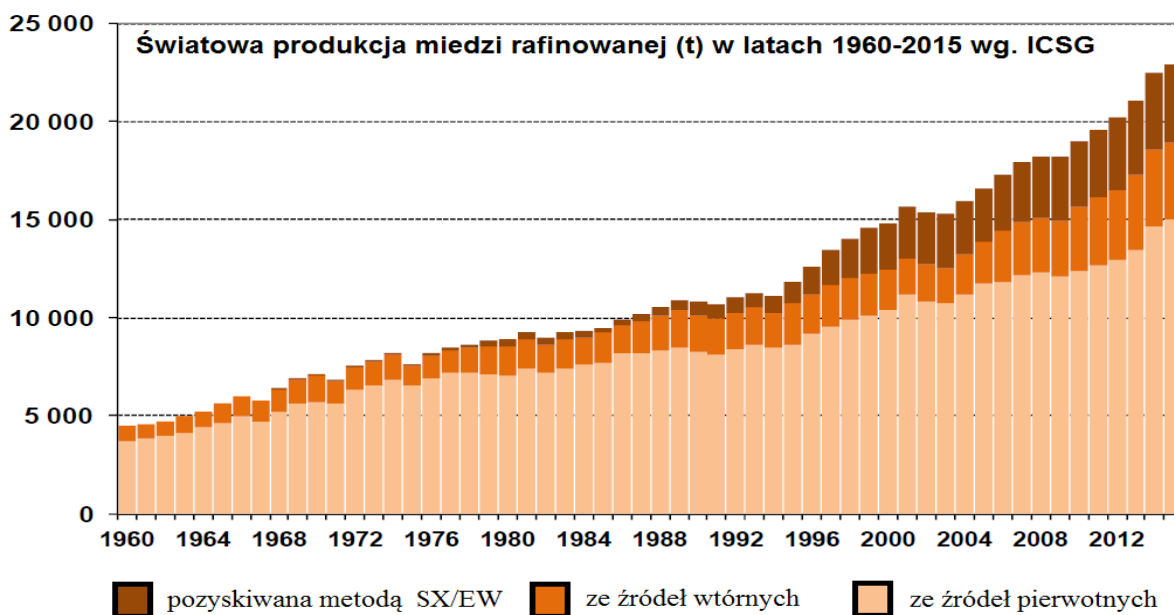


Chart 1 World production of refined copper by the report of ICSG Copper World Factbook 2016

In the 21st century, both the price and copper resources showed strong fluctuations. After a sharp decline in copper prices at the end of 2008, due to the demand of the Chinese economy, consumption (and prices) increased by 2.5 million tonnes/year. In the period of 2009-2013, they contributed to the increase of listing, and the shortage of metal on the market.

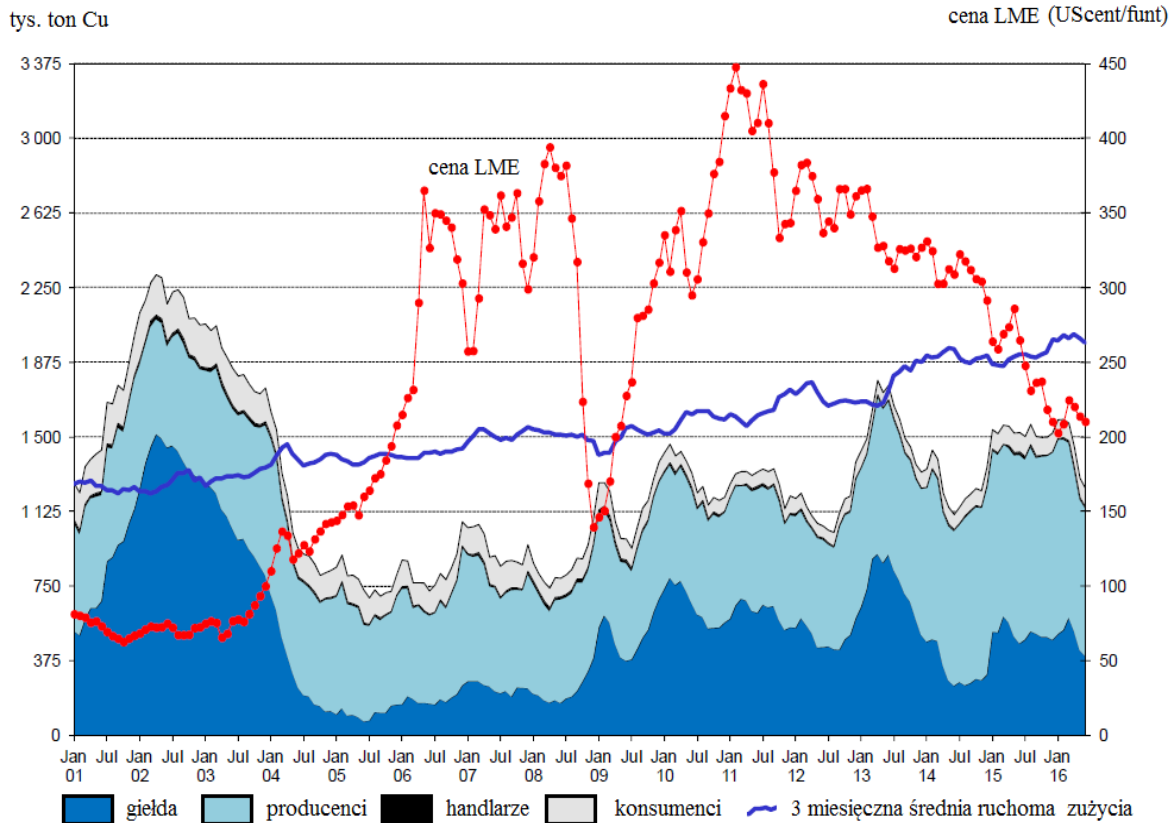


Chart 2 Prices and copper resources in the years 2001- 2015 by the report of ICSG Copper World Factbook 2016

According to the forecasts of the International Copper Study Group, in 2014 copper mining output would reach 18.6 million tonnes and in 2015, 19.8-20.5 million tonnes, and global refined copper production from all sources (including secondary ones) would reach 22.1 million tonnes in 2014 and even 23.1 million in 2015. This forecast was confirmed in the latest ICSG report from 2016.

The largest producers of mining copper are Chile, Peru and China. In Europe, the largest copper deposits are in Russia (Asian part) and Poland. Copper mines also operate in Bulgaria, Finland, Portugal, Spain and Sweden. According to BGS 2010, the mines production in the EU amounted to 855.316 tonnes of copper, or approx. 5.3% of the world production (<http://copperalliance.eu/about-copper/resources>).

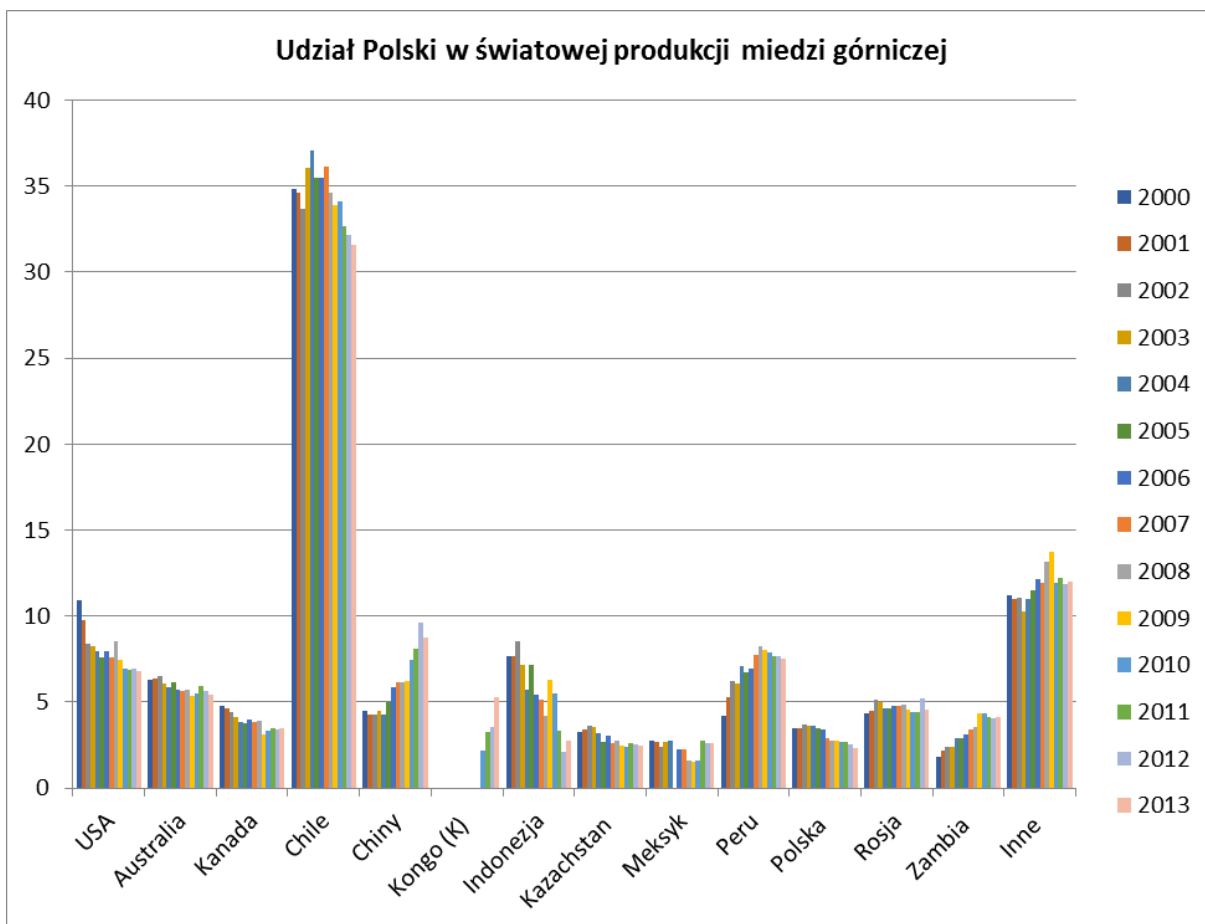


Chart 3 Percentage participation of Poland in the world mined copper production in the period of 2000-2013 (based on USGS data)

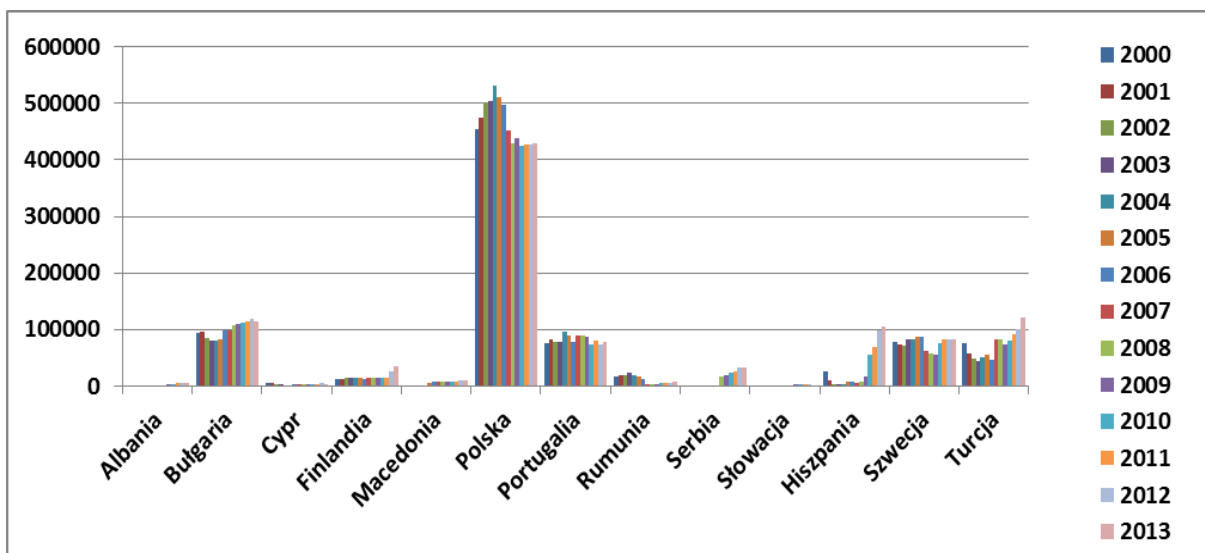


Chart 4 Copper mining in Europe in the years 2000-2013 (tonnes of metal) by the European Mineral Silver

The deposits in Lower Silesia, which are the most significant discovery in the post-war history of Europe, make Poland among the European countries the largest deposit resource and the most copper deposit producer and the largest copper producer.

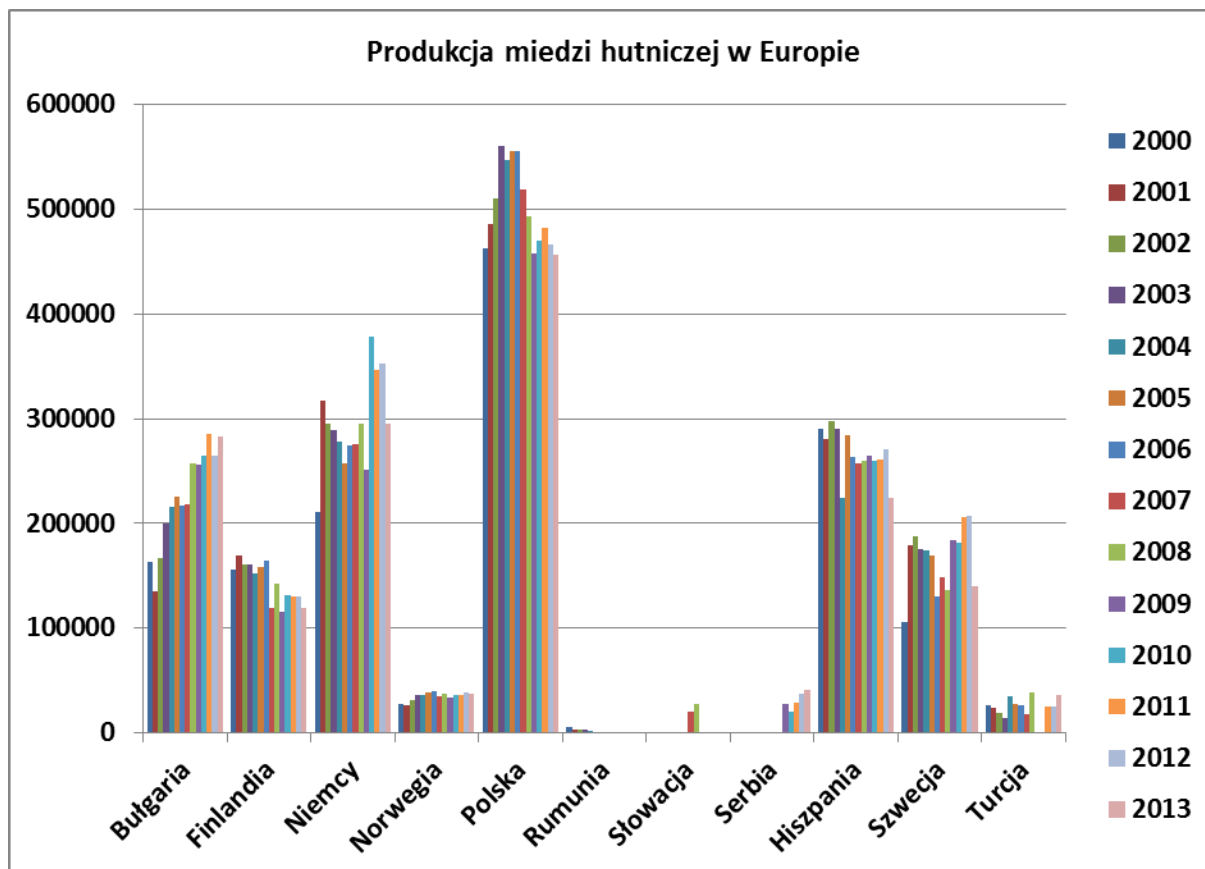


Chart 5 Copper metallurgical production in Europe (blister and anode, also from imported deposit, by the European Mineral Statistics)

However, in the production of refined copper, we are the 10th in the world, and among the EU countries, we are ahead of Germany. The situation is even worse when it comes to the production capacity of copper, copper alloys and semi-finished products according to the report of ICSG Copper World Factbook 2016, Poland is on the 20th place. Among the EU countries, we are behind Germany, Italy, Spain, France, and even Ukraine which does not belong to the EU.

Owning one's own resource base and extensive infrastructure and location in the centre of Europe create a significant competitive advantage for KGHM, enabling the company to achieve a superior position against its competitors. Unfortunately, KGHM is currently exporting mainly electrolytic (refined) copper and copper rods.

The advantage of import over export of the latter raw materials, observed from 2012, has allowed for a fuller utilization of production capacity in the range of higher processed products with higher added value (refined copper and copper rod). This means the gradual movement towards more advanced links of the value chain.

The range of offered products is gradually increasing, but they are still of a relatively low added value. The parent company's strategy of parallel configuration, that is, the reproduction of the same



links (mines) in a few countries may be beneficial if such localized production is located on the nearby markets. In the case of African, Greenland and Chilean investments of KGHM, they are far more distant than the KGHM production facilities located in Lower Silesia. Review of the products offered by KGHM published on the website of the KGHM¹ shows a low level of processing and regional neglect in creating businesses “downstream”, related to processing of extracted and pre-processed raw materials. The creation of conditions for the development of entities processing the products of KGHM into higher value added products should be a field of cooperation between the state authorities, the local authorities and KGHM. The existing export situation causes the fact that chain links of a higher added value are located in Germany, China, France and Italy.

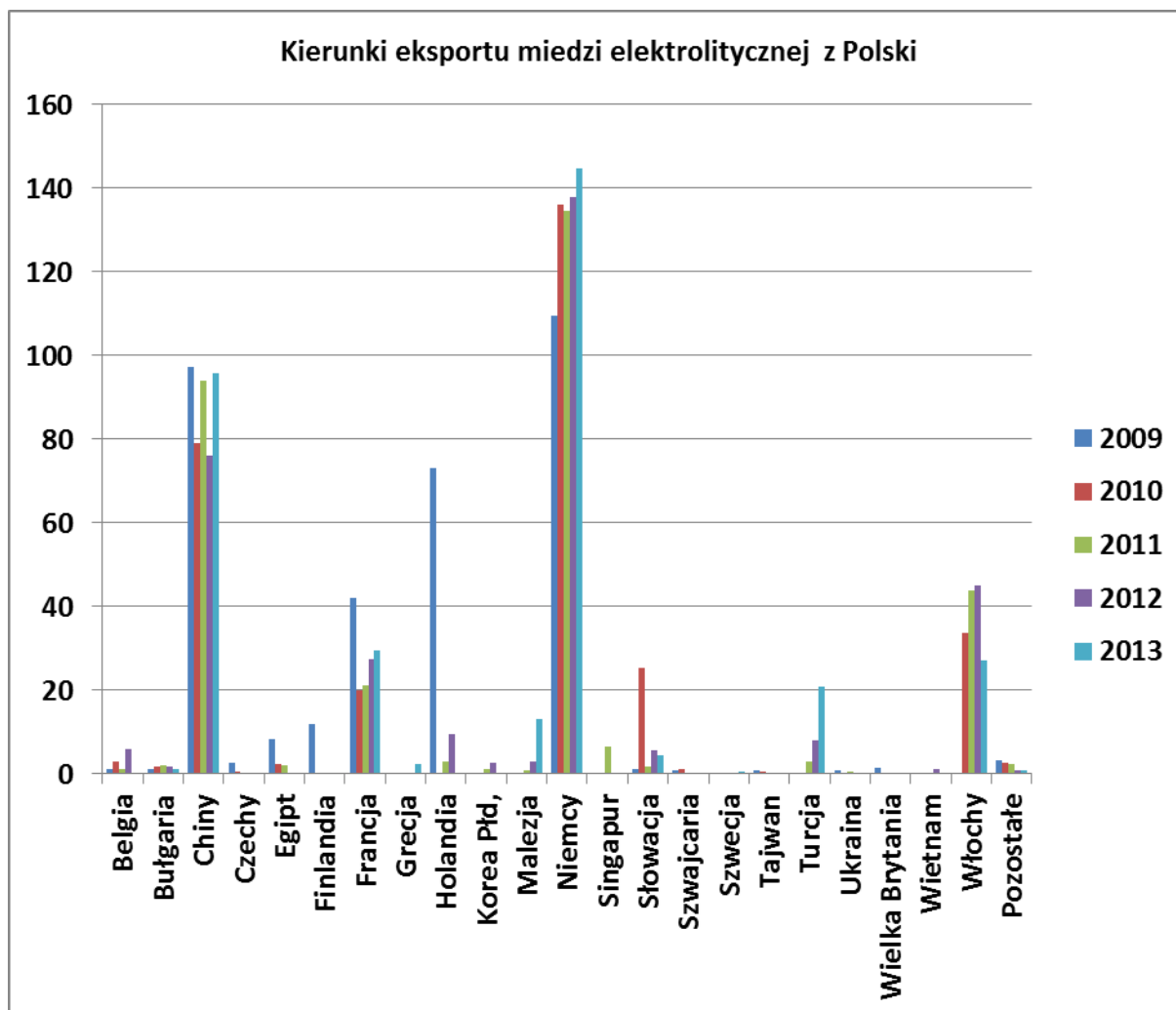


Chart 6 Directions of export of electrolytic copper from Poland

KGHM is one of the largest producers of **metallic silver**. The company annually produces approximately 1200 tonnes of the precious metal. Cathode silver with a content of above 99.99 Ag (so-called four nines) is produced in the form of bars (ingots) with a weight of 1000 jewellery oz (32.15 kg) and granules. Silver in the form of ingots, registered under the name of KGHM HG, has a

1

certificate of registration on the NYMEX Trade Exchange and the certificates of Good Delivery, issued by the London Bullion Market Association.

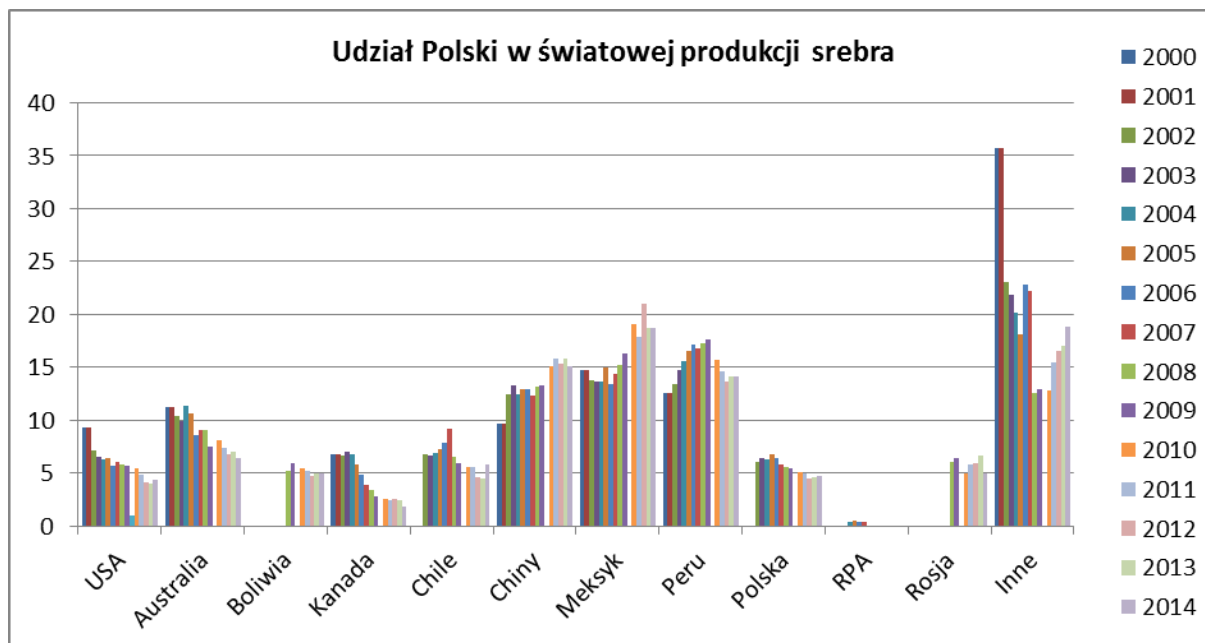


Chart 7 Percentage participation of Poland in the world silver production in the period of 2000-2014 (based on USGS data)

While in the case of copper and silver, for years the production in Lower Silesia has been approx. 6-8% of global excavation, and thus it is located in approx. 7th global position, for rhenium, which has been recorded in USGS statistics since 2009, this share has recently reached 17%, and we have been only preceded by Chile and USA in recent years. The latter country is at the same time the most important importer, therefore, Chile is the only competitor in the rhenium supply market. Chilean Molymet provides 50% of the world production of rhenium, and almost the whole production is exported to the United States.

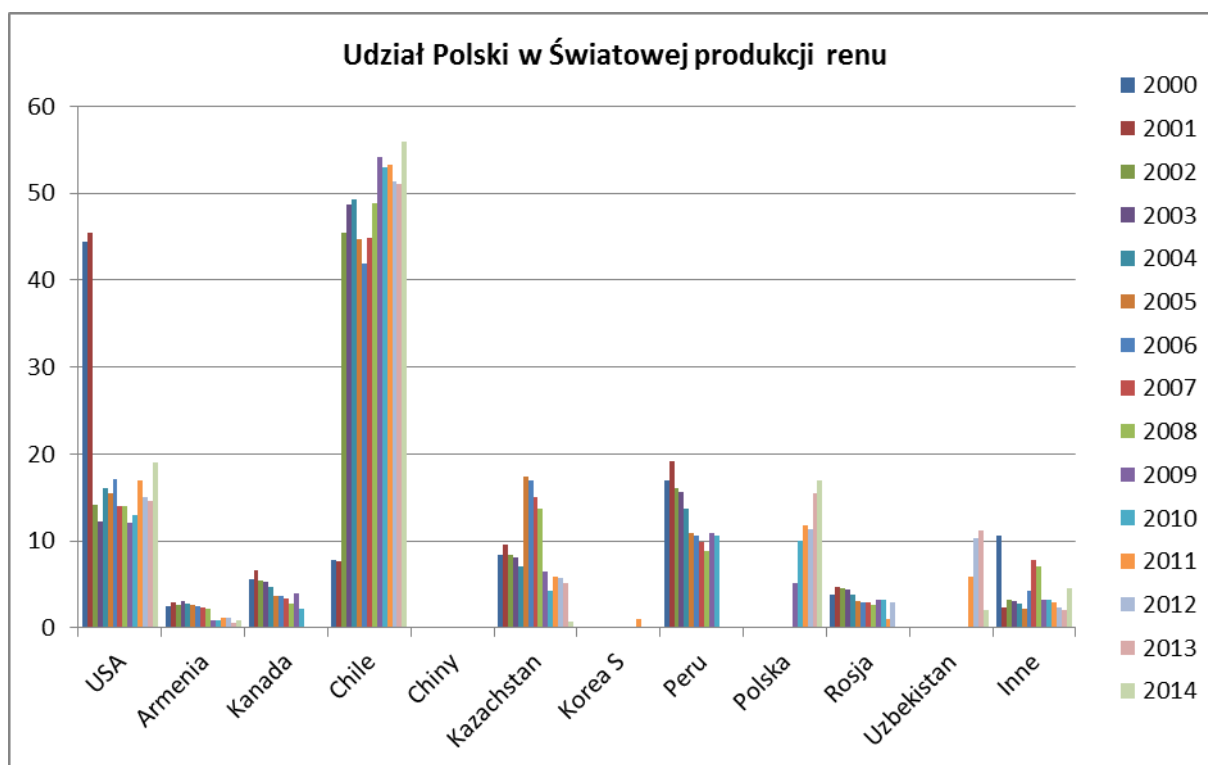


Chart 8 Percentage participation of Poland in the world rhenium production in the period of 2000-2014 (based on USGS data)

Although the downward trend in rhenium prices has been observed in recent years, it is a key raw material needed for high-temperature production and stressing rotors of turbo-jet engines. Taking into account the possible directions of development of the industry, it seems that the importance of the raw material for the development of DIS Natural and secondary raw materials may grow in the coming years.

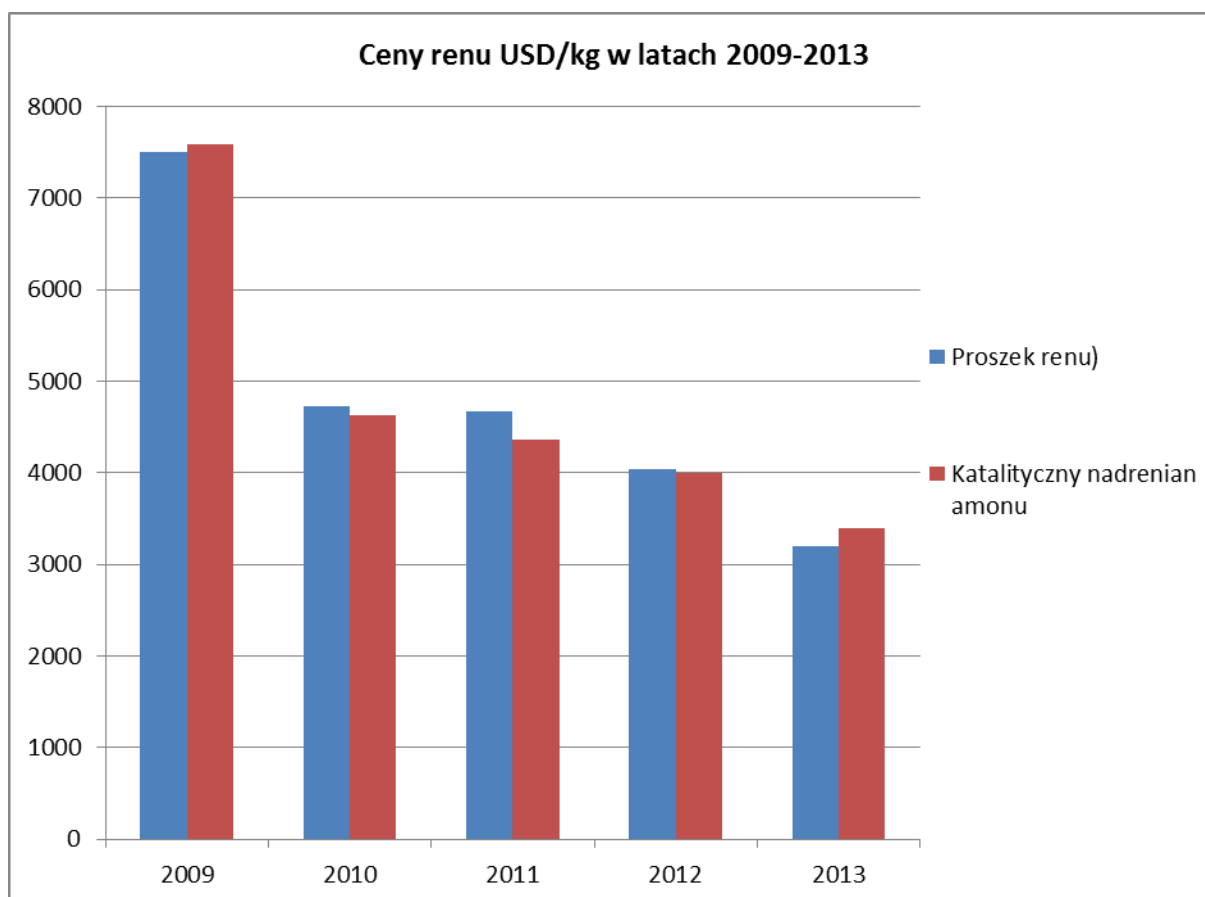


Chart 9 Rhenium prices USD/kg from 2009-2013 (based on BGSMPiŚ 2013)

Export of rhenium from KGHM is run by Traxys Belgium. The main customers are British companies Johnson Matthey and Rolls-Royce Group, as well as the American Ultamet and Engelhard and Japanese Sumitomo Metal Mining and the Austrian Plansee. An example of a mass sale of rhenium by KGHM is a contract for a hundred million dollars signed with Rolls-Royce, 13 thousands of civil aircraft engines of which are currently in use (<http://kghm.com/en/rhenium>). Scale of rotation of rhenium is kept confidential.

It is hoped that the construction investment of the Lufthansa Aircraft Maintenance and Repair Facility near Środa Śląska, for 250 million Euro (500 work places) to be built by Lufthansa and GE Aviation will enable KGHM to produce rhenium for the products of higher added value.

Brown coal is now the most important energy mineral deposit of Lower Silesia. Its documented industrial extraction in the area of Turoszowo dates back to the early 19th century. This area was then within the Kingdom of Saxony connected based on the personal union by Frederick Augustus I with the Duchy of Warsaw. Extraction was initially carried out by local landowners, and only in 1905 brown coal mine "Hercules" was built (1917) by the Kingdom of Saxony. After the end of World War II and the takeover of the mine by the Polish authorities, the German specialists gradually replaced by the Polish ones initially dominated among the employees.

In the 21st century, extraction of brown coal in Lower Silesia was approx. 14% of the national production. The Polish production of this raw material represented approx. 12% of European production. Currently, one Turów brown coal mine is currently in operation. The total balance



resources in Lower Silesia is 100 times higher than the national extraction and 855 times higher from the current extraction of Lower Silesia. In the national extraction, in 2014, amounting to 63 135 thousand tonnes, Bełchatów mine dominated (BZK2015).

Table 1 Total resources and extraction of 14 brown coal deposits in Lower Silesia (based on BZK2015)

Balance resources (thousand tonnes)	Industrial resources (thousand tonnes)	Extraction (thousand tonnes)
6 271 277	317 689	7 328

At the beginning of the 21st century, extraction of the raw material was stable, and the international trade was low. In the case of Poland, until 2007, export to Germany with conveyor belts from Turów mine to the German power plant located at the border prevailed. In 2008, a small amount of brown coal was exported to the Czech Republic, Germany and Hungary. Between 2009-2013 exports to the Czech Republic reached 214 t.t., which was 98% of export of this raw material. According to CSO data from 2006, rising import of brown coal briquettes from the Czech Republic and Germany reached the level of 194.6 thousand tonnes in 2013. One draws attention to the fact that imported briquettes are relatively high-value consumer goods with significant added value during the processing, packaging and trade, intended for individual consumers.

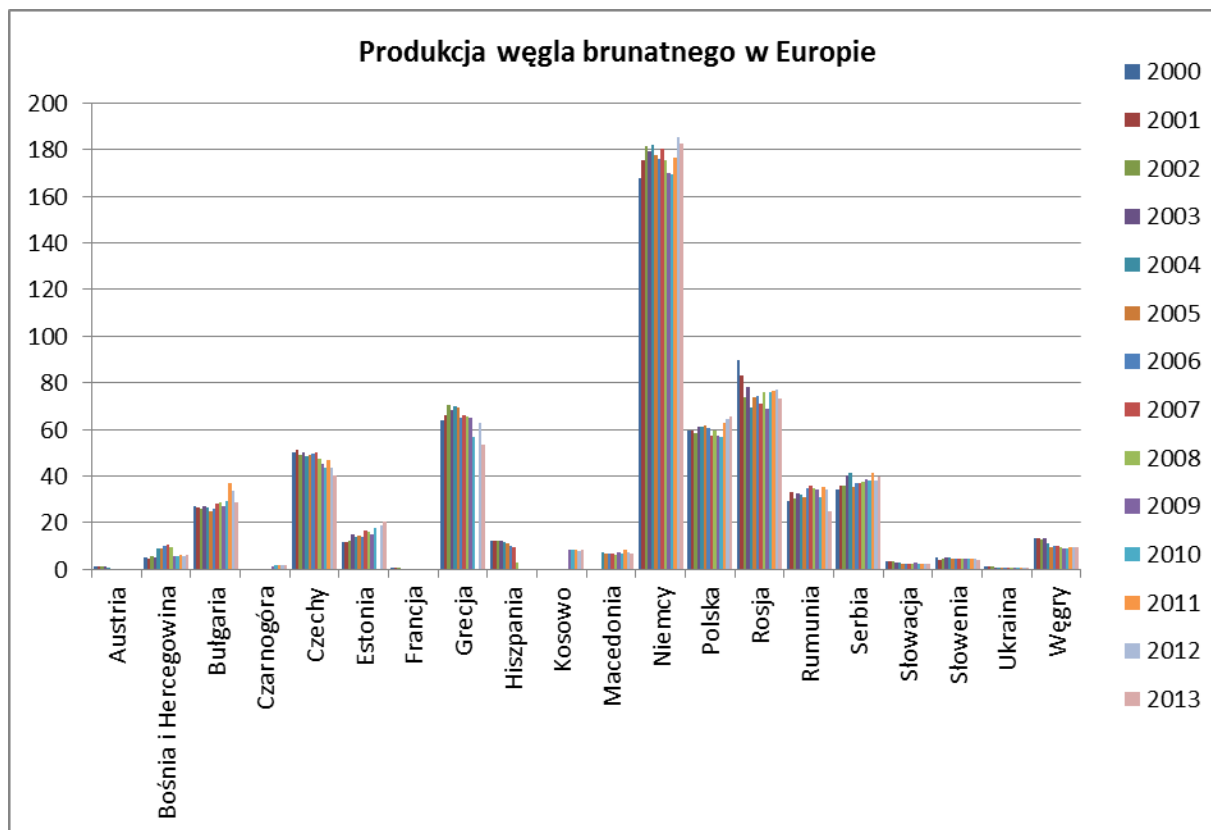


Chart 10 Production of brown coal in Europe in million tonnes from 2000-2013 by BGSMPiS data

The extraction of brown coal in Poland is almost three times lower than in Germany. The extraction in Lower Silesia, despite its many years of tradition, accounts for a low part (approx. 11.5%) of the national production. Turów Brown Coal Mine is a modern and perspective company using the latest technology. It also declares its ability to extract with full respect for the environment, despite the fact that the geological structure of brown coal of Turów mine is extremely varied and complex. The most

important factor shaping the position of Lower Silesia brown coal extraction is the fact that the Turów mine is connected with Turów power plant in terms of organisation and infrastructure.

Regardless of brown coal, six deposits of **hard coal** are located in Lower Silesia, the balance resources of which are in categories A+B+C1 equal to 188 161 thousand tonnes.

The origins of the coal mining in Lower Silesia are mentioned in documents dating back to the 15th century from the vicinity of Nowa Ruda, i.e. from the reign of King Władysław II Jagiellonian. After the annexation of Silesia by Prussia in 1742, the new mining law (1769) and nationalized coal deposits were announced. In the period just after the Prussian annexation in 1747, 7 coal mines were active in Wałbrzych. At the dawn of the age of steam and electricity, in 1805, 54 Wałbrzych plants employed 895 miners.

The dynamic development of mining in the 19th century and the first half of the 20th century, in 1939, there were 64 128 inhabitants in Wałbrzych. After World War II, displaced persons from the region of Borysław and Drohobycz and numerous French emigrants were resettled in Wałbrzych, as a part of repolonisation. A smooth continuation of the activities of the mines was possible thanks to remaining significant part of the local Germans. They were not forced to leave, and most of them migrated gradually to the late 50s of the 20th century. On the other hand, a significant part of the repatriated Poles from France had experience in working in the local mining industry. The staff of the Upper Silesia Region and the Dąbrowskie Region were also specialised. Until the period of political transformation in 1989, coal from Lower Silesia was a valued raw material. Its high quality (coking coal and anthracite) made it extracted despite the complicated geological structure that hindered the extraction and the risk of carbon dioxide emissions in Nowa Ruda area. At the end of the 80s of the 20th century, a significant modernization of the mining and infrastructure of the Wałbrzych mines was planned. At a cost of more than 20 billion PLN, PBK Lubin built a novel construction of Copernicus shaft with a depth of 1166 meters from the surface of the earth and a diameter of 7.5 meters. The shaft equipped with modern 80-metre extraction tower similar to those of KGHM, connected the levels +70, -50, -200, -400, -600² and was completed just before the elimination.

Table 2 Comparison of coal resources in Poland between 1990 and 2015 (by Sampson et al. 2016 and BZK 2015)

	Geological balance resources in categories A+B+C1+C2+D (million tonnes)	
Region	31.12.1990	31.12.2015
Lower Silesia	457	423
Upper Silesia	57 164	44505
Lubelskie	7 889	11292

²

<http://walbrzych.naszemiasto.pl/artykul/walbrzych-21-lat-temu-wstrzymano-budowe-kopernika,806664,art,t,id,tm.html>

The future of mining in Lower Silesia was determined by the development made by the staff of AGH and Design Office in Gliwice “Operating economy of coal mines in Lower Silesia”, in which in point 1 of the final conclusions stated that the mines from Wałbrzych would not reach such extraction costs that people would not pay extra, and so they should be eliminated (Kosmaty 2011). On 29 November 1990, the Minister of Industry ordered a resolution to eliminate the mines in Wałbrzych. Recognized for off-balance resources were re-assessed in 2011 by the Minister of the Environment in the paper “The verification of hard coal reserves in the deposits of eliminated mines along with the conversion of their resources based on the applicable balance criteria”, and at the end of 2015, the geological resources of this Lower Silesia Region were 423.05 mln Mg (Sobczyk et al. 2016).

The decision to eliminate the mines was conditioned by low prices of coal in the early 90s of the last century. For example, the Australian market was 40 USDA/t in December 1990. Since then there has been a significant increase in the price of coal to 80 AUD/t (31.05.2017), while in July it exceeded 190 AUD/t. In the meantime, the decision to stop mining in the Lower Silesia Region could be considered economically justified by the weak realities. As a result of the economic downturn caused by economic transformation in China and India, complete elimination coupled with the ruin of the excavations was a mistake.³

Currently, one thinks about the resumption of the extraction of coal in the area. In April 2017, the searching concessions were held by: Coal Holding (currently Balamara resources limited) in the area of Nowa Ruda, and Nexano Minerals in the area of Ścinawki.

The data about the current extraction of **natural gas and helium** in Lower Silesia are provided in the tables below. This is a small part of the national production of 5 213.52 million m³. Some of the extracted gas is further processed into high-methane gas in denitrification plants in Odolanów and Grodzisk Wielkopolski. As a result of cryogenic processing of high-methane gas, LNG, gaseous and liquid helium and liquid nitrogen are obtained in addition to high-methane gas.

Table 3 Total resources and extraction of 25 natural gas deposits in Lower Silesia (based on BZK2015)

Extractable resources (million m ³)	Industry resources (million m ³)	Extraction (million m ³)
5779.59	2006.23	600.59

Table 4 Total resources and extraction of 5 helium deposits in Lower Silesia (based on BZK2015)

Extractable resources (million m ³)	Industry resources (million m ³)	Extraction (million m ³)
4.19	4.19	0.193

Rocks suitable for the production of building and road stones, broken aggregates and **gravel aggregates** constitute the most significant group of rock resources. Extraction of construction stones in Lower Silesia dates back to prehistoric times, as indicated by Celtic sculpture circles from Ślęza. Irrespective of archaeological monuments, the first documented data on the use of Strzelin granites dates back to the first half of the 12th century, and since the 13th century, chalky sandstones have been commonly used. The example involves sandstones from the pilgrimage area used, inter alia, to

4
build a cathedral in Wrocław. . After the annexation of Silesia by Prussia, throughout the 19th century and the first half of the 20th century, chalky sandstones from Lower Silesia were commonly used in buildings.

The history of this industry in the 21st century is associated mainly with the economic climate in the construction industry, especially in road construction. Since the beginning of the transformation, the former state-owned companies were privatized (as well as in the direction of employee companies) and a number of private companies of various sizes were established. A number of foreign investors appeared, as well. The initial period of development was related to exports, mainly to the German market where the former GDR carried out road investments and renovation works of historic buildings made of stones from Lower Silesia.

Lower Silesia in Poland is a major producer of **construction stones** and a monopolist in the production of granite. Granites useful for the production of blocks exist in rocks: Strzegom-Sobótka, Strzelin-Zulowa and the Karkonosze Massif (Kudowa Massif and Kłodzko-Złotostocki Massif are not exploited due to the nature protection). The total resources of the identified deposits of granites are approx. 1623 million t. (BGSPiS2013).

The extraction of **granites** for blocks concentrates in Strzegom-Sobótka Massif and partly in Strzelin-Zulowa Massif. Low extraction is also observed in the Karkonosze Mountains Massif. The total extraction of block granites amounted to 26 deposits, in 2013 it was approx. 0.9 million tonnes (BGSMPiS2013). According to BGSMPiS, the leaders in this regard are: Borowskie Kopalnie Granitu, Grabinex, Skalimex-Borów, Morstone, Granit Strzegom, Piramida, GT&F Corporation Polska, Wekom, PWPiSKB Kwarc Skalimex-Grantin Granimex. There is also a number of smaller private companies.

In the area of Ząbkowice Śląskie, **syenite** of parameters similar to granite of Przedbórz and Koźmina type are extracted. According to BGSMPiS, the total resources of the deposits documented in this area are 56 million tonnes.

For comparison, in the remaining part of Poland, the total geological resources of granites and syenite (including glacial erratic) are less than 36 million tonnes.

Lower Silesia is practically the only area of **marbles** extraction in Poland. 11 rock deposits were recorded in the Kaczawskie Mountains, Krowiarki and in Sławniowice area (Opolskie Region). The total resources are approx. 48 million tonnes (BGSMPiS).

In India and China, the total resources of marble and granite are approx. 200.000 tonnes, and the extraction in 2013 was nearly 60 million tonnes (BGSMPiS2013).

Significant block extraction, mostly yellow chalky **sandstone** is in the area of the Stołowe Mountains, in the area of Lwówek Śląski - Bolesławiec. According to BGSMPiS, in the first area, there are 8 deposits, with the total resources of approx. 38 million tonnes, and in the other 26 resource deposits of approx. 55 million tonnes.

Red permian sandstones are also extracted in the area of Nowa Ruda, where approx. 5 mln tonnes of the material was reposted in 3 deposits. Apart from Lower Silesia, red sandstones exist only in the

Holy Cross Mountains, where the resources of Kopulak, Sosnowica, Tumlin and Wąchock deposits were 2.7 million tonnes at the end of 2015 (BZK2015).

For comparison: in Poland, the geological resources of all broken and block stones amounted to 10 800.98 million tonnes (BZK2015) in 2015, the European production in 2013 was 24.4 million tonnes and the global extraction was 136.9 million tonnes (BGSMPiS2013).

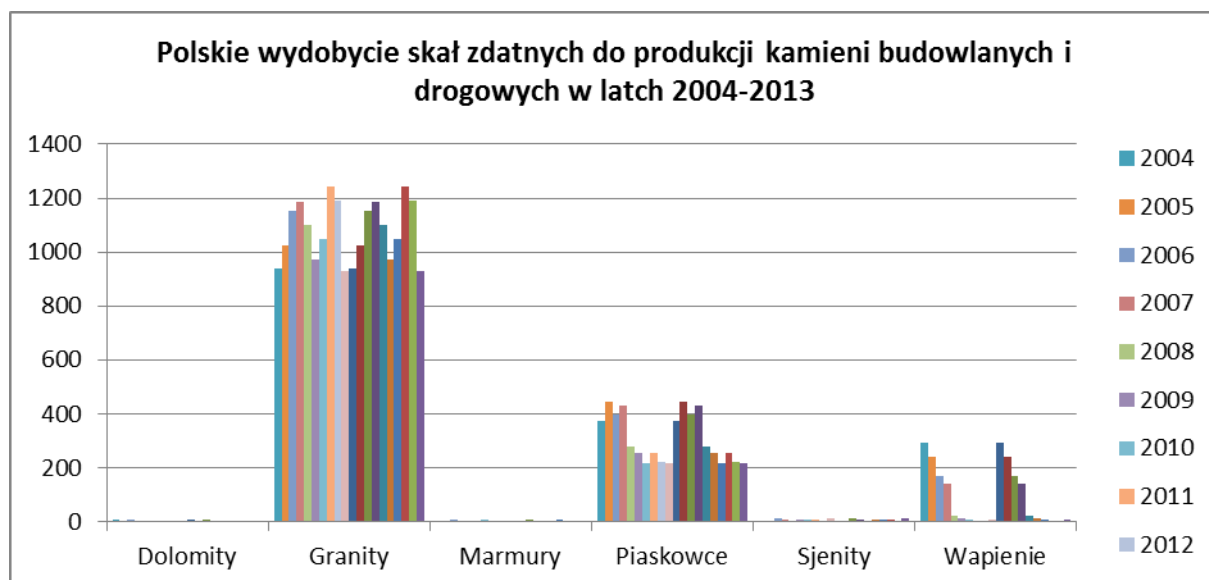


Chart 11 Polish extraction in 2004-2013 of rocks suitable for construction and road stones production (thousand tonnes) BGSMPiS 2008, 20013

After Poland's entry into the EU and obtaining funds for the infrastructure investments, the demand increased, especially for gravel and broken aggregates. Another stimulus to the development of the industry was the period of preparations for Euro 2012.

In the national statistics and comparisons with the world (BGSMPiS 2008, 20013) only granites and syenites can be considered as a completely Lower Silesia product, because in other rocks, especially sandstones, there is significant extraction in other regions of the country. In the case of the block stones, significant importance involves the import of this raw material from all over the world, which is related to expanded offers of the producers of stones of varying colour and structure. Consequently, wholesalers and plants for the processing of the imported stone (mainly from South Africa and India, Finland, Ukraine, Zimbabwe, Spain and China) have been established in the traditional Strzegom district of stone extraction. The import of block stones of varying processing dominated over the export on the national scale.

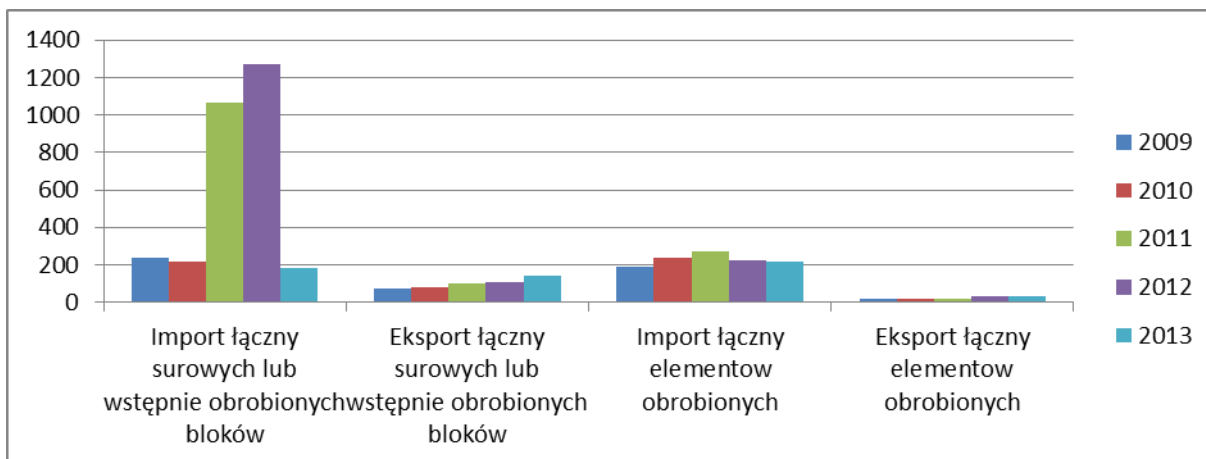


Chart 12 Balance of export/import of block stones by BGSMPiS 2013

The share of raw materials among imported raw materials has remained at the level of 168-230 thousand PLN in recent years. t/y. High import growth to the level of 0.9-1.2 million t/r was between 2011-2012. It was associated with the construction of hydraulic engineering on the Coast and import of blocks from Sweden and Norway.

The production of Polish broken and gravel aggregates in the years 2000-2011 according to the European Mineral Statistics clearly increased on a European scale and a significant part of this increase should be connected to Lower Silesia.

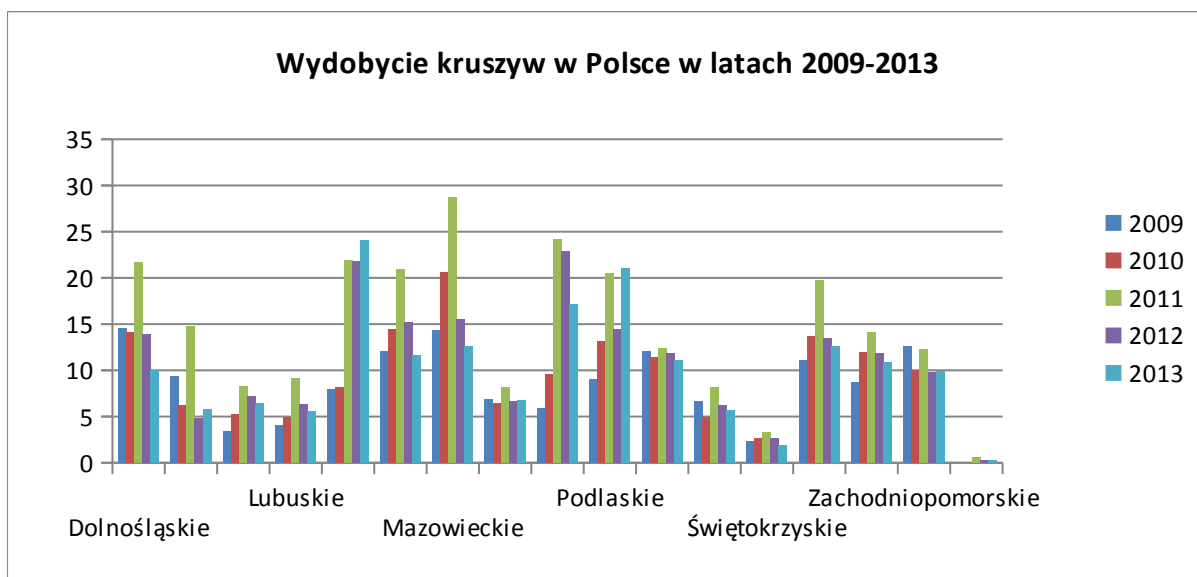


Chart 13 Extraction of aggregates in Poland, million tonnes from 2009 to 2013 by BGSMPiS 2013.

In Lower Silesia and in the Carpathian region approx. 40% of Poland's **gravel aggregates** are located in river valleys (BGSMPiS). Gravel in the Sudetes Mountains are of the highest quality because they come from the erosion of local crystal rocks massifs.

Solid crystal rocks are useful for the production of **natural broken aggregates**. Basalt and melafra are especially useful for this purpose due to the high frost resistance and low abrasion. The following are also used for the production of natural crushed aggregates: granites, gabras, diaboses, syenites, porphyrs, gneisses, amphibolites, serpentines, migmatites, hornfels, sandstones and greywackes



In recent years, the extraction of gravel aggregates in Lower Silesia has lost its importance on the national scale, but they are of high quality. The USGS data covering the world production of sand and gravel show a clear increase in the production in Poland in 2009. Even taking into account subsequent decreases, it should be noted that the volume of production is much higher than at the beginning of the 21st century.

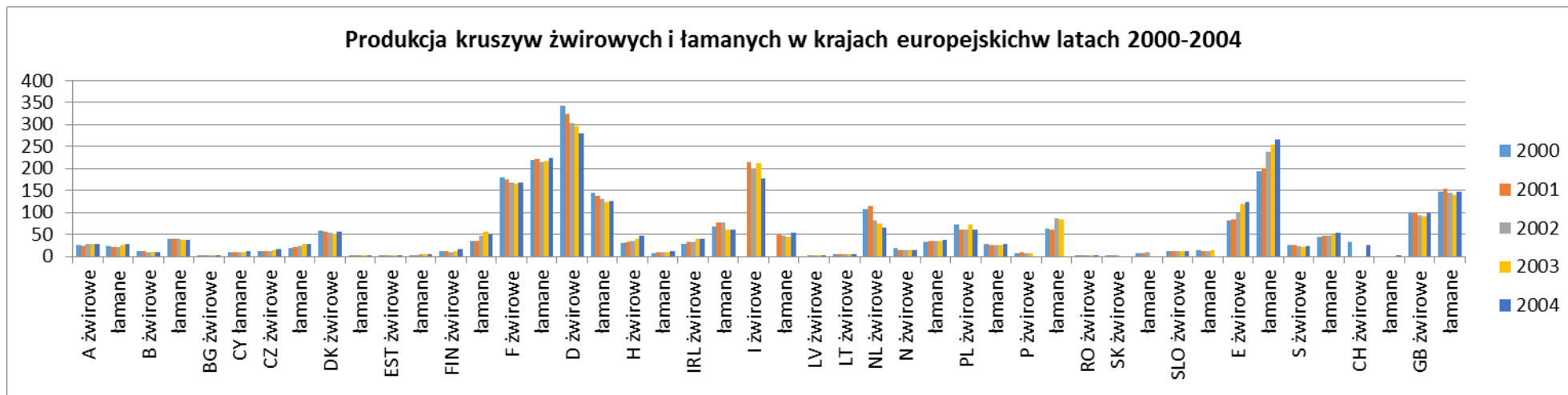


Chart 14 Production of gravel and broken aggregates (million tonnes) in the European countries in the years 2000-2004 by the European Mineral Statistics

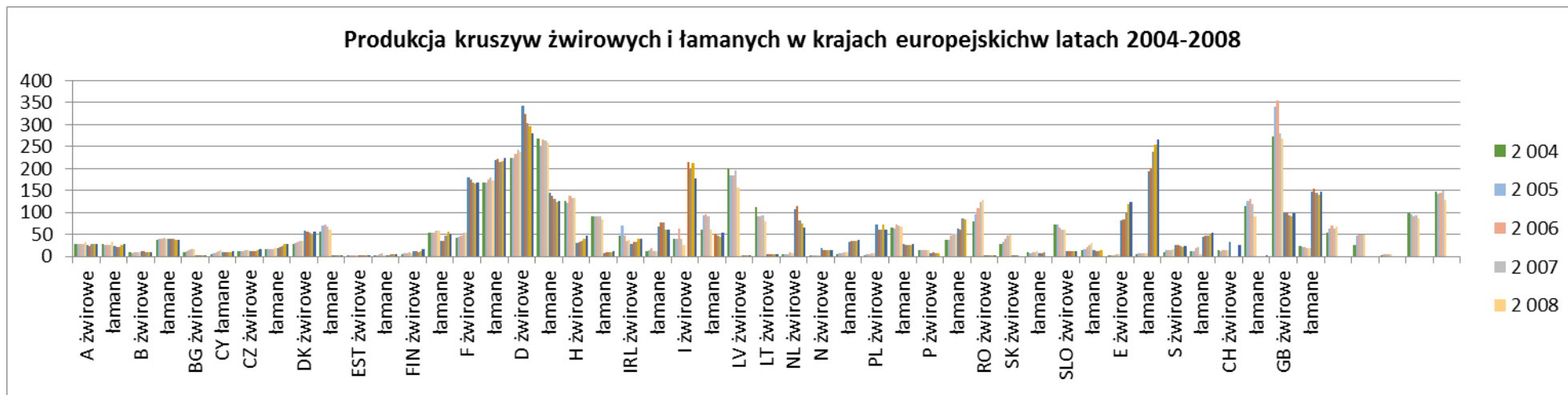


Chart 15 Production of gravel and broken aggregates (million tonnes) in the European countries in the years 2004-2008 by the European Mineral Statistics

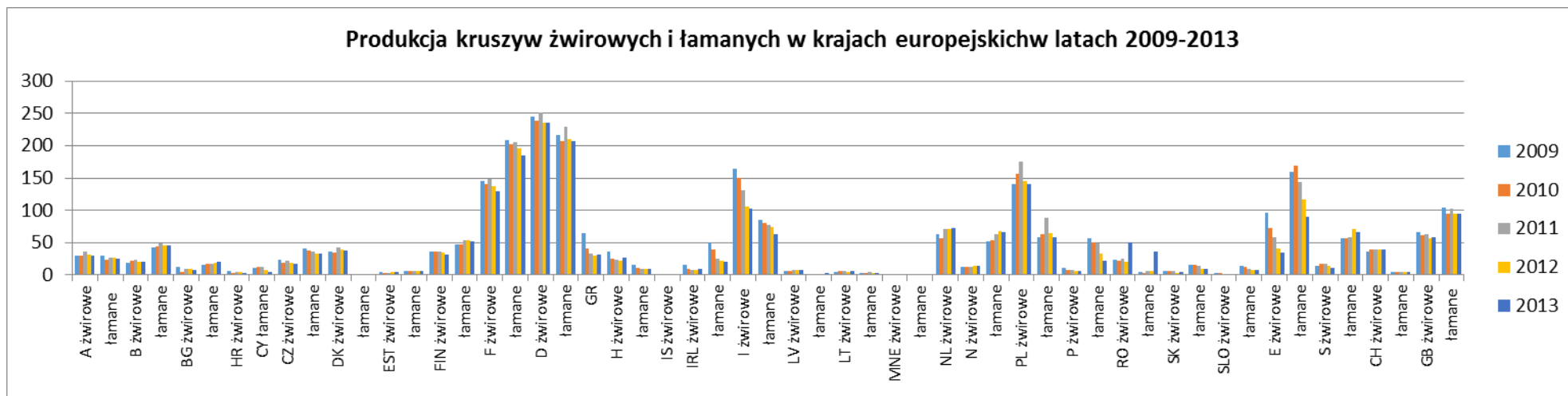


Chart 16 Production of gravel and broken aggregates (million tonnes) in the European countries in the years 2009-2013 by the European Mineral Statistics

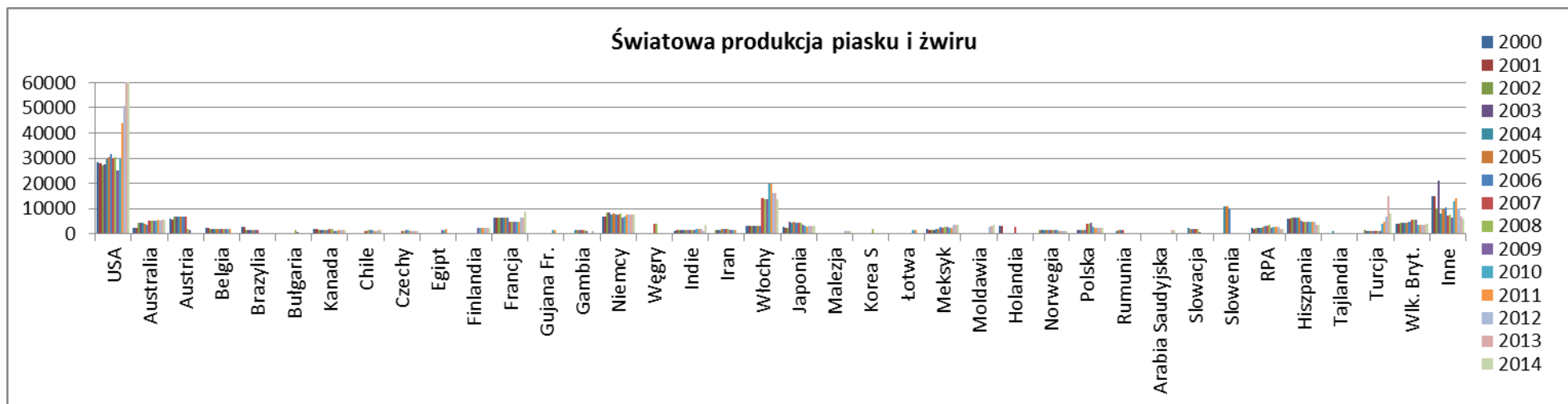


Chart 17 World production of sand and gravel in thousand tonnes in the years 2000-2014 by USGS (the U.S. production in some years exceeding the scale)



In 2013, the extraction of Lower Silesia gypsum was the only a slight percentage of the extraction and production in Poland (4%), Europe (0.4%) and the world (0.05%). In Lower Silesia, the easiest available deposits of anhydrite are found along the edge of the North-South synclinorium. Gypsum is also found in the exposed, hydrated parts of the anhydrite deposits. The extraction of gypsum in this area began in the early 19th century. The extracted material was used mainly for the production of gypsum adhesive (roasted gypsum) and sulphuric acid.

Four deposits are documented at present: three in Niwnice near Lwówek Śląski (Nowy Łąd, Nowy Łąd-Pole Radłówka and Nawojów Śląski), and one in Iwiny near Bolesławiec (Lubichów).

The total resources and extraction is provided in the table below. The enormous potential of anhydrite resources coexists with copper deposits, but they are not exploited.

Table 5 Total resources and extraction of 4 gypsum deposits in Lower Silesia (based on BZK2015)

Balance resources (thousand tonnes)	Industrial resources (thousand tonnes)	Extraction (thousand tonnes)
70,949	58,445	158

According to the information in BGSMPiS 22013, the best white gypsum from Gypsum and Anhydrite Mine Nowy Łąd in Niwnice is completely processed on site for various grades of white gypsum adhesives and special gypsum (e.g. dental, surgical, etc.). Owing to the depletion of white gypsum resources in Nowy Łąd, in 2015, the company made a satellite deposit in Nowy Łąd-Radłówka available. It is white gypsum of the best quality.

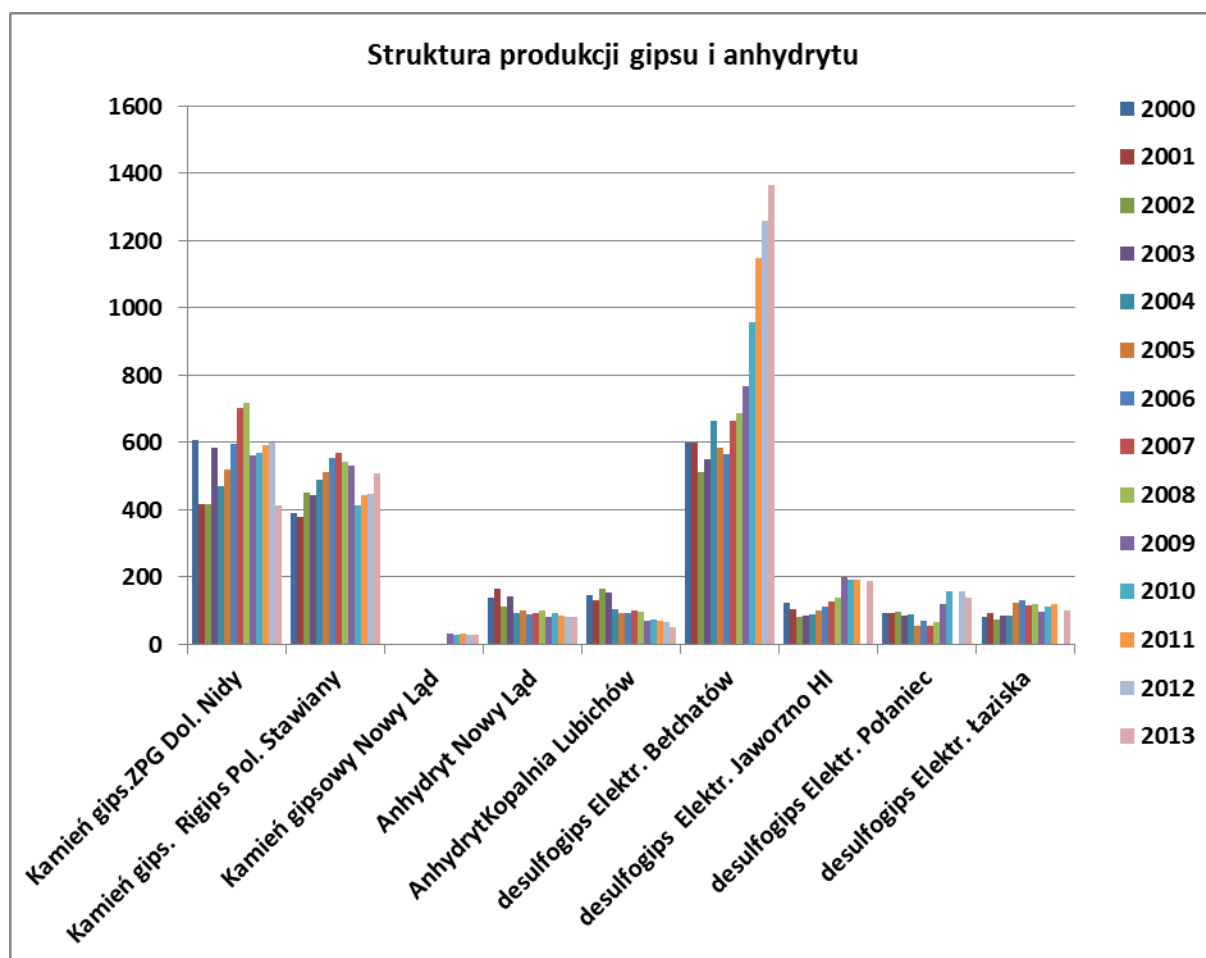


Chart 18 Structure of the production of gypsum and anhydrite (thousand tonnes) in Poland in the years 2000-2013, PKWiU 08112030 by BGSMPiS

The Polish (Lower Silesia) production of ceramic and refractory clay decreasing during the 21st century represents a low percentage of the European production, where Germany, Ukraine and Italy dominate.

White burnt clay are in Poland only in Lower Silesia, in the sandy-clay upper chalk in Bolesławiec region, where it became the raw material for the development of the so-called Bolesławiec ceramics. There are 6 documented deposits of 58 527 000 thousand tonnes (BZK 2015). One of the them, Janina I has been operated by Ekoceramika since 2004, and the extraction in 2015 amounted to 112 thousand tonnes. White burnt, stoneware and refractory clays are operated as accompanying fossil in Turów Bełchatów coal mine. However, their resources are not documented (BGSMPiS2013). Since 2006, Bolesławieckie Zakłady Materiałów Ogniotrwałych extract sandy-clay deposits from Red Water deposits, formally documented as moulding fossil.

Table 6 Total resources and extraction of 5 white burnt clay deposits in Lower Silesia (based on BZK2015)

Balance resources (thousand tonnes)	Industrial resources (thousand tonnes)	Extraction (thousand tonnes)
58 527	559	112

Stoneware clay in Lower Silesia is so-called Bolesławiec clay of the cretaceous and tertiary age where they are extracted in Zebrzydowa Zachód deposit by Ekoceramika. The properties of stoneware clay apply also to Miopolicene Poznań clay documented in Kraniec near Brzeg Dolny and a part of clays from the deposits: Odrzychów near Bolesławiec.

Table 7 Total resources and extraction of 11 stoneware clays in Lower Silesia (based on BZK2015)

Balance resources (thousand tonnes)	Industrial resources (thousand tonnes)	Extraction (thousand tonnes)
16 907	3 416	182

Refractory clay exists in Poland only in Lower Silesia (80% of the resources). There are 4 so-called Jaroszków deposits in the area of Strzegom, from which one is exploited - Rusko-Jaroszków. The exploitation history dates back to 1870, when Refractory Clay Mines in Jaroszków were established. In 1945, the Polish authorities took over the plants by giving them the name: Jaroszków Plants of Refractory Materials. In 1995, the company was transformed into a one-person state-owned company, and since 1998 the company has operated under the name: JARO S.A.⁵ Most of the production from the plant is supplied to the **Polish Refractory Ceramics "Żarów" S.A., which is one of the most modern plants in Europe producing aluminosilicate refractories mainly for steel and non-ferrous metals (including aluminium), foundries, coking plants, and glassworks.**

Table 8 Total resources and extraction of 4 refractory clays deposits in Lower Silesia (based on BZK2015)

Balance resources (thousand tonnes)	Industrial resources (thousand tonnes)	Extraction (thousand tonnes)
-------------------------------------	--	------------------------------

⁵

tonnes)	tonnes)	tonnes)
43 441	1 273	87

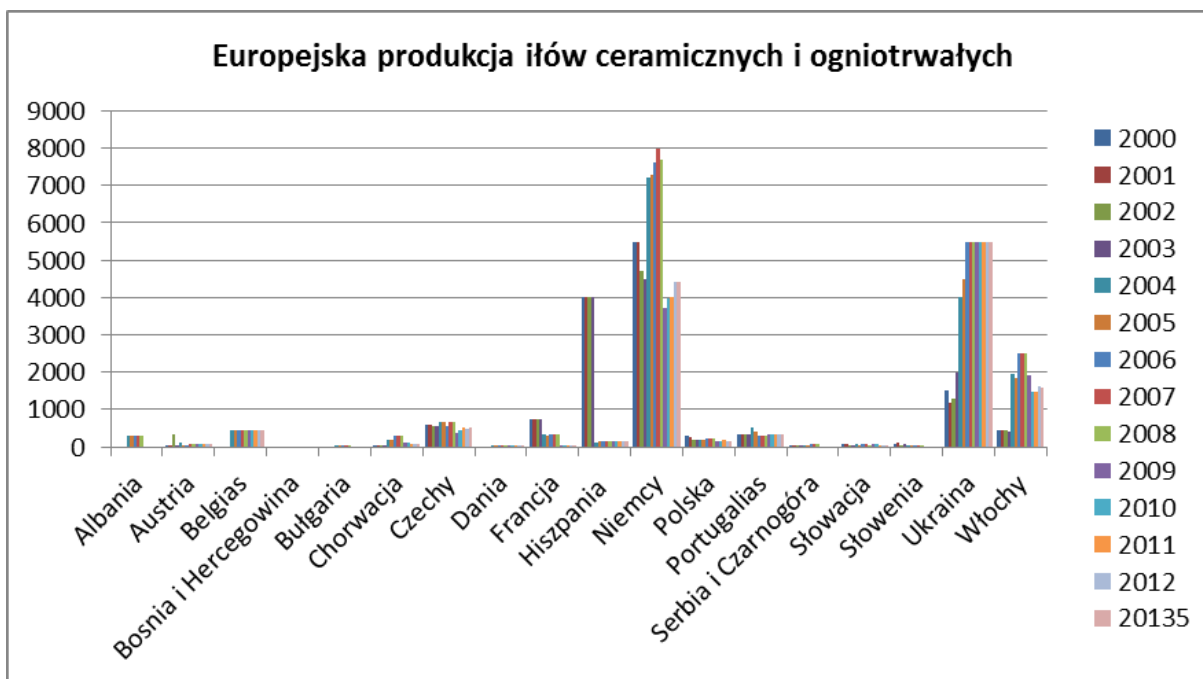


Chart 19 European production of ceramic and refractory clays (thousand tonnes) in 2000-2013 based on BGSMPiS data

Bentonites, extracted only in Lower Silesia, the extraction of which has practically disappeared since 2009, are insignificant in the world and European extraction. The national balance resources amount to 2 884 thousand tonnes. However, the operation of bentonite is carried out only in Lower Silesia from Krzeniów deposit. It was shaped in the years 2008-2013 at the level of 0.8-3.0 thousand t/y.

Table 9 Total resources and extraction of 3 bentonite deposits in Lower Silesia (based on BZK2015)

Balance resources (thousand tonnes)	Industrial resources (thousand tonnes)	Extraction (thousand tonnes)
1 578	345	0.5

Raw bentonite fossil is supplied to the Technical and Industrial Company Certech in Niedomice in Malopolska Region, which under **Submeasure 3.2.2 of the Operational Program Smart Development 2014-2020 Credit for technological innovation** has received a grant for the project *“Innovative granular bentonite products for agriculture and zoology”*. The company is the largest national producer of “bentonite gravel for pets (Super Benek). Recently (from 2011), the company has significantly increased its production for other applications (geoengineering, waterproofing, foundry and drilling), which currently account for over 30% of its products. It also produces bentonites for the ceramic, fertilizer and fast-growing industries producing feeds with detoxifying properties. The

demand for raw materials of this company is 45-47 thousand t/y. The production is carried out in 70-75% based on Slovak raw materials (70-75%), supplemented with raw material from Krzeniów deposit and beidellite clay from Bełchatów.

Similarly, in spite of a noticeable increasing trend, the production of **magnesite and kaolin** in Lower Silesia is not significant in terms of Europe.

Magnesites in Poland are found only in Lower Silesia in the serpentinite massif of Braszowice. These deposits were discovered in the mid-19th century. In 1862, H. BRUCK started the exploitation of the deposits on the commercial scale. In the 80s of the 19th century, magnesite firing in shaft furnaces was started at about 800 °C. In 1907, Konstanty Mine, and in 1912, "Szczęść Boże" mine were launched. After the end of World War II, all extracting and processing plants of magnesite in Grochowa village were taken over by the Union of the Refractory Industry based in Gliwice. In February 1946, Mine and Processing Plant of Magnesite was established in Grochowa. In the late 90s of the 20th century, the plant was privatised, and in 2004, it was converted into Magnezyty Grochów S.A.⁶

According to the information provided in BGSMPiS2013, in recent years, magnesite has been extracted by only one company: Magnezyty Grochów.

Table 10 Total resources and extraction of 14 magnesite deposits in Lower Silesia (based on BZK2015)

Balance resources (thousand tonnes)	Industrial resources (thousand tonnes)	Extraction (thousand tonnes)
14,001	3971	96

As a result of manual sorting and preliminary classification, crushed or milled raw magnesite concentrate is produced (43-45% MgO). In 2009-2013, its production increased to the level of 97 thousand tonnes in 2013. It is used for the production of several species of magnesite (so-called R40 magnesite), which is a semi-finished product for the production of NPKMg fertilizers in numerous fertilizer plants (20-30 thousand t/y). The remaining part of the production is crushed magnesite (25-35 thousand t/y.), sold, inter alia, to the national chemical plants for the production and magnesium compounds (e.g. magnesium sulphate). The plant also applies obtained side magnesia-serpentinite rocks, which are used to produce lower grades of milled magnesia, R35 and R30. In recent years, the total production of R40, R35 and R30 species has been in the range of 90-130 thousand t/y. For a dozen or so years Magnezyty Grochów has produced magnesium oxide containing 70-86% MgO, not exceeding 50 t/y.

Kaolin is only extracted in Lower Silesia, in Poland. As an industrial raw material, it was used after 1709 for the production of European hard porcelain, invented by Jan Fryderyk Böttger. Since the raw material for the production of this porcelain contains 40-60% kaolin, 20-30% feldspar and 20-30% quartz, all these minerals have become (since the 18th century) the desired raw material. Initially, kaolin was extracted from small deposits in the area of Strzelin, Żarów, Mirska. In 1947, at the northern end of Nowogrodzic, a clay raw material mine was established, which specialised in producing high quality kaolin. In 1995, it was privatized, and it is now a part of Quartzwerke group. Despite the existence of 14 documented reserves, currently only: Maria III deposit with the balance

resources of 78 939.54 thousand tonnes, where the extraction in 2015 amounted to 285.30 thousand tonnes, and Dunino deposit, originally documented as a deposit of halloysite, which was reclassified to kaolin raw materials. The current balance resources of this deposit amount to PLN 474.87 thousand tonnes, and the extraction is 1.35 thousand tonnes.

Table 11 Total resources and extraction of 14 kaolin deposits in Lower Silesia (based on BZK2015)

Balance resources (thousand tonnes)	Industrial resources (thousand tonnes)	Extraction (thousand tonnes)
212 077.41	71 355.44	286.65

The extraction of **clay raw materials of construction ceramics** in Lower Silesia is 10.9% of the national production, and their resources are 473 times of the national extraction. The largest resources of 727 650 m³ are the fossil accompanying the brown coal deposit Legnica - Pole Wschodnie (BZK2015).

Clay raw materials of construction ceramics have been used in Europe since the 12th century to produce manually formed bricks. A manually formed brick dominated in the Gothic structures, and in the 19th century, its mass, mechanised production was started in numerous plants located throughout Lower Silesia Region. The most modern plant was during in the Polish People's Republic times, located in Środa Śląska, and taken over in 1994 by the Röben family, which is one of the most modern in the world.

Table 12 Total resources and extraction of 68 clay raw materials of construction ceramic deposits in Lower Silesia (based on BZK2015)

Balance resources (thousand m ³)	Industrial resources (thousand m ³)	Extraction (thousand m ³)
789 763	22 510	181

The production of **feldspar** with a clearly increasing trend, also in the European level, looks significantly better. **Feldspar** is extracted in Poland only in Lower Silesia, from two deposits located in Wrocław Region (although there are two small deposits in Malopolska Region). The exploitation of Lower Silesia feldspar is carried out by Strzeblowskie Mineral Resources Mines, which produce feldspar and quartz flours and abrasives used in the industries: noble ceramics, ceramic tiles, sanitary goods, glass metallurgy, industrial chemicals, enamels, abrasives etc.⁷ The extraction of feldspar in the area was started in 1764, when the Prussian Porcelain Factory was tested, and the suitability of feldspar raw material from Strzelce for the ceramic industry was confirmed. In 1908, Quarzspat Strobel GmbH implemented "strzeblowski quartz spar" on the market, and in 1921 - "strzeblowski feldspar" based on the nearby feldspar deposit "Stary Łom". On 1 January 1955, the company was named "Strzeblowskie Mineral Resources Mines", and has operated till these days.

Table 13 Total resources and extraction of 9 feldspar deposits in Lower Silesia (based on BZK2015)

Balance resources (thousand	Industrial resources (thousand	Extraction (thousand
-----------------------------	--------------------------------	----------------------



tonnes)	tonnes)	tonnes)
136944.43	5486.19	76.54

Both in terms of feldspar and magnesite, Turkey is the dominant European producer. The observed last political instability in this country creates chances to increase Polish production on the European market. This production is associated with the dynamic development of the production of all kinds of ceramic tiles.

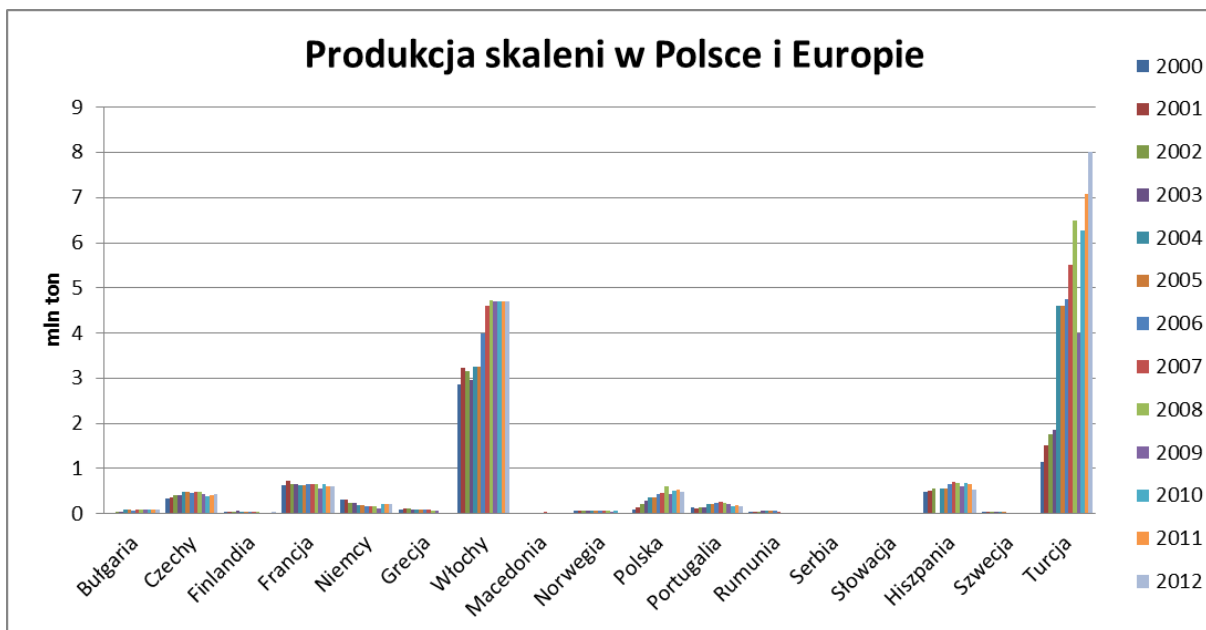


Chart 20 Production of feldspars in Poland and Europe in the years 2000-2012

The extraction of glass sands in Lower Silesia is 25% of the national production, and its resources represent 130 times of the extraction of Lower Silesia and 32 times of the national extraction. The tradition of the glass industry in Lower Silesia dates back to the 14th century and the period of the so-called period migrated steel plants moved from one place to another in searching for energy (wood). The role of high quality glass sands was initially low. It was not until the Industrial Revolution, which resulted in Lower Silesia in the establishment of a steel plant in Szklarska Poręba in 1842, the interest in high quality glass sands increased. At the same time, a glass plant was established in Osiecznica, using local resources. Since 1936, this plant has specialised in the production of polished glass. However, there are no data on its post-war activity.

At present, one of the deposits, Osiecznica II, is exploited by KiZPPS "OSIECZNICA", a member of Quarzwerke Group, which has a modern processing plant. Quartz sand produced in Osiecznica is characterized by very high chemical purity and extremely bright colour. Sands with a particularly low iron oxide content (up to 0.008% - 80 ppm) are used to produce high quality, crystal usable glass, flat glass for solar modules and packaging glass.⁸

⁸

<http://osiecznica.quarzwerke.com/osiecznica/Produkty/Quarzsand>

Table 14 Total resources and extraction of 8 glass sand deposits in Lower Silesia (based on BZK2015)

Balance resources (thousand tonnes)	Industrial resources (thousand tonnes)	Extraction (thousand tonnes)
85,832.11	12,595.31	655.48

The extraction of glass sand in Europe and the world is difficult to be assessed because sand is included in the industrial sand in the statistics. A description of the trends of changes in the production of this raw material is the information on glass production on the website <http://www.glassallianceeurope.eu>.



Chart 21 Glass production in Europe in 2005-2015 (million tonnes)

Due to relatively recent privatization and foreign capital investments, the rock and chemical raw materials industry in Lower Silesia does not differ in its development from such plants in the “old” EU and, some plants can be considered as more modern than those in the EU. Good examples involve the mines in Osiecznica and Nowogrodziec, the brick plant in Środa Śląska and many others. There are also “downstream” plants dealing with, e.g the production of automotive glass, which creates a product of higher added value.

The medicinal and thermal waters of Lower Silesia constitute 95% of the documented balance of available resources in the country. The use of thermal waters in Lower Silesia is a centuries-old tradition. The hot springs were discovered in 1175 by Duke Boleslaw Wysoki, while the oldest medicinal and nature reserve, “Jerzy”, with a swimming pool constructed on a source of the same name, was erected in 1498. The most dynamic development of Lower Silesia spas was in the 19th century, based on the mineral waters.

The volume of resources and consumption in 2015 are shown in the following table.

Table 15 Total resources and extraction of brine, healing and thermal waters from 19 deposits in Lower Silesia (converted based on BZK2015)

Available (m ³ /h)	Exploited (m ³ /h)	Consumption (m ³ /h)
38 250.55	506.72	126

In the Sudetes Mountains (Kłodzko Region, the area near Wałbrzych, the Jizera Mountains), there are mainly acidic and relatively acidic waters, relatively low mineralized, formed by acidification by dissolved carbon dioxide, which facilitates the leaching of minerals from rocks.

These valuable medicinal waters are used by both the spa and bottling industry. They occur in the following places: Czerniawa-Zdrój, Długopole-Zdrój, Duszniki-Zdrój, Gorzanów, Grabin, Jedlina-Zdrój, Jeleniów, Kudowa-Zdrój, Polanica-Zdrój, Stare Bogaczowice, Stare Rochowice, Stary Wielisław, Szczawina, Szczawno-Zdrój, Świeradów-Zdrój.

Radon water, used in balneotherapy, is associated with rock masses containing uranium minerals. They occur in the following places: Cieplice Śląskie -Zdrój, Długopole -Zdrój, Duszniki-Zdrój, Jedlina-Zdrój, Jeleniów, Łądek-Zdrój, Przerzeczyn-Zdrój, Szczawno-Zdrój, Świeradów-Zdrój, but their use in balneotherapy is limited to Łądek Zdrój and Świeradów Zdrój. Silicon water exists in: Cieplice Śląskie-Zdrój, Czerniawa-Zdrój, Długopole-Zdrój, Duszniki-Zdrój, Kudowa-Zdrój, Świeradów-Zdrój. Sulphide waters in Lower Silesia only occur in Kudowa-Zdrój, Łądek-Zdrój and Przerzeczyn-Zdrój.

The thermal waters in Lower Silesia belong to a group of low-mineralized waters, they are mainly of bicarbonate type, and occur in the following places: Cieplice Śląskie-Zdrój, Duszniki-Zdrój, Grabin, Jeleniów, Łądek-Zdrój.

The importance of the medicinal and thermal waters in modern Europe is reflected in the list of countries that have hosted the ESPA (European Spa Association) congresses in the 21st century.

10

Table 16 International Congresses ESPA in the 21st century

Year	Country	Year	Country
2000	Spain	2009	Lithuania
2001	Hungary	2010	Romania
2002	Czech Rep.	2011	Turkey
2003	Belgium	2012	Latvia
2004	Slovakia	2013	Bulgaria
2005	Iceland	2014	Denmark
2006	Portugal	2015	Poland
2007	Estonia	2016	France
2008	Switzerland		

11

According to the data of the European Spas Association¹¹, the following countries belong to the organization: Bulgaria, Croatia, Czech Republic, Denmark, Estonia, France, Netherlands, Iceland, Lithuania, Luxembourg, Latvia, Germany, Poland, Portugal, Romania, Slovakia Hungary. The Association of Health Resorts of the Republic of Poland is the Polish Member of the ESA, and in Lower Silesia it involves the following municipalities: Duszniki- Zdrój, Jelenia Góra, Mieroszów, Polanica-Zdrój, Świeradów-Zdrój, Łądek- Zdrój¹².

10

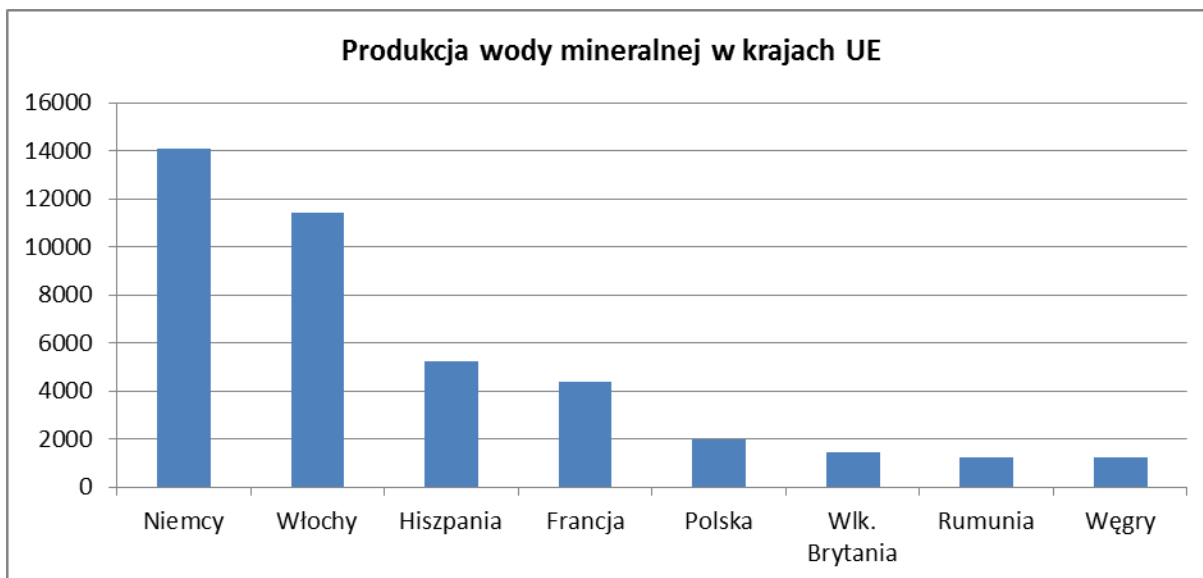
http://www.espa-ehv.eu/media/130/File/ESPA_Brochure/ESPA-Brochure_Out2014.pdf

11

<http://www.espa-ehv.eu>

12

<http://sgurp.pl/o-sgu-rp/czlonkowie-stowarzyszenia.html>



13

Chart 22 Position of the Polish among the major producers of mineral water (million litres) in Europe in 2015

In the production of mineral water, Poland is ahead of Germany, where the tradition of spa treatment has a centuries-old history. The predominance of Italy, Spain and France is partly due to the climatic and poor quality of lime water from some municipality sources in these countries. However, it should be pointed out that the consumption of bottled water in Poland is still below the European average.

3.1.2. Recovery and recultivation sub-industry

(6)	Correlation
between	the
phenomenon	of
exploitation	of raw
of raw	materials and the
materials and	development of
the development	of exploitation waste that
of exploitation waste	stimulates the need and
that stimulates the need	and ability to use secondary
and ability to use	raw materials
ability to use secondary	
raw materials	

The largest volumes of waste related to the exploitation of mineral resources are related to the mining of copper and brown coal ores.

So far, the exploitation of copper ores and other metals have been used in KGHM for over 600 million Mg of post-flotation waste at the presently abandoned Lena, Iwina, Wartowice and Gilow landfills and at the currently active site of Żelazny Most. The mass of post-flotation waste may amount to approx. 2000 million tons of Mg by the end of the exploitation of Lubin-Głogów deposit. Quartz and carbonate minerals (dolomite and calcite) and clay minerals dominate in the composition (Łuszkiewicz, 2000).

After the examination of Gilów landfill, Kijewski and Downorowicz (1987) stated that they can be considered as poor granular copper and silver deposit. According to Łuszkiewicz (2000), the future

use of inactive landfill sites as a source of copper and other valuable components is not excluded. It should be emphasized that the main waste mass can be used as a mining floor, building material, cement raw material, fertilizer etc.

After 40 years of activities of KWB Turów in 2006, 1.5 billion cubic meters of overburden (Zajączkowski 2012) were found on the landfill, with significant content of clays. Irrespective of this, significant amounts of furnace waste from Turów power plant is collected, e.g. in 2010 more than 2 165 thousand tonnes were developed (Rzepecki 2011). Over 1722 thousand of the above was transferred to rock placement in the mine excavation. Almost 432 thousand tonnes were provided to fill the inactive part of KWB Turów within the recultivation. More than 11 thousand tonnes were provided to Eltur-Wapora Sp. z o.o. for further economic use mainly as admixtures for concrete products.

The exploitation of rock raw materials involves the accumulation of significant amounts of fine-grained fractions generated during crushing and cutting of solid rocks (basalt, melafir, granite). In the case of waste generated in the production of basalt and melaphy, they can be used as fertilizer, raw material for the production of mineral wool. All fine fractions can potentially be used as fillers for construction chemicals, and from some of which one can try to recover rare earth elements (A. Solecki's own research).

Processing of significant quantities of apatite ore originating from Koło led to the formation of phosphorus pile in Wizowo. According to Jaroński (2016), it is a potential source of rare earth elements and contains an average of 0.69% of Ln_2O_3 , with resources of 828 thousand tonnes of rare earths, including 200 tonnes of yttrium and at least 33 tonnes of europium. Despite the importance of rare earths as critical raw materials, there are serious problems with the development of cost-effective recovery technologies from this pile.

The collected data did not reveal the influence on the development or recession of the natural resources and secondary raw materials industries. The most probable possibility of this relationship, i.e. the temporary shift of the development and recession tendencies in both sectors, is difficult to detect in the observed time horizon. The mining industry is characterized by extremely long up to tens of years' investment cycle, from the moment of started searching to running a mine and return. A prospective scenario for waste processing is possible mainly in the case of metal mining. It can be stated here that there is a strong connection between the business cycle and the development of technology, and the possible conversion of waste. With technological advances and a growing trend for metals, the technological process is being carried out so that fewer and fewer metals are left in waste.

For example, in 2007-2010, the post-flotation wastes in Nowe Zagłębie (Polkowice-Lubin) contained 0.18-0.25% copper and silver no more than 0.004 g/Mg. In the meantime, the content of copper was similar in the waste landfills in Stare Zagłębie (Bolesławiec-Leszczyno), but the silver content was much higher and ranged between 13.7 and 15.4 g/Mg (Kotarska 2012). The potential silver recovery should in this case be associated with "old" waste containing much more of this metal. Since many of the metal deposits are polymeric in nature, metals are sometimes subjected to the processing of metals that did not previously attract attention. Deposits of rhenium co-occurring in copper can be a potential example of such metal, the content of which in waste was not thoroughly investigated. As a

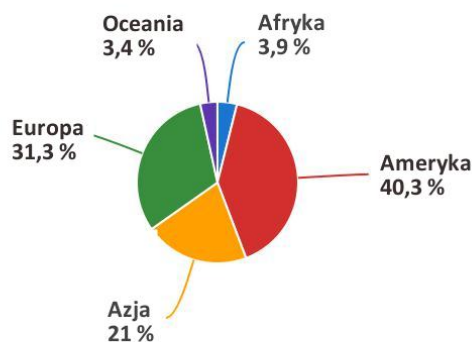
rule, acquiring metals from mining waste takes place many years after new technologies and possible price increases will make such a procedure profitable. The history of the Golden Stokes, where the oldest traces of gold mining date back to 4000 years ago, is an exemplary scenario for the mutual influence of natural resources extraction and recycling of waste materials in Lower Silesia. The first documents written about mining work come from 1273, and the apogee of gold extraction took place in the 16th century. Later, due to the influx of gold from the Western Hemisphere, gold extraction collapsed, partially offset by the production of arsenic. Only in the second half of the 19th century, due to the technological progress (Güttler's method), there was a renaissance of gold extraction combined with the re-processing of waste from piles.

3.1.3. *Wood processing sub-industry*

(I.2) The history of the Lower Silesia industry against the background of the history of industry development in Poland and Europe (2000-2016);

(I.3) Assessment of the development status of the Lower Silesia smart specialisation, the natural and secondary raw materials industry in the context of Poland and the European Union on a global scale;

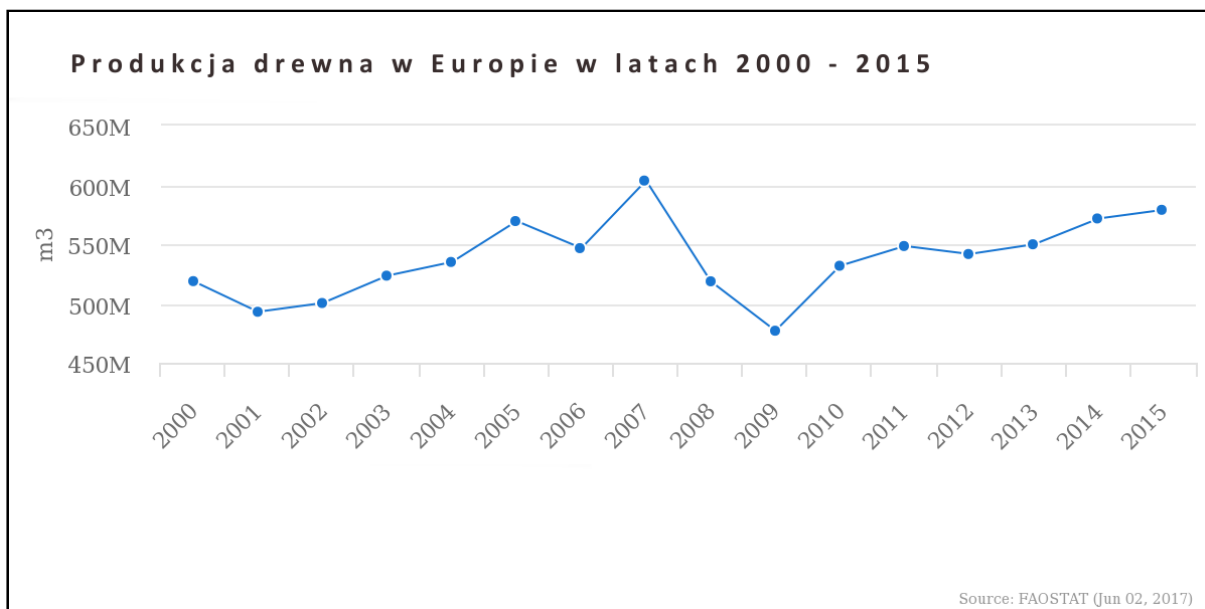
The largest producers of **wood** in the world are North and South America, which produce over 40% of wood and has been a leader in this field since the late 1970s (formerly Europe). Europe's participation in the world production of wood kept stable over the years 2000-2015, and was approx. 30-32%. 2007 was the exception, when the participation exceeded 34% for the production of both Americas. It was the year of the highest European wood production since the collapse of the early 1990s, and at the same time the onset of the American economic crisis and a significant decline in the production, which reached its peak in 2009. The below figure shows the participation of the continents in the world production in 2015.



Source: FAOSTAT (Jun 02, 2017)

Chart 23 Participation of the continents in the world wood production in 2015 (source: FAO)

Since 2000, the size of the wood production in Europe has ranged from 477 million m³ in 2009 to 603.6 million m³ in 2007. A large decrease in the production in 2008 and 2009 was associated with the global economic crisis, which began in mid-2007. By comparing the production of wood in Poland since 2000 to the trend on the European markets, one can see the increase in the production in 2007. No decrease in the production in the years of crisis is observed. In assessing the trend, it should be noted that the wood production in Poland is developed and its size increases. In 2000, it was 24.5 million m³, and in 2015, it was 36.5 million m³. The production size in Europe and Poland is presented in Chart 24 and Chart 25 .



Source: FAOSTAT (Jun 02, 2017)

Chart 24 Wood production in Europe in the period 2000-2015 (source: FAO)

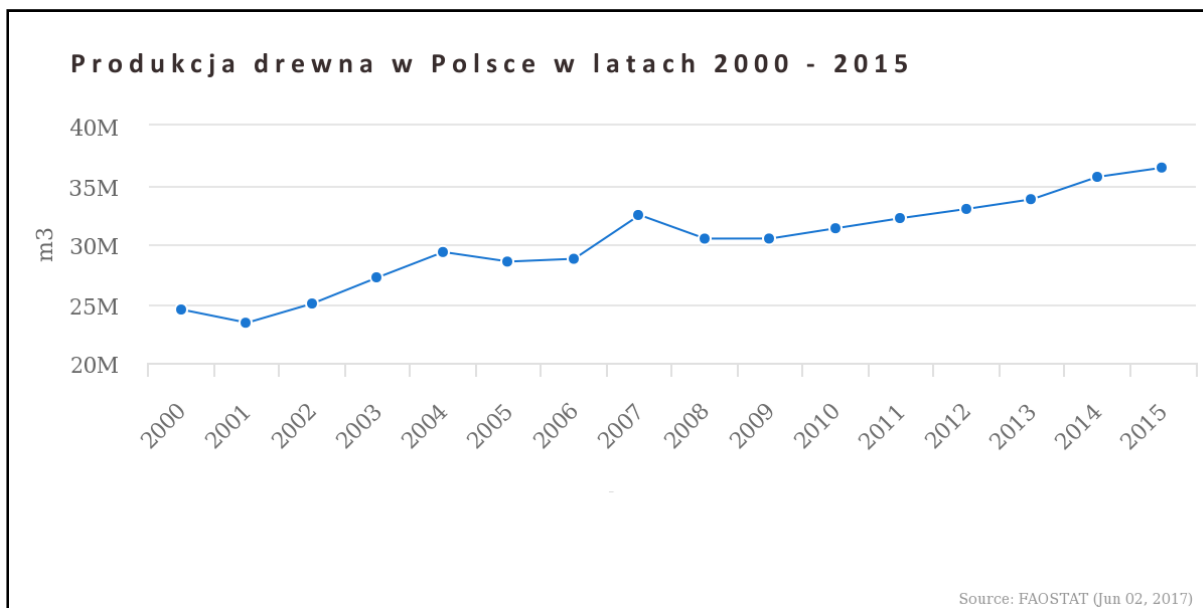


Chart 25 Wood production in Poland in the period 2000-2015 (source: FAO)

The wood production in Poland still increases, and its size ranks our country at the forefront of the countries of the European Union. In addition, among the countries leading in the wood production in the EU, Poland has recorded the largest increase in the production since 2000, the other countries show much slower growth: Sweden and Finland, and even a decrease in the production of: Germany and France. Figure 4 shows the production of wood in the countries of the European Union.

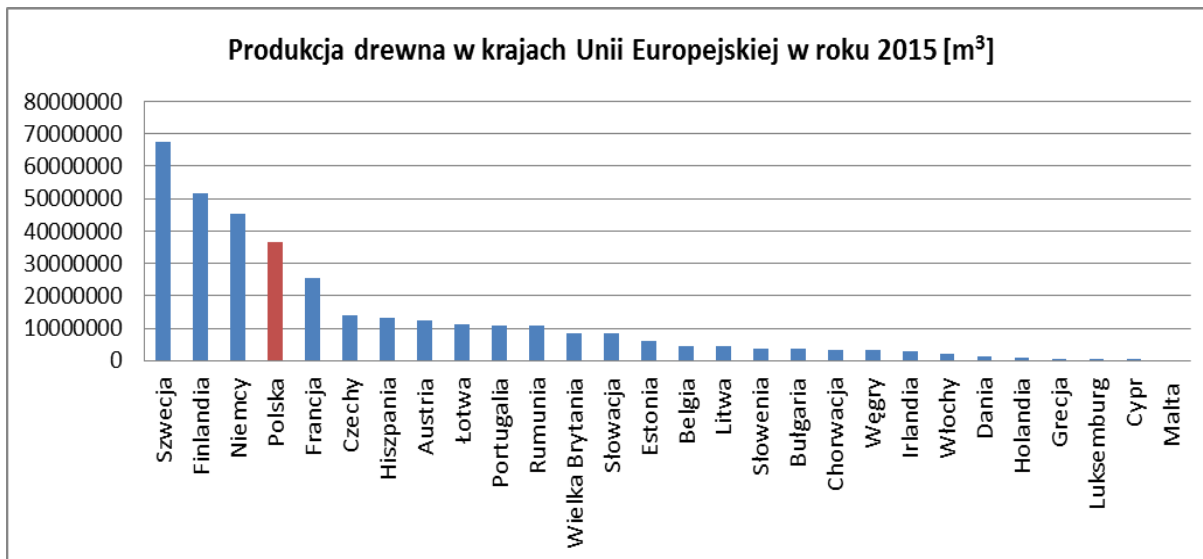


Chart 26 Wood production in the countries of the European Union in 2015 [m³] (own based on FAO)

In the years 2000 - 2015, there was an increase in the production of wood and all wood products in Poland, except for veneers, the production of which decreased more than doubled. Over 15 years, an increase in the production of lumber was 42.5%. The largest increase was recorded in the production of wooden floors - more than five times higher, and wood-based plywood - more than doubled.

By analysing the wood industry in particular regions, one can notice that most of them are obtained from western and northern Poland. Lower Silesian Region is on the 6th position in the country in terms of the acquisition of raw material. Zachodniopomorskie, Warmińsko-Mazurskie and Wielkopolskie dominate among the regions. In terms of the quantity and availability of the raw material, i.e. wood, Lower Silesia does not distinguish in comparison with other regions. It is distinguished by species diversity. The wood acquisition in Poland is shown in Figure 1 .

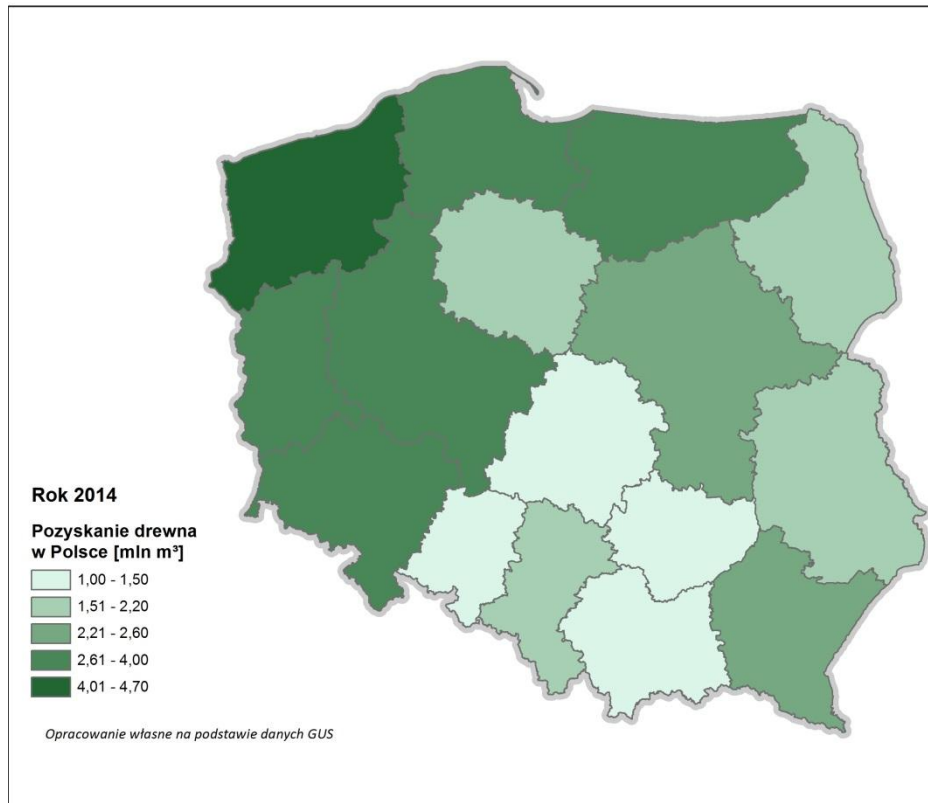


Figure 1 Wood acquisition in Poland according to the regions in 2014 (the data source: GUS - Central Statistical Office).

The above figure shows the high availability of the raw material, i.e. wood, in Lower Silesia. However, the introduction of the wood sales system by the State Forests on online auctions caused great difficulties in accessing the raw materials for small businesses. This system consists in auctioning of wood, where small businesses have much less opportunity to increase prices and lose with large wood companies, the plants of which are often located in Germany, Austria and the Czech Republic. It is worth mentioning that since 2010, the system has led to the bankruptcy of many sawmills operating in the area of Kotlina Kłodzka.¹⁴

In Lower Silesian Region, in 2015, 120 dam³ of lumber was produced, 99.9 dam³ of which was coniferous lumber. The total lumber production represented 2.5% of the total production of the country, while coniferous lumber was 2.3%. Chart 27 shows how the production changed in 2005, 2010, 2014 and 2015, as well as the participation of lumber produced from coniferous and deciduous species. The graph shows that the production of wood products increased from 2010 to 2015, however, a large decrease in the production compared to 2005 was observed.

¹⁴

<http://www.drewno.pl/artykuly/6993,tartaki-w-kotlinie-klodzkiej-na-krawedzi.html>

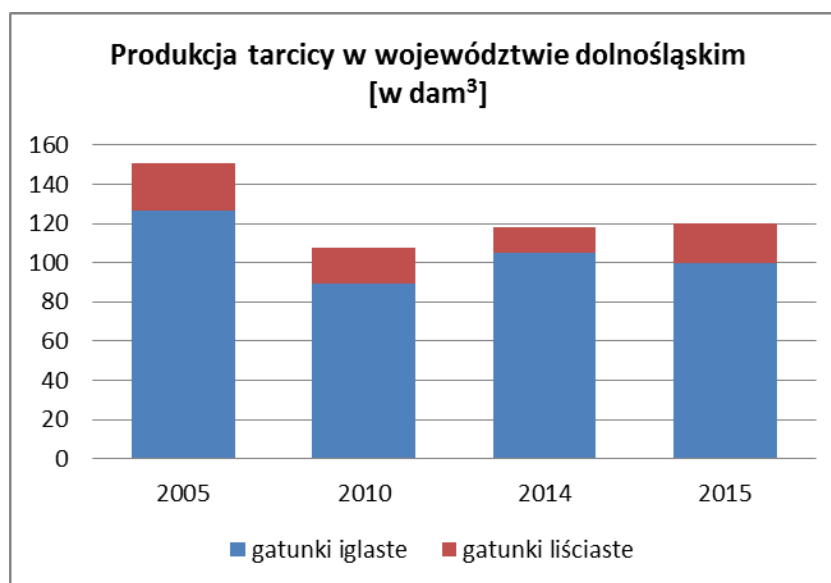


Chart 27 Lumber production in Lower Silesia [in dam³] (source: Yearbook of Lower Silesia 2016)

In 2015, the sold production of wood, cork, straw and wicker products in Lower Silesia reached 616.1 million PLN, and it was lower than in 2014, when it amounted to 662.3 million PLN. Compared to the value of 2005, sales of wood, cork, straw and wicker products increased by 50%. By analysing the data, it should be borne in mind that this study does not cover the products made of straw and wicker.

The significant increase in the value of the marketed production was recorded for paper and paper products. In 2015, this value was 3440.8 mln PLN. Compared to 2010, it was 75% higher, compared to an increase of more than eight times in 2005. The paper production is mainly made of pulp fibre - obtained in the process of mechanical or chemical fibre. However, other plant fibres such as straw or reed, other raw materials not included in the research, and waste paper after proper processing are also used for the paper production.

The development of the **furniture industry** in the country subject to the availability of raw materials – forests cover 30% in the country. Poland is the sixth furniture producer in the world and the fourth exporter. In 2016, the value of the furniture production in Poland reached 42.45 billion PLN, in Europe Germany and Italy showed higher production. Currently the largest part of furniture produced in our country is exported to the German market - approx. 36%, British - approx. 8%, Czech - 7%, French - 6% and Dutch - 5%. The Polish furniture are valued for high quality and an interesting design.

The furniture production in Poland increased by more than three times between 2000 and 2015. Over the years 2007–2011, the production remained at a similar level, a clear increase in production has been observed since 2013. The furniture production in Poland is shown in figure 6.

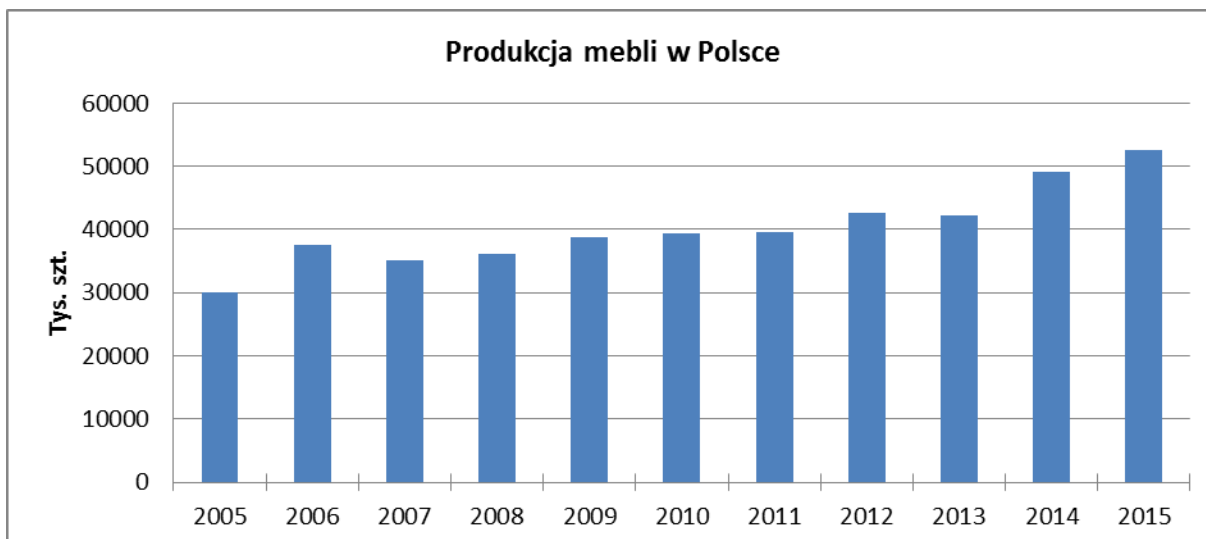


Chart 28 Furniture production in Poland in the period 2000-2015 (source: *Production of industrial products in 2015, GUS*)

In 2016, 28 680 business entities engaged in the furniture production were registered in Poland. Nearly half of these companies are located in the following voivodships: Wielkopolskie, Mazowieckie, Malopolska and Silesian Region. In Lower Silesia, there are 1750 companies producing furniture (source: GUS).

Wielkopolska also dominates in terms of the number of employees employed in the furniture production. In 2014, 158 808 people, 26% of whom worked in Wielkopolska, were employed in Poland. Lower Silesia employed 10 595 employees in the furniture production industry.

3.1.4. Advanced materials sub-industry

(I.2) The history of the Lower Silesia industry against the background of the history of industry development in Poland and Europe (2000-2016);

(I.3) Assessment of the development status of the Lower Silesia smart specialisation, the natural and secondary raw materials industry in the context of Poland and the European Union on a global scale;

According to an article published in the journal *Chemia i Biznes* (02/2013), it is estimated that in 2013 in our country there were 490-550 small, medium and large companies that were engaged in the production of **composite materials**. The Polish composites are used especially in the automotive sector (e.g. in the production of bodyworks of trucks, buses, cars, bumpers, masks and caravans) and in the construction sector. In addition, Poland has a significant contribution to the production of vessels made of composite materials. In 2009, more than 10 thousand yachts and boats were exported. In addition, in the wind energy industry, there is a significant increase in the use of composite materials. They are inter alia for the production of turbine blades. When analysing the

situation on the world market of the composite materials, it is worth mentioning that in comparison with traditional materials such as aluminium and steel, the composite materials still accounted for 5.5% of the total production in 2009. In the following years, the increase was observed, and in 2012 their market participation increased to 16%. However, in terms of the production of the composite materials, the European market was close to 26% of the global market. The most dynamic growth was observed in China, India and Brazil, and only subsequently in the North America and Europe. It is estimated that in 2012, the production of the composite materials in Europe was 1.096 million tonnes, close to 16% of which was produced in Central Europe and Eastern Europe. Poland represented more than 30% of the market, that is nearly 53 thousand tonnes of the produced composite materials. At the same time, the total increase in production was observed by approximately 14.6% compared to 2011. During the research, one did not manage to reach more up-to-date data. There is also no detailed information on the number of companies dealing with the composites in Lower Silesia.

According to the Specialised Technology Report: Nanotechnologies and Nanomaterials for 2014, nanomaterials are expected to be applied, inter alia for: production, storage and transmission of energy, components for use in electronics, electrical engineering and the automotive industry. The carried out analyses shows that the nanotechnology industry in Poland develops constantly. According to GUS data, in 2015, there were 101 companies carrying out any type of the nanotechnology activity, compared to 2013 there was an increase by more than 40% (in 2013, there were 71 such companies), and the research and development in the field of nanotechnology were carried out by 170 entities (in 2013, there were 149 entities). In 2015, there were 78 nanotechnology companies in the country, an increase of 63% over two years - in 2013, there were 48 such companies. These statistics indicate a strong development trend for both the nanotechnology and nanomaterials industries. According to information from the representatives of the Silesian Cluster NANO (Lower Silesia Branch) in Lower Silesian Region, approx. 20 companies closely related to the nanotechnology sector can be identified. Definitely more interest in this industry occurs in Upper Silesia, i.e. approx. 50 companies.

3.1.5. Identification of key factors and barriers to the development of the industry;

(I.9) Analysis of key factors and barriers to the development of the industry;

Based on the CATI and IDI research, in which the entrepreneurs were tasked to identify the key drivers of their industry development, the following factors were identified:¹⁵

- **Availability of the EU and national funds to support the activities** - vast majority (73%) of the respondents indicated the availability of funds to support the activities as a significant factor in the development of the industry. Only 12% of the entities of this group indicated that it was a barrier, which specifies a positive perception of the factor. At this point, it is worth to return to the analysis of the effectiveness of public intervention¹⁶ which indicated that only less than half

¹⁵

These factors have been used in the SWOT analysis (see chapter 6.4 "SWOT analysis")

¹⁶

See chapter 4.3. "Analysis of the effectiveness of public intervention"

of the respondents (46%) believes that the action taken by the public administration are essential. Thus, in the minds of the entrepreneurs, these issues are treated separately and the benefits of implementing the EU funds are not connected with the effectiveness of public intervention. It is difficult to say whether such tendencies concern only DIS natural and secondary raw materials or general companies in Lower Silesia.

- **Availability of financial instruments (Bank loans)** - DIS natural and secondary raw materials (especially the mineral and wood industries) are characterized by high costs. Due to the above, most entrepreneurs (62%) considered that the availability of financial support instruments (Bank loans) is an important factor in determining the development of their business.
- **Legal requirements in the field of running business** - More than half of the entrepreneurs (58%) considered that the legal requirements associated with these activities are an important factor in the development of their industry. According to the information obtained during the IDI and focus meetings, this mainly concerns the provisions regulating the implementation of new undertakings, in particular long waiting time for the environmental decisions and difficulties in ensuring good relations with local communities - these problems concern, in particular, the extraction of fossil.
- **Natural conditions (environmental impact assessment)** - Less than half of the involved entrepreneurs considered this factor important in their business. Half of the companies from this group considered it a barrier and the other half stated it was a chance. These results do not correlate with the common opinion that it is precisely the protection of the environment that inhibits the development of entrepreneurship in Poland. By analysing this element in detail, one can indicate a variety of answers depending on the sub-industry. This factor is identified as an important barrier mainly by the mining industry and by some entrepreneurs in the wood industry - which is directly related to the availability of raw materials.¹⁷
- **Cost of running business** - Entrepreneurs specified costs of running business as an important barrier (81%) – This applies in particular to the SME group. Similar results (80.5%) concerned the assessment of the cost of the work that the vast majority of the respondents considered as an important factor inhibiting the development of the industry.

In the context of the IDI research, the entrepreneurs were asked to indicate other, not listed in the scenario of the CATI research, factors that significantly impact on the development of the industry. Among the responses, the following factors were mentioned the most often:

- **Access to raw material and costs related to its purchase** - Entrepreneurs of the wood sub-industry pointed to complicated rules of purchasing wood from the State Forest, its too high price and difficult access to some species of wood. When referring to the mineral resources, the stone industry indicated that it was a significant problem, with an increasing share of the market, the import of cheaper stone outside the country (mainly from China) and the problem of access to high quality raw materials. In addition, the group pointed to a significant problem with access

¹⁷

61% of the respondents considered access to raw material as a significant factor in the development of the industry

to financial resources for the purchase of raw materials, which correlates with the factor related to the availability of financial instruments.

- **Condition of local infrastructure** - In some cases, the state of local transport infrastructure (e.g. communal roads passing through built-up areas preventing the non-invasive transport of spoil) was identified as a problem;
- **Low number of skilled workers** - A significant part of the response was to the lack of skilled workers - although a significant proportion of the respondents pointed to a general problem in this area, i.e. less workers' availability and increased labour costs. These issues directly impact on the competitiveness of DIS natural and secondary raw materials industry.
- **Lack of social education** - Entrepreneurs in the recovery and recultivation sub-industry pointed out that the major problem was the lack of education of the public on the environmental benefits of the use of secondary raw materials.

3.1.6. Analysis of competitiveness relative to the remaining part of Poland and the European Union

(I.6) Analysis of the competitive position of the industry in relation to Poland and regions of the European Union

Based on the information in chapter 3.1., describing the history and current state of individual sub-industries and the analysis of business environment institutions (Chapter 4) and spatial determinants (Chapter 6.1), the factors that combine the competitive advantages of natural and secondary raw materials at the EU and the world level:

- **The occurrence of different groups of raw materials within tens of kilometres, which is a factor contributing to the production of a wide range of consumer goods from furniture to the aerospace industry.** This allows a significant reduction in the cost of raw materials supply, especially for the SMEs, which, because of the small size of raw materials, usually use a relatively expensive transport by vehicles. Virtually no region in the world has a comparatively wide range of natural resources;
- **Natural monopoly at the EU level for rhine, copper and silver.** The efficient use of this monopoly requires careful strategy that will not violate the WTO standards (cf. question of rare earths in China¹⁸). These metals are located in the centre of Europe, with easy access to the market,

18

A popular discussion of the problem of rare earths in the global economy is contained in the film "Precious Stones" produced with the participation of the French television and broadcasted in Planete channel.

As Gavin (2013) writes, China accounts for 97% of global demand for rare earth metals and produces 60% of their products. According to the US sources in 2013, China had 36.5% of the world's rare earth reserves (although China claimed only 23%). In 2016, according to the USGS, Mineral commodities was 17%. Because these resources are non-renewable, the government of China decided to use them for their own economic development by forcing more and more restrictive export rules. When in 2010, it drastically reduced its

enabling to develop the whole range of aviation engines, air conditioning and solar heating systems, furniture and jewellery with copper and silver finishing, additionally decorated with stones from Lower Silesia.

- **The existence of educated workers and the tradition of exploitation and processing of various groups of mineral resources.** Staff resources include both technical graduates (Wrocław University of Technology) as well as designers and performers of artistic products (Fine Arts Academy, School of Arts and Crafts Management). There are also law, economics and management professionals (WIT, EA). The potential human resources include not only the young graduates, but also a large group of professionals with many years of experience;
- **The existence of numerous scientific research institutes, dealing with the field of mineral raw materials and advanced materials** equipped with modern apparatus. These institutions are able not only to provide counselling services, but also to train the necessary staff (see chapter 4.1. Research and scientific entities operating in the natural and secondary raw materials industry);
- **Road and rail infrastructure enabling efficient transport, including those located in Lower Silesia, unused airports, which may be a potentially interesting test ground for aircrafts.** The road network with the A4 motorway leading west to the German border and east to the Ukrainian border is particularly important. In addition, the express road S8 and the planned road S3, on the one hand leading to the border with the Czech Republic and on the other to the port of Szczecin, allows for both efficient road transport and transport by sea;
- **Urban nature of the Wrocław,** which makes it an attractive place of residence for potential high-qualified importers. Due to the expanded social infrastructure, Wrocław is able to secure not only social and recreational needs, but also education in foreign languages for children of the importing staff. The international airport and the A4 motorway provides the ability to maintain family contacts and social events not only from the neighbouring countries. Expanded housing construction allows to seamlessly purchase a flat/house of a various size and standard.

export prices by 40%, it raised concerns about the lack of supplies in importing countries that are dependent on China. These export restrictions undermined the confidence of the international markets in China as a credible supplier of raw materials to the global economy. In 2009, the EU, the United States and Mexico made their first formal complaint to the WTO against the Chinese export restrictions on nine raw materials. The WTO Dispute Settlement Body issued a verdict against China in July 2011. Following the Chinese appeal, the WTO Appellate Body confirmed the verdict of January 2012. Despite this clear WTO ruling, China did not attempt to remove its export restrictions. This forced the EU to question the Chinese export policy again in order to ensure fair access to these materials for European businesses.

The second formal complaint in the WTO led to an unprecedented alliance between the EU, Japan and the US on the Chinese export restrictions on rare earths and two other strategic raw materials, tungsten and molybdenum. The provided allegations were very similar to those contained in the first complaint. However, over the past few years, China strengthened its defense by announcing new legislative measures to close the legal gaps that existed in the first complaint. In June 2012, the State Council, the supreme administrative body of China, published its first White Paper on Rare Earth-based Industry, which justified the export restrictions and defended strongly against the WTO.

3.2. Economic potential

(I.1) Main determinants of economic development in Lower Silesia and characteristics of smart specialisation industry - natural and secondary raw materials

Lower Silesian Region is distinguished by its dynamic development. The GDP in the region has been growing steadily since 2003, and in 2015 it amounted to 151.5 billion PLN, which constituted 8.4% of the country's income and provided the 4th result in the country after Mazowieckie, Silesian and Wielkopolskie Regions (*source: STRATEG*). The comparative analysis of the gross domestic product per capita indicates that since 2006, Lower Silesia has been ranked second in the country after Mazowieckie Region, ahead of Silesian and Wielkopolskie Regions. In 2015, this ratio was at the level of 52 158 PLN, which represents 111.5% of the national average.

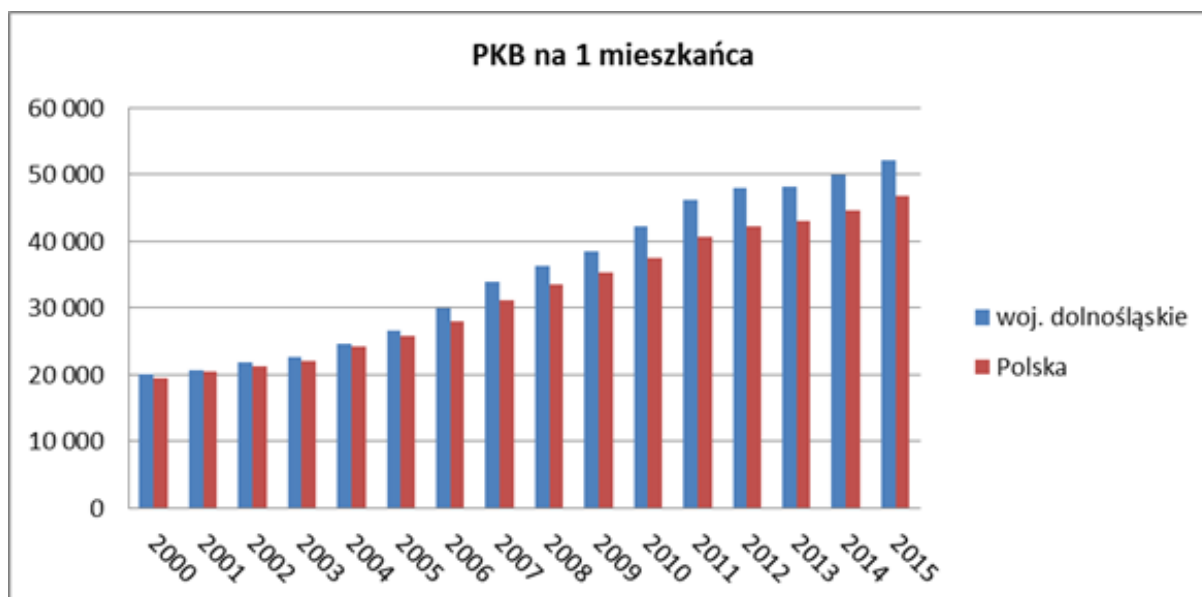


Chart 29 GDP per capita (at current prices) for the years 2000-2015 (*data source: GUS - Central Statistical Office*).

The value of exports from Lower Silesia Region has increased significantly since the accession of Poland to the European Union (from 20042.7 million in 2004 to 68225.1 million in 2014). During the entire period of the membership in the EU, the share of exports from Lower Silesia in the export of the country was from 9.9% to 12.8% (*source: STRATEG*). In 2014, total export value per 1 employee in Lower Silesia was 90424 PLN, for comparison, this value for the country amounted to 77031 PLN. Most of the goods are exported to the German, Czech, British and French markets. China is the most important export market, mainly due to the sale of copper.

Since 2002, gross added value per 1 employee has increased more than twice in both Lower Silesia and Poland. In 2014, the value of all products and services generated by all national entities minus the costs associated with their production per one employee amounted to 125 384 PLN for Lower Silesian Region. Gross added value per 1 employee working for the country amounted to 109 899 PLN. For the industry, gross added value per 1 employee in Lower Silesia was 179 178 PLN (GUS). The

higher value of the indicator in the region was recorded only for financial, insurance and real estate services. For comparison, in the country the value of the indicator for the industry amounted to 142 518 PLN, and among the regions only Mazowieckie had a higher gross added value per 1 employee.

In 2016, 361 307 business entities were registered in Lower Silesia, including 67 700 companies and 234,7 natural persons running business activity. Micro companies dominated, accounting for 96.5% of all registered companies. Small companies, with 10 to 49 employees, had a share of average 2.9%, with from 50 to 249 employees - 0.6%, and the rest companies with 250 or more employees (GUS).

3.2.1. Number and location of companies and employment status

(I.1) Main determinants of economic development in Lower Silesia and characteristics of smart specialisation industry - natural and secondary raw materials

As indicated above, in 2016, in 361 307 companies were registered in Lower Silesia. Out of these companies, 7928 companies were involved in the natural and secondary raw materials according to the Polish Business Classification selected for the research. In Section B - Mining and extraction, there were 463 registered companies, Section C - Production - 6917, Section E - Water supply; wastewater and waste management and remediation activities - 336, Section Q - Health and social services - 212 (data by the section selected by subclass, GUS). However, these data also include the entities not related to DIS natural and secondary raw materials. For example, in the section on health and social welfare, only spas and sanatoria (as therapeutic water treatment companies) are included in DIS, but they do not have the separate PBC.

To calculate the location indicator, the companies from the natural and secondary raw materials, were selected from the following sections and divisions by the PBC 2007 (without indicating the class) Section B chapters 05, 07, 08, 09, Section C chapters 11, 16, 23, 24, 31, Section E chapters 38, 39, Section Q chapter 86 (GUS). Based on the quotient of the share of the companies from the above-mentioned sections in the total number of companies for the regions and the country, the localization indicator of the companies of the natural and secondary raw materials sectors was calculated. The indicator values calculated for the data for 2016 are in the range from 0.78 to 1.27. Lower Silesia with the value of 0.92 is counted in six regions, for which the calculated indicator is lower than 1, which means that the indicator of the companies from the raw material industry to the total number of the companies in the region is lower than the value of those data for the country and the same means less concentration of these companies. Figure 2 It shows the distribution of values in the location of individual regions. As one can see on the map, the lowest location indicator of the companies of the raw material industry concerns highly developed regions, i.e. Mazowieckie, Śląskie and Lower Silesia.

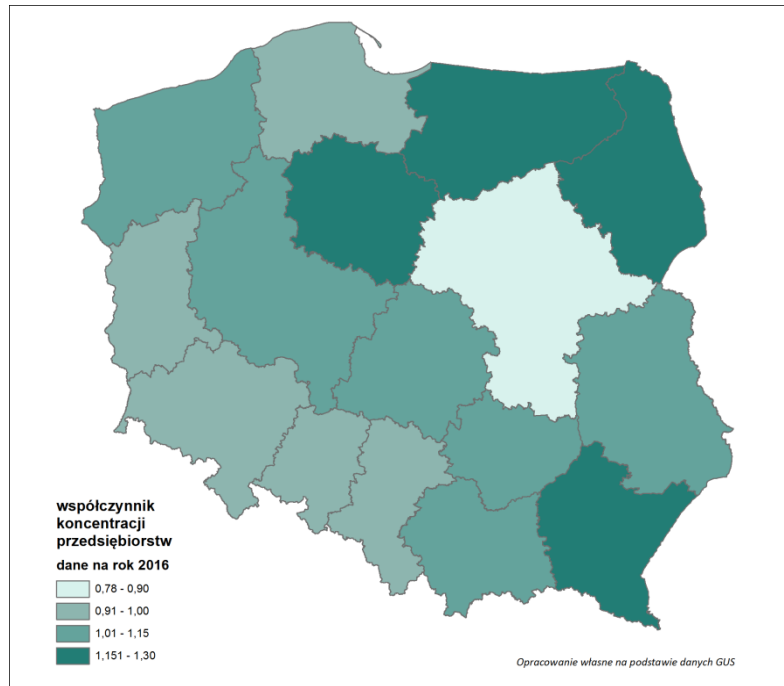


Figure 2 Companies location factor (source GUS data)

Calculation of the location indicator on the basis of revenues of the natural and secondary raw materials industry is impossible due to the fact that data on mining and extraction in Lower Silesia are covered by statistical confidentiality. However, it supposes that in terms of revenue, Lower Silesia can be in the forefront of the ranking of regions. In 2015, the value of sold production of industry in Lower Silesia exceeded 100 billion PLN, which provided the 4th position in the country after Mazowieckie, Śląskie and Wielkopolskie Regions. The share of sold value of the industry in these four voivodships is nearly 60% of the value of sold industry for Poland.



Chart 30 Value of the industrial production sold in 2015 (source: GUS).

The total number of the companies established in Lower Silesia in the years 1945-2016, with the analysed PBC (appendix 3) by the database of the companies for 2016. (Tech-Media Publishing House) is almost 2400. By the division for each year, the number of the companies established since 2000, characterized by a decrease in 2000-2002. In subsequent years, a significant increase was observed and lasted until 2012 with the maximum value in 2011 of 139 companies established in one year. 2013 is another decrease similar to 2002. In later years, one observed an increase up to 100 companies in 2015.

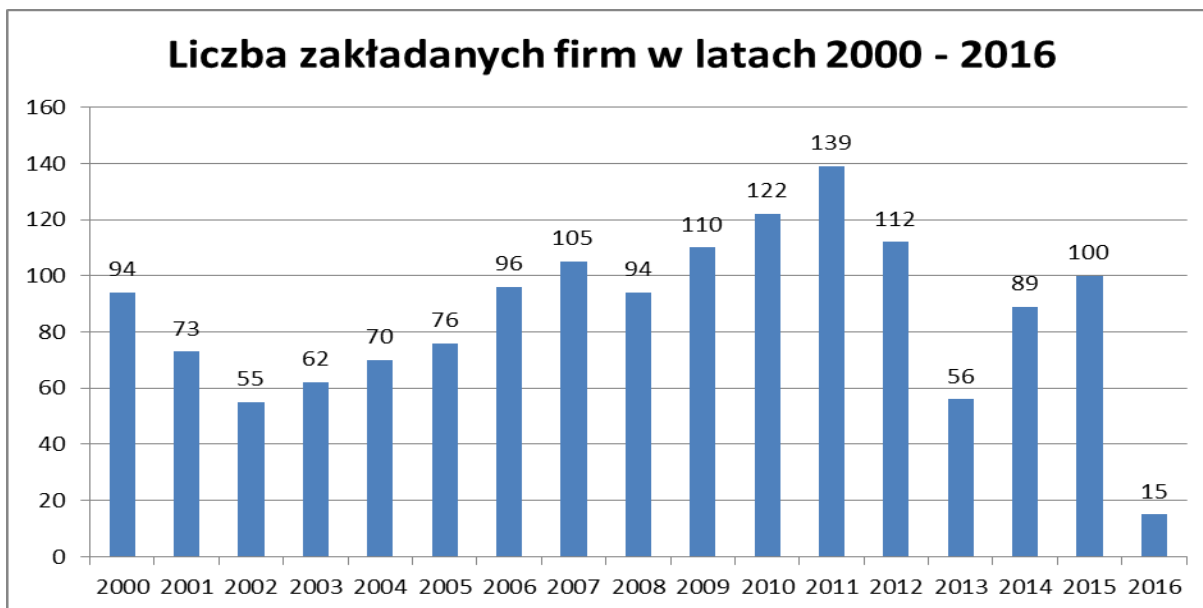


Chart 31 Number of established companies with the PBC taken into account in Lower Silesia in each year from 2000 to 2016

Focusing on the years 2000-2016 (Chart 31), it can be stated that a total of 1 468 companies were established and existed until 2016. All companies located in Lower Silesia within the analysed PBC, established in the years 1945-2016, employ over 67 000 people. In contrast, the companies established in the years 2000-2016 employed a total of 14 576 people. One-person companies account for 75% of all companies, i.e. 1089. The companies employing up to 9 people account for 13% of the total, i.e. 188, the companies employing up to 49 people account for 8%, i.e. 120, the companies employing up to 249 people account for 3%, i.e. 50, over 249 people - 1%, i.e. 15. (Chart 32)

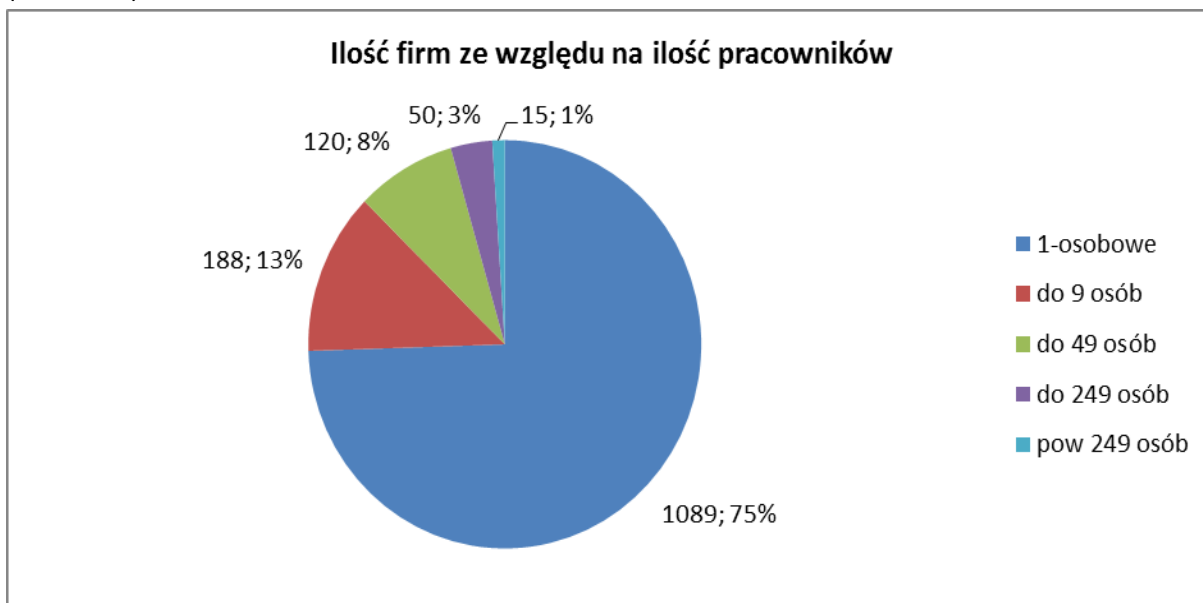


Chart 32 Number of companies of DIS natural and secondary raw materials industry due to the current state of employment in the general statement.

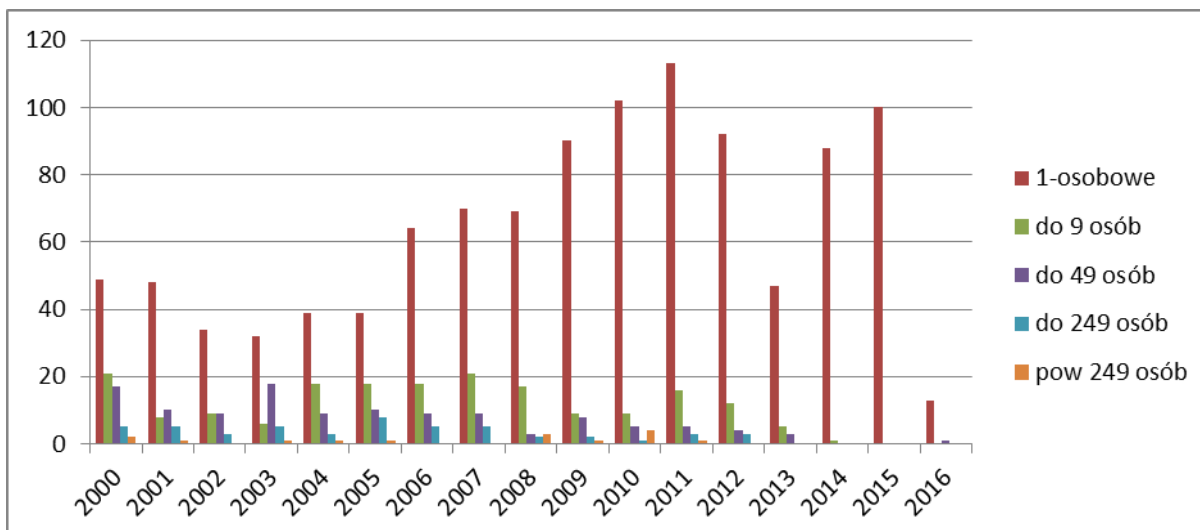


Chart 33 Number of companies of DIS natural and secondary raw materials industry due to the current state of employment in 2016 in the general statement divided into the year of starting operations.

The quantitative comparison (Chart 33) of the established companies in particular years of different state of employment shows that one-person companies dominate in each year. The number of the established companies is the lowest in the years 2002-2005. The upward trend continued until 2011. In 2013, a decrease was recorded. Re-growth was observed in the following years. It is worth noting that since 2014 the number of the established micro-companies represents almost 100% of all established companies at that time. It should be considered whether this is due to the desire to establish an independent one-person company or a form of employment selected by larger units as a replacement of a contract of employment.

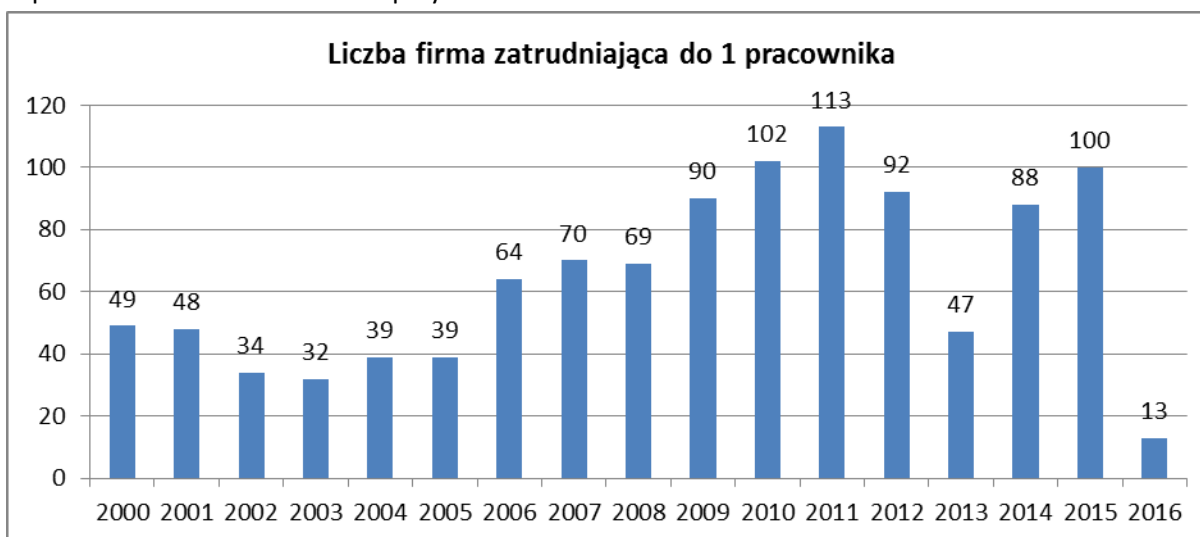


Chart 34 Number of companies of DIS natural and secondary raw materials industry currently employing 1 person (self-employed) established in individual years in the period from 2000 to 2016.

The number of established companies in individual years, which employed up to 9 people in 2016, characterised with a considerable amplitude from 21 in 2007 to 0 in 2015 and 2016 (Chart 35). In 2000, and then in the years 2004-2008, there as an average of 20 companies per year. Slightly less,



an average of 14 companies in 2011 and 2012. The lowest number of 5-8 companies accrue for the years 2001-2003, 2008-2010 and from 2013 to decrease to zero in 2015.



Chart 35 Number of companies of DIS natural and secondary raw materials industry currently employing 9 people established in individual years in the period from 2000 to 2016.

The companies employing up to 49 people were established in 2000 and 2003, respectively 17 and 18 companies (Chart 36). The general statement showed a decrease in the established companies. In the years 2014-2016, only one was established.

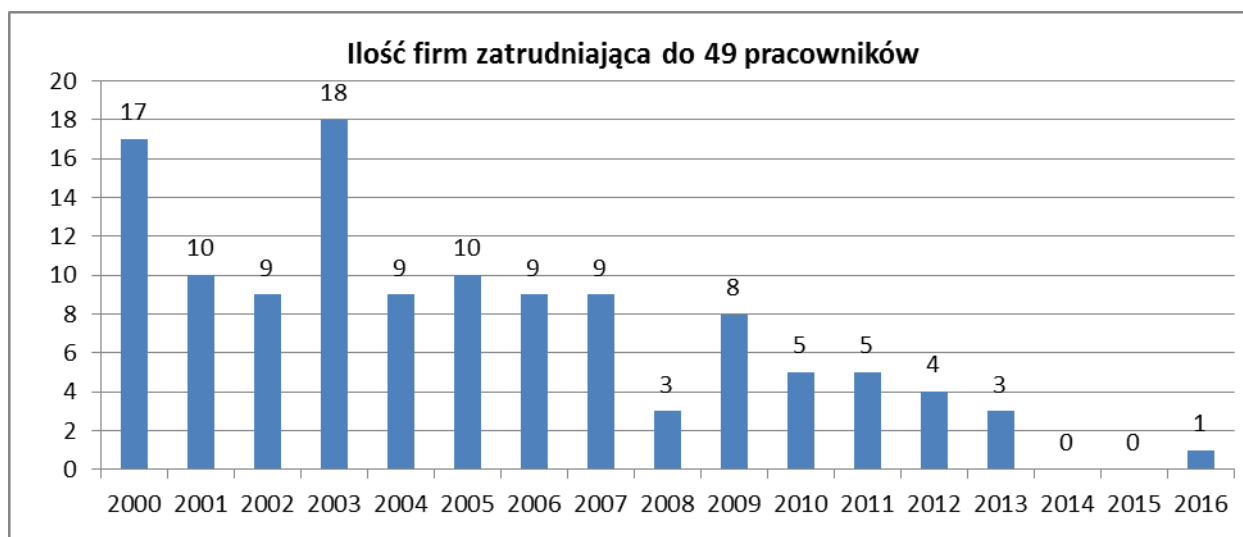


Chart 36 Number of companies of DIS natural and secondary raw materials industry currently employing up to 49 people established in individual years in the period from 2000 to 2016.

A similar situation as above concerns the companies employing up to 249 people. The most companies were established in 2005, i.e. 8 (Chart 37). In contrast, since 2013 no company was established.



Chart 37 Number of companies of DIS natural and secondary raw materials industry currently employing up to 249 people established in individual years in the period from 2000 to 2016.

The largest companies with more than 249 employees were established in the years 2000-2001 and 2003-2005. The range from 2008-2011 indicates a slight intensification of the phenomenon, because within nine years a total of 9 companies were established, which constitutes 60% of all established companies in this group over 16 years (Chart 38). In other years, no company was not established.



Chart 38 Number of companies of DIS natural and secondary raw materials industry currently employing above 249 people established in individual years in the period from 2000 to 2016.

By comparing the companies in terms of the number of employees and the starting date, it is clear that the largest total number of work places was established in 2000 and then in 2008. The employment at the level of 1100-1500 employees concerns joint companies established between 2003 and 2005 and also in 2010 and 2011. The apparent decrease was since 2013, where the value fluctuates at 100 new work places. The above analyses indicate a relatively long incubation period for new companies of the researched industry, which is a minimum of 4 years for the companies employing up to 9 people and longer than 8 years for the companies currently employing 49 or more people. An increase in 2008-2011 should be attributed to the provision of substantial funds from the EU of the previous programming period.

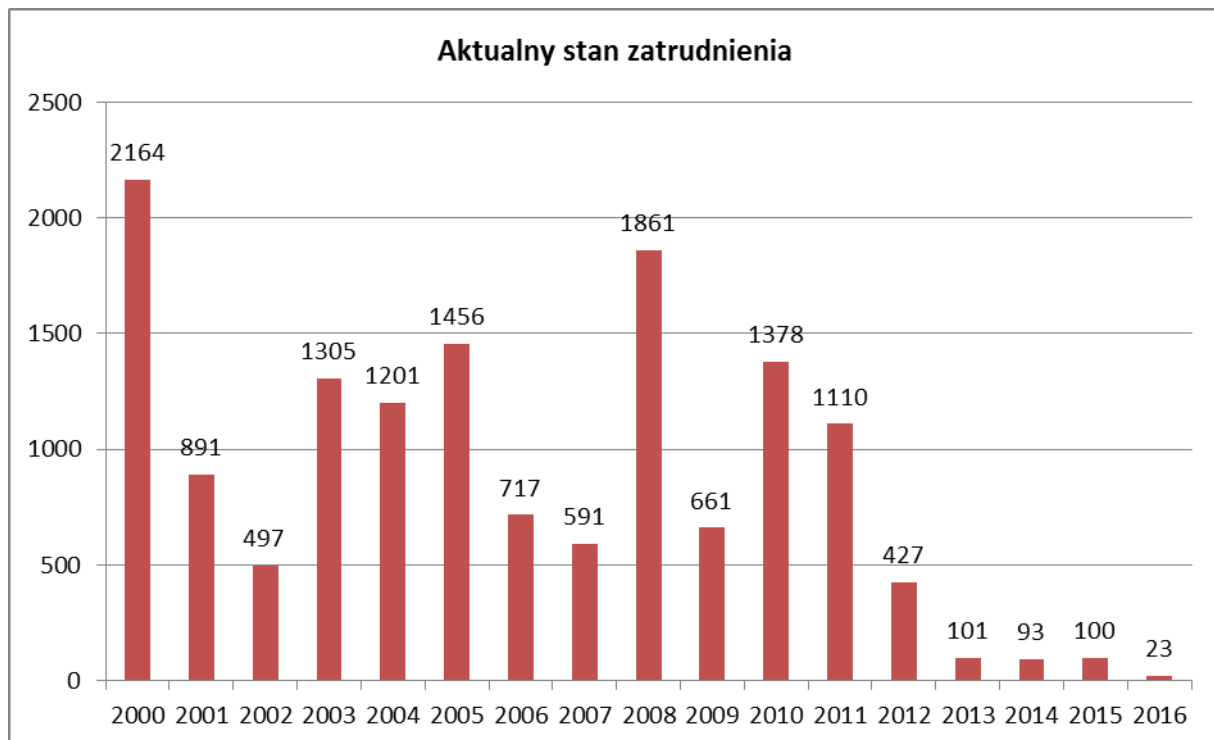


Chart 39 Total number of people employed in companies of DIS natural and secondary raw materials industry, which started operations in the period 2000-2016.

3.2.2. *The innovative potential of the region*

(I.1) Main determinants of economic development in Lower Silesia and characteristics of smart specialisation industry - natural and secondary raw materials

Lower Silesia is a region with great potential for socio-economic development and high dynamics. In the region innovation ranking developed by the Polish Agency for Company Development, Lower Silesian Region occupies the 3rd position behind Mazowieckie and Silesian Regions.

Statistical indicators determining the level of innovativeness of the region should be divided into those that show the resources and expenditures on innovation and R&D activities - input indicators and indicators of the innovation activity - output indicators.

One of the indicators is the input value of the internal expenditure incurred on research and development activities calculated in relation to the GDP. The expenditures on research and development in Lower Silesia steadily increased since 2003, and in 2015, the expenditures incurred for this purpose amounted to 1 282 million PLN, which accounted for 0.85% of the GDP of the region. This value was lower than the national average, which was 1%.

In Lower Silesia, the internal expenditures incurred on research and development in the industry amounted to 340.6 million PLN in 2015, which accounted for 26.6% of the total expenditures on R&D and 0.22% of the GDP of the region. The data are shown in the figure below.

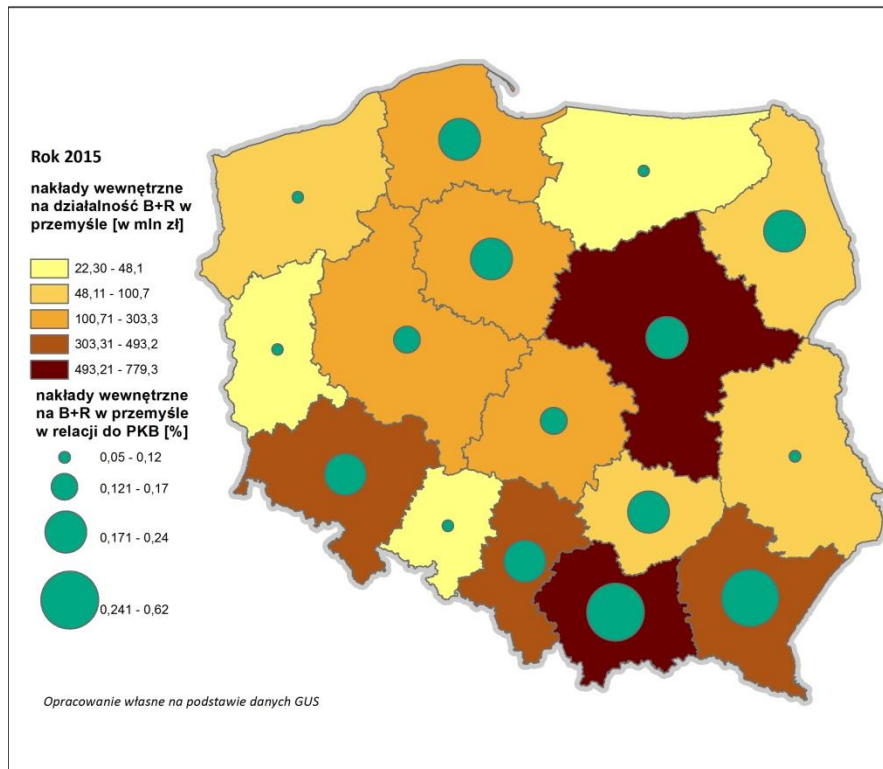


Figure 3 Internal expenditures for R&D in general and in relation to the GDP (data source: GUS)

Data on the share of the expenditures on R&D funded by the companies sector in total R&D expenditures, where the absence of a clear upward trend is visible, is different. In 2015, these expenditures accounted for 38.2% of total expenditures on research and development, and the result was lower than the national average of 39%, and the 7th result in the country. While two years earlier, in 2013, the share of the expenditure on R&D funded by the business sector amounted to 50.1% and this value was significantly higher than the national average of 37.3% (Chart 40).

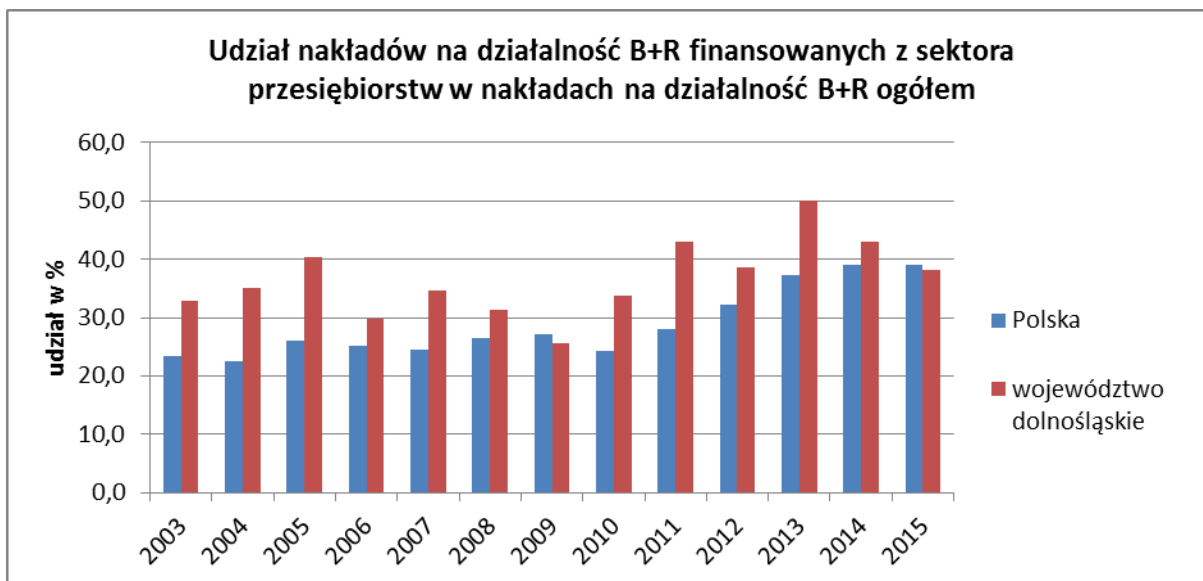


Chart 40 Share of the expenditures on R&D funded by the business sector in the expenditures on R&D in total (*data source: GUS*)

In the structure of the internal expenditures on R&D activities according to the sources of financing in Lower Silesia, the government sector and the companies sector are very similar, their share in the financing of R&D is very similar and amounts from 75% to 88% of total expenditures (GUS data for 2011-2015). The relatively large share of the expenditures on internal R&D activities relates to foreign institutions, in the years 2011 to 2015, it was a share ranging from 9.7% to 17.7%. The remaining part relates to the internal expenditures derived the higher education sector and private sector of non-profit institutions.

Another important indicator illustrating the resources of innovative activity in the region is the average share of the innovative companies in the total number of companies. In Lower Silesia, the value of this indicator was 14.2% for 2015, a value higher than the national average for the year, i.e. 13.7%.

The share of the innovative companies within all industrial companies in Lower Silesia was 36.1% in 2015. 27.9% of the industrial companies of the public sector and 36.9% of the industrial companies of the public sector in Lower Silesia introduced product or process innovations in 2013-2015. The table below details the share of the companies that introduced the innovations in the general industrial companies in Lower Silesia. The data concern economic entities employing more than 49 people.

Table 17 Industrial companies that introduced the product or process innovations in % of all companies in the period 2013-2015 (*source: GUS*)

Industrial companies	Industrial companies that introduced the product or process innovations in % of all companies in the period 2013-2015
Mining of metal ores	100.0
Other mining and extraction	15.8
Production of beverages	100.0



Production of goods from wood and cork, except for furniture; production of goods from straw and plaiting materials	20.0
Production of other non-metallic mineral products	48.6
Production of metals	54.5
Production of furniture	37.5
Waste collection, treatment and disposal activities; raw materials recovery	14.8
Recultivation services and other services related to waste management	-

Lower Silesia is in the forefront of regions in terms of the share of people employed in R&D in the professionally active population. These are the people associated with the activities of research and development, both technical staff and support staff. In Lower Silesia, the percentage is 0.99%. The share of people employed in research and development in the industry in the economically active population for Lower Silesia in 2015 amounted to 0.2%, which is the 3rd highest in the country. The average value for Poland is 1.3% (GUS).

The last input indicator for the innovation level of the region is the percentage of the companies cooperating in the field of innovative activity in general innovative companies. The cooperation is based on jointly implemented projects for innovative activities with other companies or non-profit institutions, and does not have to immediately bring immediate tangible benefits. In Lower Silesia, the percentage of the cooperating companies in innovative activities in 2015 amounted to 6.8%. Chart 41 It illustrates how this percentage changed over the years 2009-2015 in comparison with an average value for the country.



Chart 41 Percentage of the cooperating companies in the field of innovative activity at all innovation active companies; data in % in 2015 (data source: GUS).

In 2015, in Lower Silesia, there were 268 innovative industrial companies among the companies employing more than 49 people (data of the Statistical Office in Wrocław). 88 companies had



established agreements with the institutions in the country, while 79 had agreements with the foreign institutions.

The share of revenues from the sale of innovative products to the market in total revenue of the industrial companies is a starting point, helping to determine the level of innovation in the region (Chart 42). For Lower Silesia, this share amounted to 8.56% in 2015, which is the highest percentage in the country. Similarly, the high proportion was reported for Kujawsko-Pomorskie Region. For other regions, this indicator was from 1.4% to 5.24% The chart below shows how dynamically the share of sales of the innovative products for the market increased in total revenues in 2009-2015.

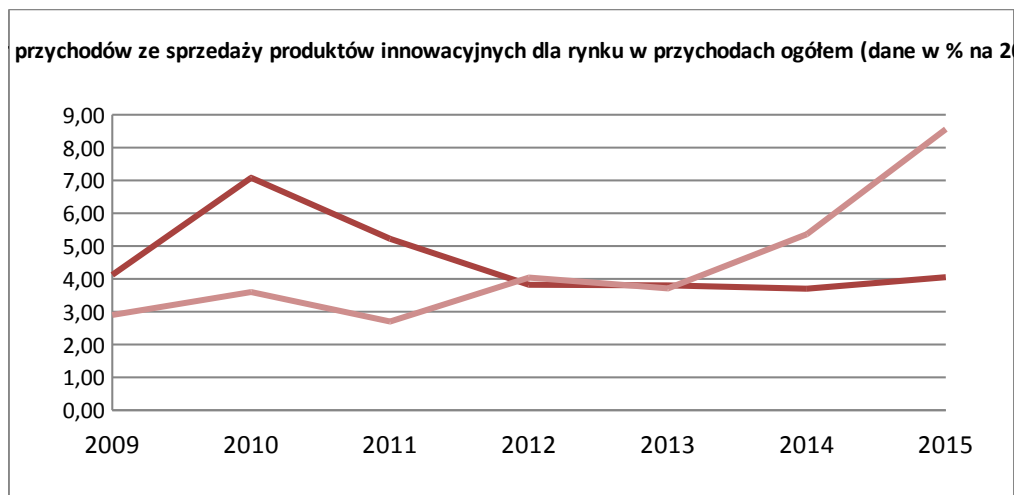


Chart 42 Share of revenues from sale of the innovative product for the market in total revenue of the industrial companies for 2015 (data source: GUS)

The share of net revenues from sales of new or significantly improved products in net sales from industry in 2015, for business entities with more than 49 employees, amounted to in total 16.3%. Depending on the type of business ownership, this is 0.8% for the public sector and 16.7% for the private sector.

The second indicator of the effects of innovative activity is the share of revenues from the sale of the innovative products for exports in the total sales of the industrial companies. As mentioned earlier, the value of the export of Lower Silesia has increased substantially since the Polish accession to the European Union. In 2015, the total value of exports amounted to 747 248.2 mln PLN, which translates into 77 031 PLN per employee. The share of net income from the sale of new or significantly improved products, in the industrial companies, in revenue from total sale of Lower Silesian is at a very high level. In 2015, the value of this indicator in Lower Silesia and Wielkopolskie Regions was significantly lower than the average for the country. Lower Silesia with the value of the indicator of 11.78% occupies the 1st place in the country, for Wielkopolskie Region this coefficient is assumed to be 10.23, while for other regions these values range from 1.9 to 7.21%. The average for the country is 5.44%. The situation is shown Figure 4.

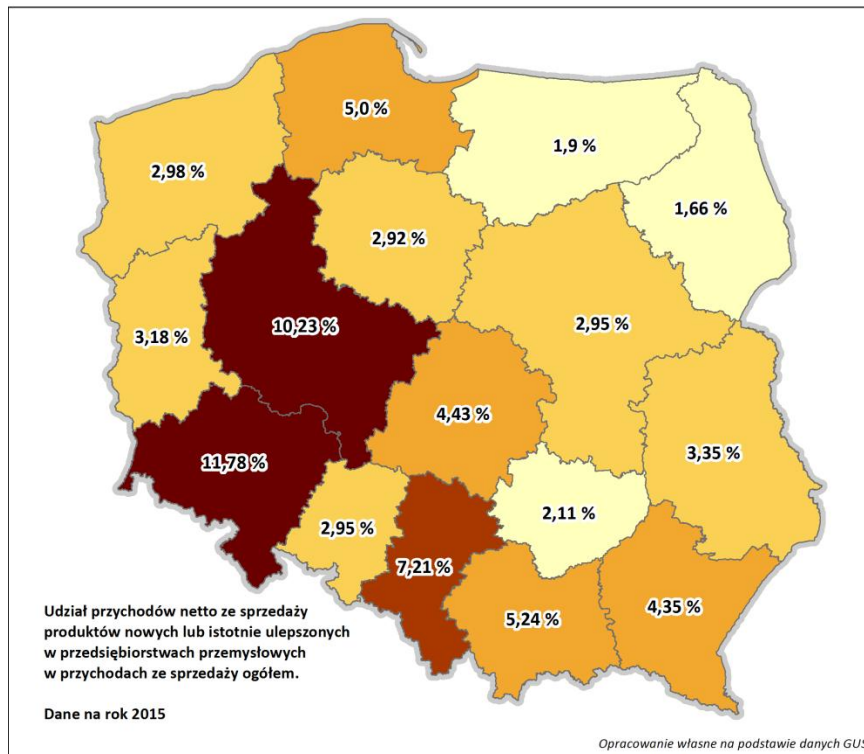


Figure 4 Share of net revenue from sale of new or significantly improved (innovative) products in the industrial companies in total net sales revenue (data source: GUS)

The number of patents granted by the Patent Office per 1 million of residents is another statistical indicator that allows the regions to be compared in the context of innovation. Again, Lower Silesia can be distinguished with the highest value of 92.9 in 2015. A similar number of granted patents per 1 million of residents relates to Mazowieckie Region, while the average for the country is 62.5. In general, in Lower Silesia, 270 patents were granted in 2015, more were granted in Mazowieckie and Silesian Regions. In the same, the protection rights were granted for 36 utility models.

Figure 5 shows the differentiation of region in terms of the number of patents granted in general and per 1 million of residents.

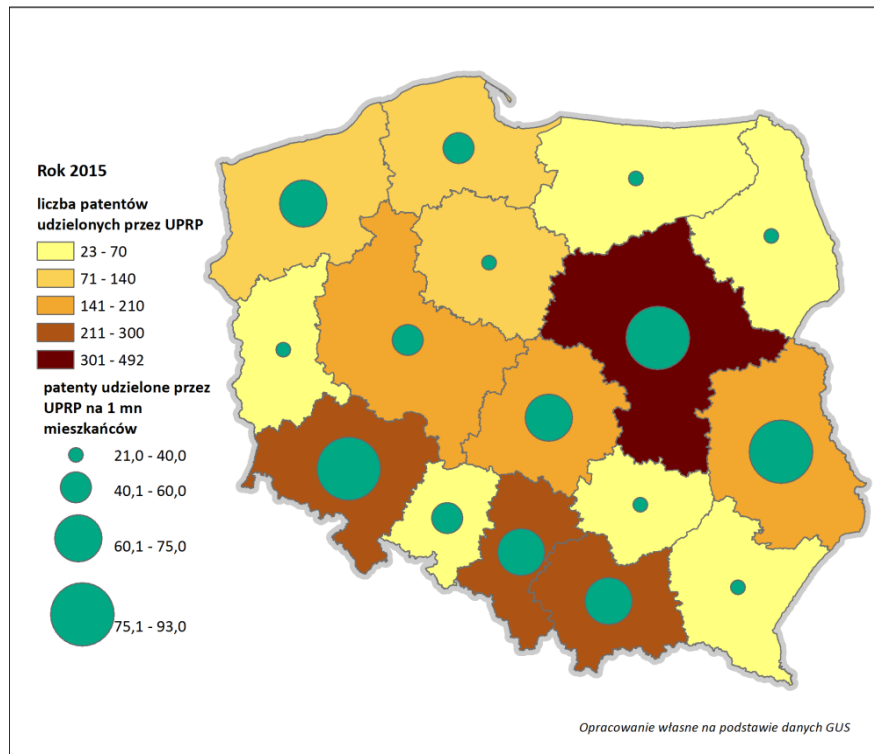


Figure 5 Number of patents granted for national inventions by the Patent Office of the Republic of Poland and patents granted by the UPRP per 1 million of residents in 2015 (source: *GUS*)

The ratio of the number of patents granted and the number of population in individual regions to the value of the whole country allows to calculate the indicator of localization, whose value illustrates the scientific potential of the region. The value of this indicator calculated for the data of 2015 (GUS) for the regions are from 0.34 (for Warmińsko-Mazurskie) to 1.49 (for Lower Silesia). Value 1 means that in the region the scientific potential is equal to the average potential of the country, values < 1 mean a lower potential, and > 1 means a higher scientific potential. Figure 5 shows the values of the location of individual regions. Comparing the data, one shows a high level of concentration of scientific potential in Lower Silesia, comparable with the level for Mazowieckie Region.

The number of registered patents is a common indicator of innovation. According to the experts, approx. 48% of patents registered per year in Poland is generated by universities. However, there are no statistical data regarding deployments. According to the experts responsible for the implementation, this value is approximately 1-2%. Within their research, universities develop new solutions that are patented, but in most cases, the minimum necessary time to obtain a patent is paid. The points awarded for the patent, not licensing itself or sale, are the benefits to the university from the application. The research and development institutions that are inventors of new solutions, which can potentially bring measurable economic benefits, often fail to report them to the Patent Office, as a patent description in the bulletin can be a basis for the industry for illegal use of their ideas. Hence, when analysing the innovation of the region or the country, it is important to bear in mind what information is involved in the indicator, i.e. the number of registered patents.

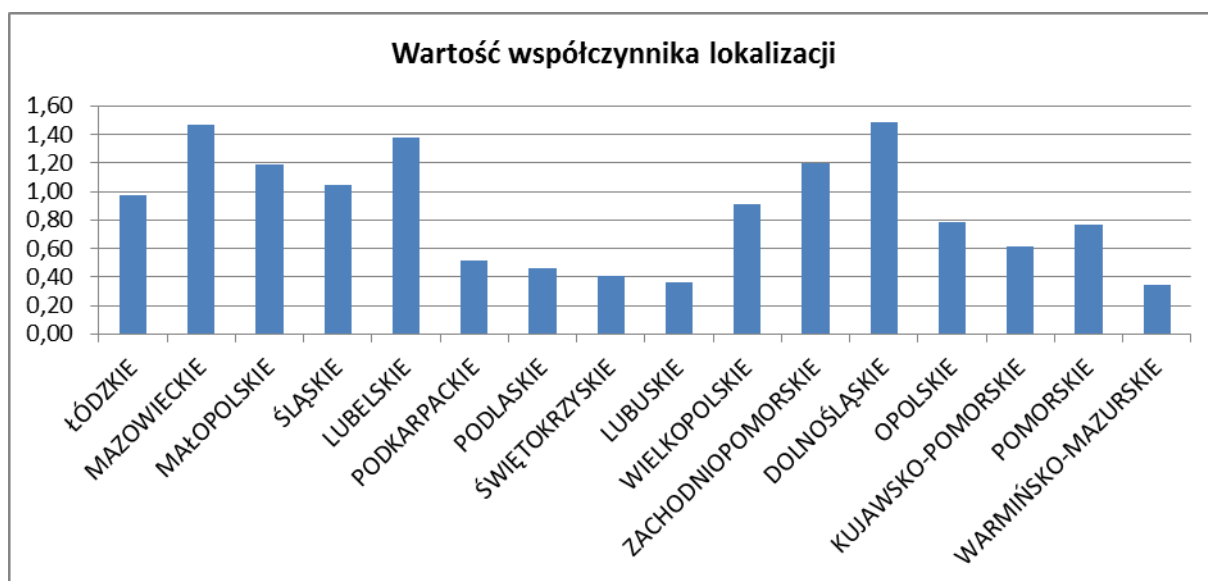


Chart 43 Values of the location according to the data from 2015 (GUS data source)

3.2.3. Export of goods and services

(I.4.4)

Internationalisation of the companies of the natural and secondary raw materials industry, including size, dynamics and export concentration

The export of goods and services is one of the possible directions of development for the companies. Focusing on the external markets allows for greater productive independence for the company that is more independent of local and national market conditions. According to the experts, gaining new markets requires more innovation and more sophisticated solutions than it results from functioning on the national market. Only such an approach allows for a real strengthening of a position on foreign markets. The directions and size of exports of particular raw materials are presented in Chapter 3.1. Sub-industries of DIS natural and secondary raw materials against Poland, Europe and the World. The following analysis was carried out on the basis of the carried out CATI research.

The international business coverage is declared by nearly half (48%) of the companies involved in DIS natural and secondary raw materials. However, for the vast majority of them (44%), turnover in the international trade is less than 10% of total turnover. This revenue structure demonstrates that these companies are focused on the regional or national market and foreign sale is regarded marginal. This can be due to the lack of proper preparation for activities under other sales conditions, lack of adequate resources to implement the procedures and innovations facilitating such activities, or lack of business needs. The share of turnover from the international activities is over 26% of the total amount declared by the entrepreneurs of Lower Silesia who consider their scope of activity to be international. This is a satisfactory indicator that more than 10% of the total researched companies have become independent of the local economy, focusing on the export of their goods and services.



The carried out survey indicates a significant geographical diversity in the case of the scope of activity of the companies. The largest proportion of the companies (64%) declaring the international range occurs in Legnica-Głogów region, and the lowest (43%) in Wrocław sub-region (Chart 45).

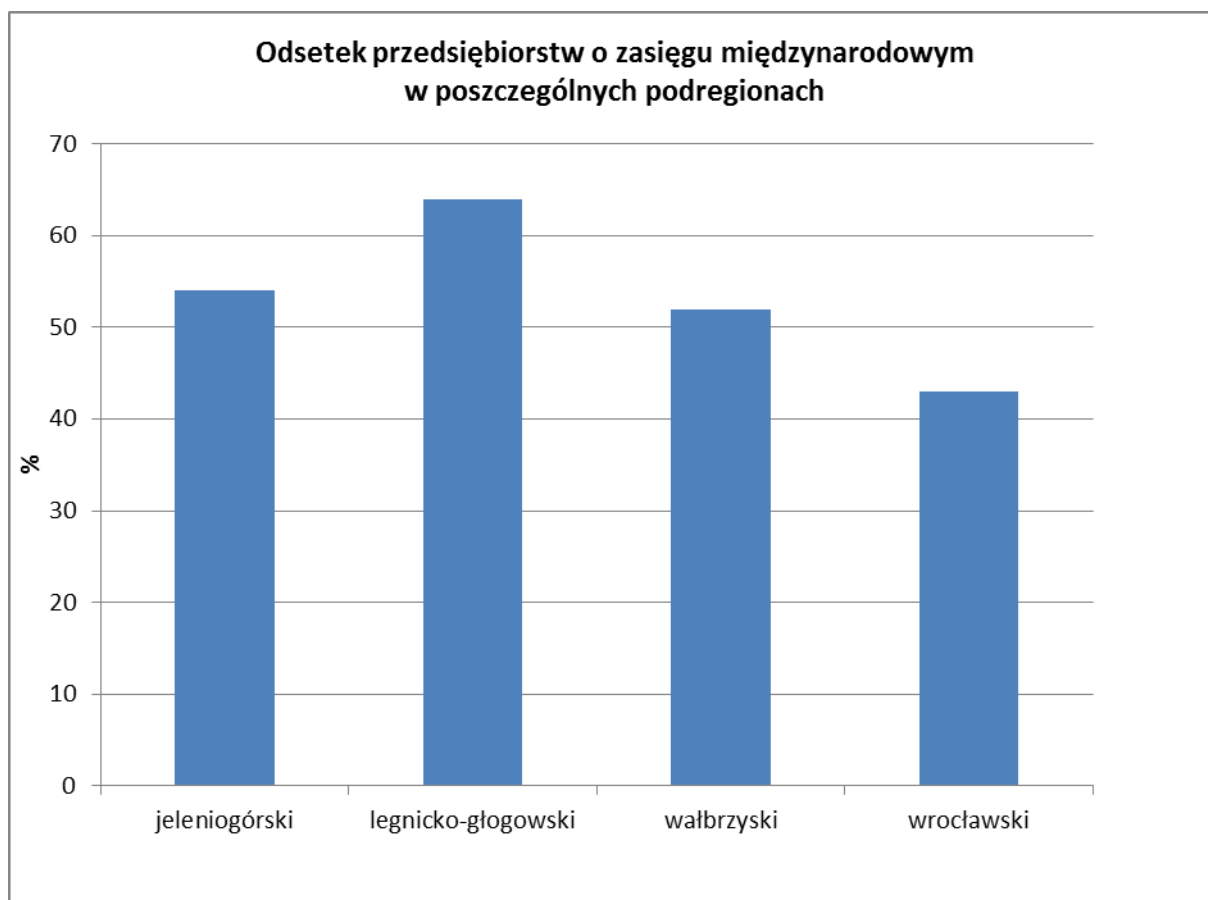


Chart 44 Percentage of the companies of the international range in each sub-region (based on CATI research)

Such results can be related to the fact that many companies connected with Wrocław agglomeration have a wide market in Wrocław, so they do not need to look for external markets. The companies located further from the capital of the region are inevitably heading towards alternative export markets for their products or services. However, the responses to the share of the international trade in business turnover are completely different. The most often, the entrepreneurs from Wrocław sub-region (33%) report more than 50% of their sales in foreign trade. This can prove the fact that these companies are directly oriented towards the international activity, and for businesses more distant from the capital of the region, such activity, although more common, is merely a supplement to local or national sales.

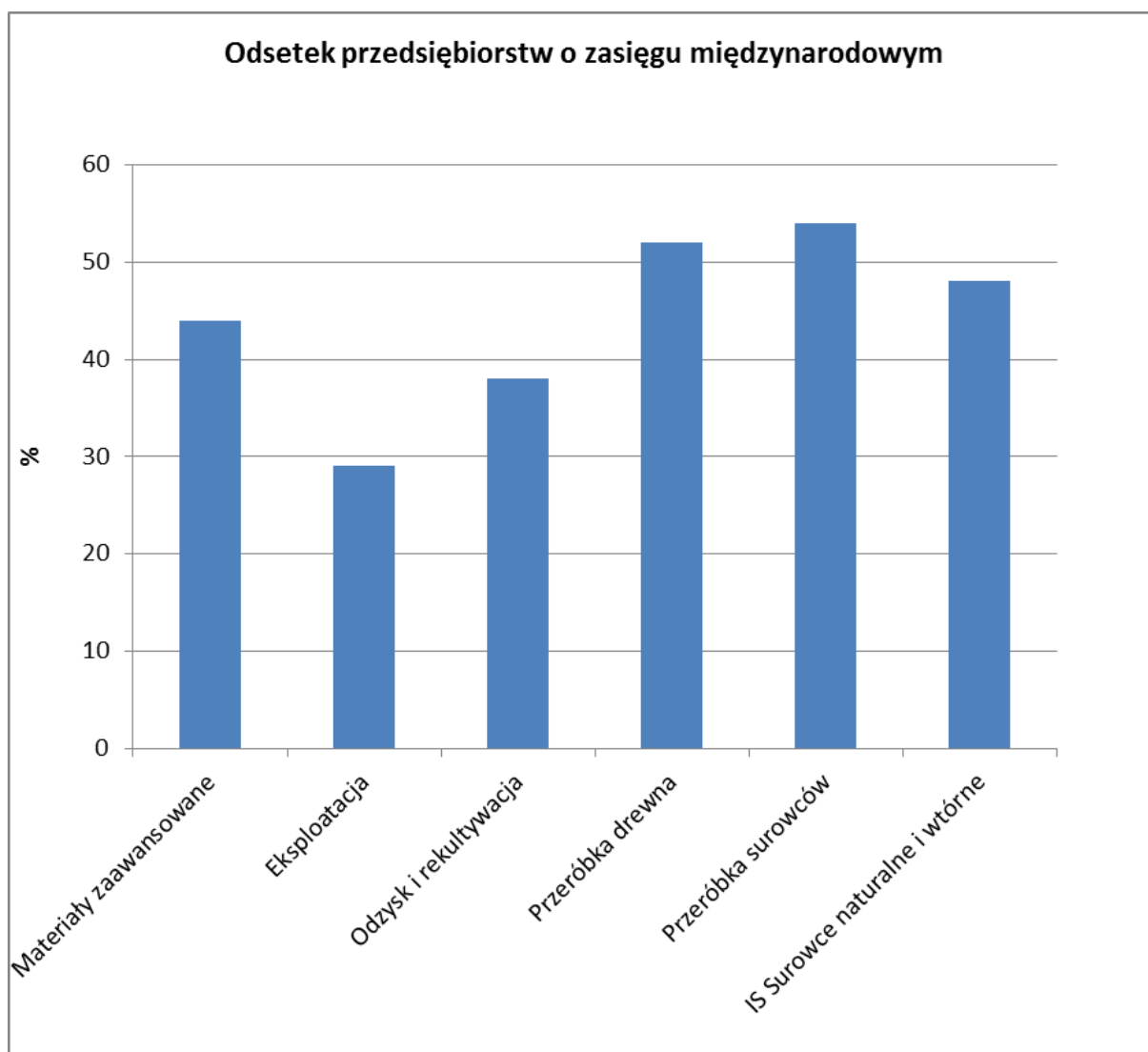


Chart 45 Percentage of the companies of the international range based on CATI research

Taking into account the sub-divisions of DIS natural and secondary raw materials, the largest focus on the export of the products and services can be seen in the case of the processing companies, both in terms of wood and mineral resources. It is associated largely with strong competition in these areas on the national market. The entrepreneurs, looking for sale markets, have to move towards other markets, because the national sales are not able to provide an adequate level of revenue.

The Local Government of Lower Silesia works to promote the industries of Lower Silesia abroad, including in the non-European markets. One of such initiatives is the project of Lower Silesia investor and exporter service centre DAWG aiming at organizing study visits of economic missions and travels to fairs for the entrepreneurs from particular industries of Lower Silesia. However, these activities are addressed only to the following industries: automotive, electronics and household appliances, IT/ICT, chemical, cosmetic, agro-food and machine industries, with the exception of DIS natural and secondary raw materials.

3.2.4. Analysis of forecasts and development trends in sub-areas of the specialisation of the natural and secondary raw materials;

(II.1) Analysis of forecasts and development trends in sub-areas of the specialisation of the natural and secondary raw materials in Poland and Europe;
(I.7) Analysis of the attractiveness of the industry development for Lower Silesia;

Starting with the analysis of the trends¹⁹ one must remind the division into the sub-areas of specialisations adopted in the introduction of this study. A detailed description is presented in Annex 2 to the report. On the basis of this, it can be seen that among all the companies currently registered in Lower Silesia potentially belonging to DIS natural and secondary raw materials (2244 companies)²⁰, the most represented group of the companies is included in the production and processing sub-area (1426 companies), a part of which declare the production of advanced materials²¹. The percentage of the remaining groups is illustrated in Chart 44, where the woodworking industry is the second largest group of the companies of DIS natural and secondary raw materials (564 companies).

¹⁹

The analysis of forecasts and development trends (in the probable scenario) in sub-areas of specialisations of natural and secondary raw materials is based on the information obtained during the two focused meetings (panel of experts) and during in-depth interviews (IDI). The results of other analyses carried out for this study were also taken into account.

²⁰

The state of 2016 was assumed based on the Polish companies developed by Tech-media Publishing House.

²¹

It was estimated based on the answers of CATI research, which refers to the list of the PBC.



Chart 46 % Percentage distribution of the companies registered in Lower Silesia (as of 2016) by the division of DIS natural and secondary raw materials (based on the data from Annex 2 of the Report).

The activity directly related to the acquisition and processing of raw materials lies in the so-called first sector of the economy, which includes all companies focusing on, inter alia, in the researched sectors: mining, therapeutic and health, construction i.e. construction materials such as cement, lime, stone, glass, ceramic, etc.

The level of utilization of mineral resources by individual sectors of the first sector determines, inter alia, the demand for products, reported by the sectors concentrated in the second sector of the economy, inter alia, by the metal or construction industry, which in turn depends on the condition of other branches of the economy, focused in the industries:

- automotive,
- transport,
- aviation.
- agricultural market and agricultural machines,
- food and packaging machines,
- communal,
- electrical and electronic equipment.

According to the diagnosis carried out in the beginning of the report, the most important area of smart specialisation in Lower Silesia, despite its third place of business, is the extractive industry,

dependent on the location of raw materials. KGHM Polska Miedź is the leader of the industry, and the largest percentage of the GDP in all of the analysed sub-areas is generated by its case, and the largest impact on the growth of other economic indicators for Lower Silesia and the country is noted. Copper production in Poland is now at the forefront of the world copper suppliers and associated metals. This trend will certainly continue regardless of the scale of the Polish innovator's progress, mainly due to the increasing importance of the extraction of metals such as: Cu, Ag and Re. There has been a worldwide trend of price increases and demand for these metals, even in spite of strong market fluctuations in the 21st century. The analysis of the situation in the industry shows that the mining and processing potential of copper in Lower Silesia is not used, which is confirmed by the statistics on produced copper semi-finished products (only the 20th position of Poland in the rankings). This points to an undeveloped niche that could contribute positively to the development of the processing and production industries, not just the copper products in our region. Similar trends are shown by the production of rhenium and following the availability of this metal, the jet engine industry, which can already be seen in the region.

The analysis of profitability and possible development of the mining and processing market for energy fuels in Lower Silesia can be used to exploit and use brown coal of Turów Mining and Power Plant. So far, the use of this raw material in the region has been carried out using the latest innovation, and does not deviate from the European standards. The direction of development of this industry, whether connected with further documented deposits of brown coal or stone, is, however, questionable. On the one hand, the new strategy of the State (the Policy for responsible development), which is oriented towards the reindustrialisation, raises the importance of energy fuels and, on the other hand, the EU's tendency to reduce the share of fossil fuels in the energy security of its individual members. The situation does not improve the rapidly growing imports of highly processed, finished heating products from other countries, mainly neighbouring, which can jeopardize the internal stock of their own resources.

No less important field of the mineral industry involves the **processing industry and the production of construction materials**. This industry, with the exception of prefabricated factories, locates near the sources of supply with suitable raw materials. Among the branches concentrated in this sub-area, the most active are those related to the processing of construction stones, glass production and precious ceramics. The cement or lime industry is significantly less important or marginal. The trends in the industry related to the exploitation and processing of construction stones, roads, broken aggregates and blocks are dependent on the economic situation (local and national market).

While the long-standing dominance of Lower Silesia in the production of granite or syenite is observed, which puts the region at the first place on the national scale, with the development of the market, there is no increase in the importance of the processing and production activities of the products made of processed and pre-processed stones. The import of these products continue to dominate over the export, and the differences in this trend are regulated only so far by an increase in the demand for these materials on the national scale, rather than the condition of the industry in Lower Silesia. In the gravel aggregates industry, despite the fact that since the beginning of the 21st century, the growth of aggregate production in Poland has been observed, with regard to other countries, the importance of Lower Silesia decreases. In recent years, from the groundbreaking 2009, when our country was in the European average, we are already in the top 10 producers of this raw material. Following this, it is possible to forecast a good climate for this extraction industry.

It is worth mentioning the increase in importance of feldspar extraction in Lower Silesia. A clear trend of increasing the demand on the European scale will lead to the acquisition of new markets, mainly in terms of taking over the markets of existing leaders.

The remaining minerals extracted in Lower Silesia and unique in the country, such as: clay and refractory clays, kaolin, bentonite, magnesite or glass sands, are estimated to be of no importance in building a new development potential of the region. The world suppliers, also dominating on the national market, and the lack of local contractors or even national customers, place these industries in a niche of importance.

Following the trends on the Polish market, according to GUS statistical yearbook data ²², over the past 10 years, the production of the mining and quarrying sector was in direct contrast with the dynamics of the production industry, which translates into profitability (Figure 44).

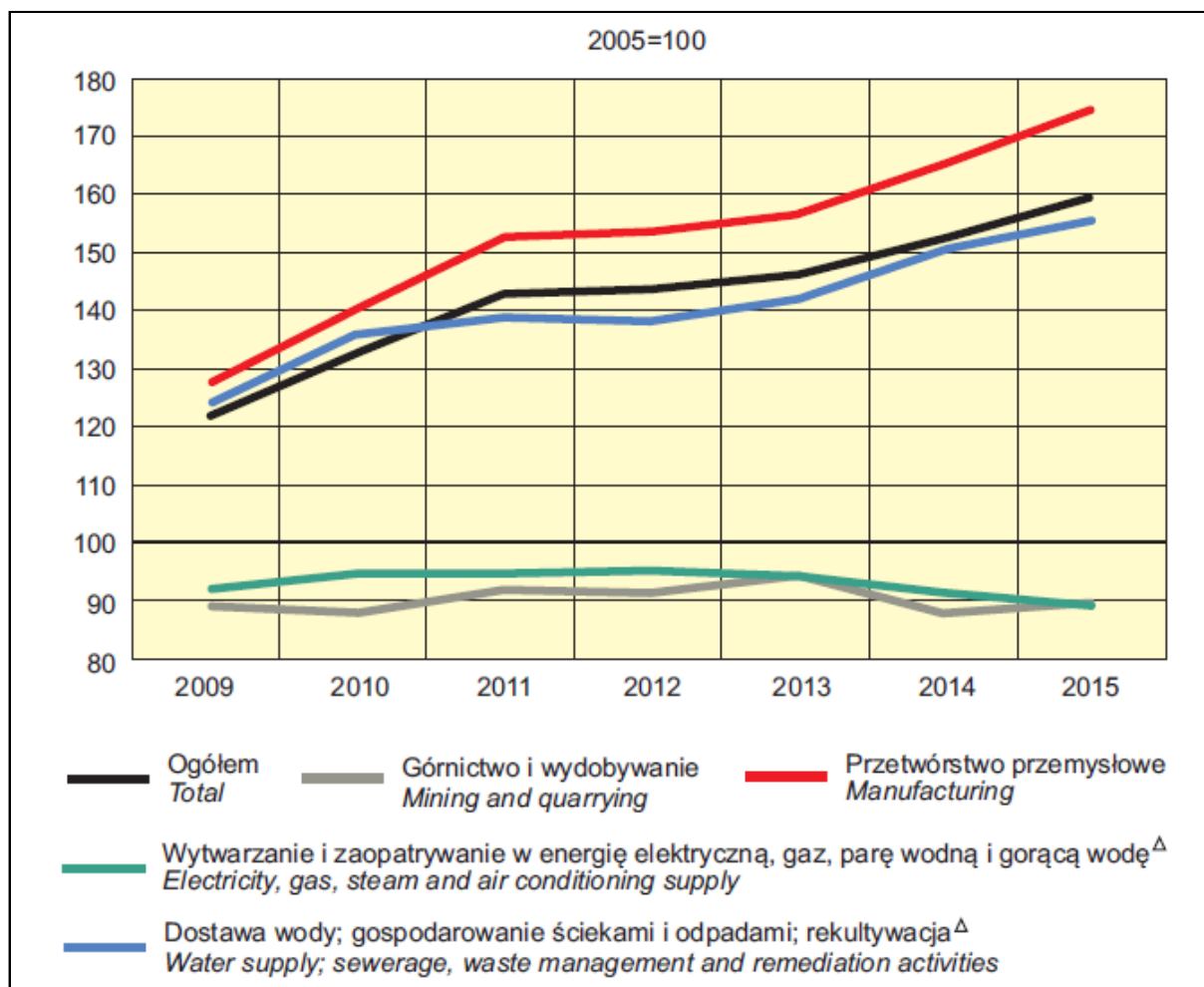


Chart 47 Dynamics of the sold production (fixed price), referred to the values of 2005 (source: Polish Small Statistical Yearbook, 2016).

The percentage data of share of the sold production in mining and extraction (5.1% in 2005, 4.1% in 2014, 3.7% in 2015) and total processing (83.1% in 2005; 85.0% in 2014, 86% in 2015) indicate that

²²

Polish Small Statistical Yearbook, 2016 (data from 2005-2015)

there are clearly high values and thus the dominant character of the processing area. Using the same data on the dynamics of investment expenditures, also calculated at fixed prices, it can be seen that expenditures incurred on the development of the mining and extraction industry increase more slowly than the registered increase of the expenditures in the sectors related to the processing of raw materials. The percentage data reveals many times lower values of the expenditures in the mining and extraction industry than in the processing industry (the difference in percentage of expenditures amounts to an average of a dozen percent). On the regional scale, the dominant sub-sector of the processing and production sub-sector still seems to be insufficient in terms of potential use of national raw materials. The recently promoted EU approach to the development of the closed-circuit economies can be conducive to the development of this sub-area, but there should be concrete incentives, regional aid, balanced between new niches and the development of existing industries.

(II.2) Analysis of the correlation between directions of development of the industry in Lower Silesia and Poland and Europe

It is estimated that the correlation between the market of Lower Silesia and the national market of natural and secondary raw materials is not as significant as correlation with trends observed in the EU countries, especially in the neighbouring and even world trends. However, the fact influencing the prosperity and success of the industry the most depends on the economic and social situation of the country. This is particularly true for the SMEs in the aggregate and production industries and processors, more sensitive to short-term turbulence. These DIS representatives find the most important the stability of the business environment and the prospect of using grants with the possibility of mobility of the gained funds. Investments in innovations, but not only their own, but also, and perhaps above all, patenting and construction of the internal market of consumers, can in fact produce higher goods for the representatives of large companies of KGHM type and Turów Mine and Power Plant. For them, the interest should involve an increase in the importance of the industries centred around the so-called “downstream”. The threat to “large players” can certainly involve the politicization of the economy or untaken risk in the pursuit of innovation.

The above analysis shows the fact that the correlation between directions of development of the industry in Lower Silesia and Poland and Europe is of two types:

- short-term, connected with the opportunities provided by the SMEs for aids (provided they are flexible enough to correct uncertain macroeconomic factors) and to strengthen the role of the region in relation to competitive neighbours,
- long-term, associated with the investments in innovation of large company (KGHM), which can result, inter alia, in:
 - strengthening the internal and regional market (closed-circuit economy) especially after a period of public support from funds,
 - regional competitiveness on the world markets by producing innovative higher goods, and by this to:

- the possibility of becoming independent of the price turbulence and the demand for raw materials.

3.3. Identification of the development niches in the specialisation sub-areas

(II.5) Identification of the development niches in the specialisation sub-areas.

The identification of the developing niches in individual sub-sectors of DIS natural and secondary raw materials, allowed to indicate the places where the research should be carried out, which could be commercially successful in the future, and enable the introduction of new products or services that will be the specialities of Lower Silesia.

The identification of the development niches was made on the basis of IDI interviews carried out with entrepreneurs and scientific research institutions and during the panel of experts. It must be stressed, however, that some entrepreneurs, even though they showed knowledge of possible development niches, did not want to define the subject matter and details of the niches. The development niches are a very important development alternative for the company. The diversification of products and services minimizes the company's vulnerability to market fluctuations. So it seems reasonable to not want to share a business idea with potential competitors. According to CATI research, only 24.5% of the entrepreneurs have knowledge about possible development niches, and 71.5% of which plan to use these niches.

The most frequently mentioned developmental niche is the use of post-mining waste, which can be a source of valuable raw materials, which have not been used yet but can be valuable resources in the future. As an example, the experts point out the development of waste piles as sources of lanthanides (which do not occur in Poland as natural raw materials) and use them in new materials and devices such as hybrid motors. Furthermore, the accumulated multi-millionth waste of flotation waste and slag smelters as a result of KGHM activities become the subject of extremely profitable processing business. The concepts of using them as a raw material for the construction materials industry and in geoengineering are well known. A part of the concept at this stage remains undisclosed.

The coal shale piles and waste from coal processing in the area of Wałbrzych and Nowa Ruda can become a valuable raw material for the construction materials industry. Years of experience in the development of innovative techniques in this field in Upper Silesia is held by Haldex²³, and a part of the potential technique is described in the publication available on the website of the Polish Society of Production Management (Duda J., Kołosowski M., Malinowski P., Tomasiak J. Ekoinnowacyjne techniki utylizacji odpadów powęglowych.)²⁴

A serious niche can be a **fuller use of the products of KGHM**. Regardless of the development of high-tech products based on renaissance, it would be beneficial to develop products based on silver

²³

<http://www.haldex.com.pl/produkt/kruszywo>

²⁴

http://www.ptzp.org.pl/files/konferencje/kzz/artyk_pdf_2017/T1/t1_035.pdf

and gold. These can be both jewellery using local decorative stones and gold and silver investment coins. The last industry develops very good in the world, and there are specialised mints in a number of countries. It has centuries-old tradition in Poland and Central Europe, and Polish 20th-century engraver, Czesław Ślania, has gained a worldwide fame. It would also be desirable to support all types of producers using silver and copper in their products such as furniture with silver or copper handles with bacteriostatic features, glassware decorated with silver and gold, etc.

Considering the large coverage of Lower Silesia (approx. 33%) of the protected natural areas and still functioning in the minds of Poland, the idea of mining as a dirty industry and significantly detrimental to the environment, representatives of scientific research units indicated as an area where research and development should take place, **development of a technology that minimizes the impact of mining on the environment** and promotes and disseminates the extractive industry as an indispensable industry for the functioning of every human being and the functioning of a number of consumer goods. Although the promotional activities are not directly related to DIS natural and secondary raw materials, they are likely to contribute to a better perception of the industry by the general public, which will facilitate to run the existing or locate new companies.

Another niche in Lower Silesia, indicated by the entrepreneurs, can be the **production of processing machines and equipment for the mining industry and the processing of raw materials**. Taking into account the number of operating and processing companies, it can be surprising that in the whole region there are less companies supplying the necessary machines for the entrepreneurs in the mining and processing industry. They would be able to provide an excellent testing ground for new devices that can be applied in the industry.

As a potential speciality of our region, **the use of stone (e.g. granite) as a jewellery raw material is indicated**. This unusual use of stone could become a showcase and a distinctive product of Lower Silesia. Jewellery using e.g. granite could be advertising products used at the international fairs, etc.

So far, **the use of hard-to-sell materials**, unused and undemanding R&D expenditures, produced during the processing of rock raw materials, which are currently waste for the entrepreneur, and in other areas could be used industrially for example as a bitumen additive or for the production of mineral wool (except for the raw materials used for this purpose). In addition to using the smallest fraction for the production of mineral wool, they can be used for petroleum products (basalt lava) produced by melting rocks and casting them into desired shapes, e.g. acid-resistant pipes and sinks, and even usually cobblestones.²⁵ It is also possible to connect basalt fibres into composites, e.g. with polyethylene²⁶. A part of the potential solutions at this stage remains undisclosed because of potential military applications²⁷.

²⁵ (cf. Koziel 2009)

²⁶ (cf. Piszczek, K., et al. 2013)

²⁷ (<http://www.compositesworld.com/articles/basalt-fibers-alternative-to-glass>)

Fine basalt and melaphifone fractions, due to their chemical composition, can be used as slowly decomposed organic fertilizer.²⁸ These type products are at the prices of EUR 3980 per ton²⁹ while basal grits cost PLN 150 per ton.³⁰

Fine fractions generated in the production of granite-crushed aggregates and cutting of granite blocks can also be the subject of profitable development, but rather towards the production of ceramics and as fillers for the construction chemicals.

According to the Foresight of the industry in Lower Silesia, **the technology of the system of exploitation of copper ore deposits in associated conditions at depths below 1200 m** should also be developed. The authors of the study point out that, given the successive increase in depth and the constrained operating conditions, the risk of bumps in the future is to be expected. This is confirmed by the constant increase in the number of recorded high-energy shocks generated during operation. This suggests that the research into new copper exploitation systems at depths below 1200 m can produce positive results.

In addition, Foresight³¹ indicates that that Poland's major problem is the lack of opportunities for significant diversification of energy from other (otherwise exploited) sources. It is therefore necessary to gain access to new raw materials or new mineral deposits unused so far. The authors of Foresight indicate that shale gas, which is also found in the northern part of Lower Silesia, can be a chance. However, the current state of research on shale gas resources in Poland is beginning to show some initial enthusiasm in this area. It is more realistic to acquire coal from the deposits unused so far, e.g. from Legnica-Ścinawa lignite mining complex (one of the largest deposits in Europe). At the moment, attempts are not made to start operations in this area, due to the rather dense development of these areas and the associated strong social resistance, but given the exhausted exploitation of coal deposits, it seems only a matter of time to start extraction in this place. Therefore, it is necessary to carry out the research on the technique of making available and exploiting this deposit in the least invasive way for the environment and the surrounding population. The research should therefore be carried out on alternative ways to exploit this field, e.g. by improving underground coal gasification or bio-gassing techniques.

The growing demand for demand for mineral resources, while the depletion of mineral resources, results in the fact that the development of mineral-based extraction technology should be a priority. The development of these technologies in Poland would increase the level of innovation and efficiency, and thus the competitiveness of the Polish industry and the security of raw materials in Poland. Considering the documented reserves of deposits in Lower Silesia, its long history and the potential of scientific and research units, it can be assumed that it was Lower Silesia that could be a pioneer in this industry.

²⁸ (<http://www.semaille.com/fr/712-poudre-de-roche>,

²⁹ (cf. <https://hector-produits-naturels.com/boutique/jardin-111/fertilisant-poudre-de-roche-5-kg-86.html>)

³⁰ (cf. <http://herkam.pl/oferta/kruszywo/grys-bazaltowy-8-16mm-detail>)

³¹ Industry Technological Foresight InSight 2030

Balneology involves an interesting niche indicated by the entrepreneurs, i.e. the technologies of recovery from heat from thermal waters. In areas such as Cieplice, where the temperature of water (from deep wells) reaches over 80°C or in Łądek Zdrój, where water reaches approx. 45°C,³² the potential of using thermal springs is not used at present. The entrepreneurs lack the technology to increase the possibility to recover heat from thermal waters.

Advanced materials such as composites, nanomaterials, etc. are relatively young and constantly develop. As a result of new research, new materials can be used in the chemical, construction and pharmaceutical industries. According to the publication "Industry Technological Foresight. Insight 2030. The summary of the final analysis "as key technologies on which the research, implementation and investment works should be focused, are identified in the nanomaterials by the experts: metallic, ceramic and diamond-like, polymer nanocomposites and structural nanomaterials.

In DIS natural and secondary raw materials, one can also analyse the possibility of using nanomaterials or composite materials in the furniture industry and wood processing. The use of advanced materials in the wood industry will increase the wood resistance to contamination and external conditions (e.g. rain, wind, low temperatures), which can increase the life of the material and its greater functionality. According to Foresight in the wood industry - Poland 2020, the research results indicate that in the coming years the development of new technologies for the production of wood composites using inferior quality wood, plant and wood waste from industrial and post-production waste can be the most important, and allow for the development of modern energy and material-saving technologies for the production of wood composites that favourably increase their ecological value as non-burdensome (or to a lesser extent) to the environment.

4. INSTITUTIONS SUPPORTING THE INDUSTRIES

(I.8)

Analysis of research and development institutions in the "natural and secondary raw materials" sector

Institutions supporting the branches include both scientific research institutions as well as clusters that associate and help in mutual cooperation between entrepreneurs, scientific units and business environment institutions, eg. Technology Parks.

4.1. Scientific and research units operating in the natural and secondary raw materials sector

The vast majority of scientific research units operating in the natural and secondary raw materials sector operate in the city of Wrocław. These are both universities and research institutes. The most important area of activity of the following institutions is research for the needs of the mining industry, production and processing of raw materials, including advanced materials as well as recovery and reclamation. It is worth noting that none of the analyzed units conducts, as their main activity, research on wood processing. Entrepreneurs from the wood processing industry indicated as the main scientific and research unit with which they cooperate, University of Life Sciences in Poznań with the Faculty of Wood Technology.

4.1.1. Description of units

KGHM CUPRUM sp. O.o. The Research and Development Center continues the activities of Zakłady Badawcze i Projektowe Miedzi "Cuprum" established in 1967, as one of the Zakłady Górniczo-Hutniczy Miedzi in Lubin, to provide comprehensive research and design services for the Lubin-Głogów copper basin. zatrudnia ono około 170 osób, z czego 104 jest pracownikami naukowymi zatrudnionymi przy realizacji badań/prac naukowych, w tym 30 posiada stopień/tytuł naukowy. KGHM Cuprum prowadzi badania w takich dziedzinach jak m.in. górnictwo i geoinżynieria, geologia i hydrogeologia, geodezja, wentylacja, automatyzacja, mechanika oraz elektryfikacja kopalń, wzbogacanie rudy, składowanie odpadów flotacyjnych, ochrona środowiska oraz nowe technologie energetyczne. Ponadto wspiera przedsiębiorców w pozyskiwaniu środków z funduszy pomocowych – unijnych i krajowych. KGHM CUPRUM is the winner of many awards and has numerous certificates. An innovative study entitled "The method of revitalization of mineral landfills, especially soilless land" received: Gold Medal at the 61st World Fair "Brussels Innova 2012", 1st prize in the Competition of the Wrocław Council of Federation of Scientific and Technical Associations NOT "For outstanding achievements in the field of technology" in 2011. On the initiative of KGHM CUPRUM and the Head of the High Level Group of the European Technology Platform, in 2011, the Polish Technology Platform for Mineral Resources was established. It has the task of initiating and supporting integrated activities for the creation and implementation of the Polish raw materials strategy. The operational objectives of PPTSM are: exploration and inventory of the resource base of mineral resources, development of technologies for extracting raw materials from deep and submarine land deposits, development of energy-saving process technologies for the processing of primary and secondary raw materials, recovery of elements based on sustainable and economically viable technologies, recycling and recovery of critical elements

KGHM Cuprum as a unit created for the needs of KGHM conducts mainly research, whose final phase is implementation in the mines of the plant. These implementations are not registered in the POLon database, as most of them are covered by the security classification.

KGHM Cuprum has 19 active patents, including 16 inventions and 3 for utility models.

Wrocław Research Center EIT + sp. O.o. has a comprehensive research infrastructure allowing the implementation of tasks for industry in the form of research projects and basic research that take into account global development trends. In its activities, it implements the idea of broad cooperation between scientists representing various fields using the potential of Wrocław and the national scientific community. The institution employs approx. 73 people in scientific positions „ employed in the implementation of research / scientific work, including 39 people with a degree / degree.

EIT + conducts research in the areas of: biotechnology, medical diagnostics, pharmacy, nanotechnology, laser techniques, material science, chemistry.

EIT Raw Materials found itself in the group of 116 partners from Europe within the framework of KIC, which is the most important undertaking of the European Innovation Partnership for non-energy raw materials (EIP RM), whose action plan is to preserve the security of raw materials in Europe.

According to the information from the POLon database, EIT + implemented 3 results of scientific research (not classified), of which two were implemented by enterprises unrelated to DIS natural and secondary raw materials and one by a scientific research institution.

From the beginning of its activity, EIT plus has submitted over 90 patent applications, of which 29 have received active Polish patents, which it introduced independently or in cooperation with other scientific and research institutions.

Poltegor - The Opencast Mining Institute deals with the development and implementation of industrial innovative technologies, processes, methods and technical solutions for the needs of opencast mining as well as broadly understood environmental protection. The Institute employs approximately 43 people in scientific positions „ employed in the implementation of research / scientific work, including 16 people with a degree / degree.

The Institute's strategic objective is to create innovative, clean and environmentally friendly mining technologies in the opencast mining industry and to implement new technical solutions.

As part of the institute, the following laboratories are run: Sustainable Development and International Cooperation, Mining, Geology and Environmental Protection, Basic Machines and Transport Equipment, Technology and Operation of Conveyor Belts.

Poltegor Institute has implemented over 200 results of its research since 2013, most of which concerned the implementation of products (93) and technology (83), the rest related to inventions.

In addition, Poltegor Instytut was granted 33 patents, 16 of which are still valid. It also has a protective right for two trademarks and one utility model

The Faculty of Geoengineering, Mining and Geology of the Wrocław University of Technology is a unit with nearly 50 years of experience in conducting scientific and technical research. It meets the demand of the developing national economy and the regional mining industry of Lower Silesia. Currently, the Faculty educates and conducts research in the field of underground and open-cast mining, exploratory and mining geology, geoinformatics and geoengineering. The Faculty cooperates with universities and scientific, research and industrial units in Poland and in the world.

There are about 62 people in the faculty at scientific positions, employed in the implementation of research / scientific work, including 49 people with a degree / degree.

The department has an offer addressed to business in specific fields:

- Economic and financial analyzes of investment projects and companies along with the analysis of profitability and risk,
- Research and diagnostics of conveyor belts and their connections,
- Testing conveyor rollers,
- Research into the basics of mineral processes and the creation of technologies for the enrichment of mineral resources,
- Research on extraterrestrial natural resources, Construction and implementation of spatial information systems,
- Spatial data analysis in GIS,
- Innovative solutions in belt transport,
- Specialized geodetic surveys of engineering objects.
- Forecasting deformation of rock mass on mining and post-mining areas,
- Three-dimensional modeling of deposits, mine design and reclamation, planning and optimization of extraction, visualization of 3D models in VR environment.

Wrocław Polytechnic has drunk about 17 research results or scientific papers, 30% of which are research conducted in the department of geoengineering, mining and geology. Most implementations were implemented in enterprises associated with DIS natural and secondary raw materials. The Polytechnic has around 260 patents, 13 of which are the result of work in the department of geoengineering, mining and geology.

University of Wrocław, Institute of Geological Sciences, University of Wrocław is one of the largest research and teaching institutions in Poland dealing with earth sciences. It employs over 50 teaching staff (including 5 with the title of professor). The Institute's research and teaching activities cover practically all areas of geology.

The Institute conducts research in Lower Silesia. Research teams deal with petrology and geology of crystalline rocks and provide the Institute with a leading position in Poland and a significant position in Europe. Research in the field of geology and isotopic geochemistry, which is largely geo-environmental in nature, is mutually important. The Institute also has achievements in the field of stratigraphy, palynology, sedimentology and deposit geology. In addition, research is carried out in the areas of hydrogeology and groundwater protection.

The University of Wrocław has 8 research implementations registered in the POLON database, half of which are implementations of research carried out at the Institute of Geological Sciences. At present,

the Institute does not have active patents for inventions. It has only protection rights for two trademarks.

The Institute of Low Temperatures and Structural Research Włodzimierz Trzebiatowski of the Polish Academy of Sciences is a scientific institution of the Faculty of Sciences and Earth Sciences of the Polish Academy of Sciences. The Institute employs 116 scientific workers; of which - 33 professors, 26 habilitated doctors, 35 doctors. The Institute's research topics include comprehensive physicochemical studies of solid structure and its impact on physical, chemical and spectroscopic properties, with particular emphasis on low temperature tests. The specialty of the Institute are magnetic studies of 5f- and 4f-electron systems, superconductor research, phase change physics and molecular spectroscopy.

The institute's tasks include conducting research (mainly basic research), training of scientific employees and specialists with qualifications related to the research directions pursued and applied research methods; cooperation in the didactic process carried out at universities; transferring the results of scientific papers for practical use; supporting state services in the field of metrological work; dissemination of knowledge in the field of work carried out at the Institute. The Institute's Scientific Council has the right to confer doctoral and postdoctoral degrees in physics and chemistry.

The Institute of low temperatures has implemented 2 results of scientific research or development works. The number of registered implementations may be influenced by the fact that some of the implementations are related to the confidentiality clause.

The Institute of Low Temperature has 17 active patents and has protective rights for one trademark, 3 transferable rights to know-how and one license.

The College of Artistic and Management Crafts in Wrocław is the only university in Poland that educates craftsmen in the jewellery industry, the expertise of precious stones and the preservation of works of art. As one of the few in Europe, he conducts studies in the field of gemology, or science about precious stones. Specialist education takes place at the undergraduate level in the full-time and extramural studies. The university is focused on preparing highly qualified professionals who are able to independently run a business.

The university employs about 5 scientific employees, including one with a professorial title, which is also employed in the implementation of research / scientific work.

Information from the POLon system indicates that the institution has not implemented any research work or claimed any patent.

According to the list of scientific units that were granted scientific categories, most of the above institutions received the scientific category B, only the Faculty of Geoengineering, Mining and Geology of the Wrocław University of Technology received category A, while the Institute of Low Temperatures and Structural Research received the highest category A +, where :

A + - leading level; A - very good level; B - satisfactory level, with the recommendation to strengthen scientific, research and development or stimulate innovation of the economy; C - unsatisfactory

Wrocław Research Center EIT + sp. O.o. does not have a scientific category, it is caused by too short activity of the unit. At present, an application for the category is made.

Scientific category B of most scientific and research institutions is not necessarily related to its low innovativeness or lack of research. A significant number of points can be obtained by the institutions for publications published in scientific journals from the Philadelphia list. However, some of the research results (especially those carried out on behalf of the entrepreneur) can not be disseminated.

1.1.1. Research and financing of research

All the above-mentioned institutions conduct, on a larger or smaller scale, research in the field of DIS natural and secondary raw materials. Some of them, ie Poltegor Institute, KGHM Cuprum or the Mining Faculty of the Wrocław University of Technology are specialized in this field. The remaining institutions deal with research in the DIS sectors of natural and secondary raw materials in approx. 20-40% and these are mainly research in the field of nanotechnology and advanced materials. Most of the conducted research is carried out in cooperation with entrepreneurs. It results from the experience of these institutions indicating low effectiveness of commercialization of scientific research conducted in isolation from market expectations.

The type of research funding depends on its scientific category (the higher the category, the higher the subsidies from the state budget). However, it can be stated that research funding in all institutions comes mainly from public funds (statutory funds, grants, publicly available funds for research, European funds). Only about 15-20% of the research is financed by the private funds of the entrepreneur (the majority of which is own contribution with public funding). Custom research with a 100% own contribution occurs when the research results are to be covered by complete secrecy or when the research costs are relatively low in relation to the costs and time devoted to obtaining European funds.

During the IDI interviews, the entrepreneurs indicated that they most often cooperate with INB when carrying out standard laboratory tests that they are unable to carry out at the plant, and they are necessary to determine specific product parameters.

In addition, entrepreneurs, as the most important directions of research performed by scientific and research institutions in the field of DIS natural and secondary raw materials, indicated generally understood innovative technologies, the production of innovative market products and a reduction in production costs. Representatives of companies also indicated as a subject necessary for further research, management of waste generated during production and methods of reducing the impact on employees of harmful factors, such as noise, dustiness or vibrations.

In addition to the above-mentioned directions, it is very important that research institutions conduct research in the directions that allow the use of niches indicated in Chapter 3.3.

Most universities have business offers addressed to entrepreneurs, which can be easily found on their websites. It is hard to find such a link on the websites of the University of Wrocław and the School of Artistic and Management Crafts in Wrocław. On the websites of other institutions, research offers addressed to entrepreneurs can also be found in an instinctive way, however, the exception here is the Institute of Low Temperatures and Structural Research, which has demonstrated the

scope of scientific research which it does, but they seem to be only issues performed within the unit, and not offer for external entities.

1.1.2. Cooperation with entrepreneurs and factors that inhibit and encourage cooperation between entrepreneurs and scientific research units

Only 21% of entrepreneurs indicated that they know any scientific and research institutions (INB), of which only 19% use their support (ie 4% of all surveyed enterprises). According to interviews, companies with an established position on the market and large financial possibilities cooperate most willingly.

INB indicates that the willingness to cooperate is initiated both by themselves and by entrepreneurs. In the case when the initiator is INB, they most often come out with the initiative of cooperation to large companies with whom they have already cooperated on the occasion of other projects. Respondents during the IDI survey indicated that they sometimes also go out with the offer to new entities, but their interest is dim.

The biggest factor inhibiting INB's cooperation with business is the lack of entrepreneurs' knowledge about their functioning. In addition, among entrepreneurs who have such knowledge, as many as 65% of respondents declared that they do not know the offers of these institutions.

Among entrepreneurs who have knowledge about the existence and scope of individual INBs (but not those who use their offer), the biggest declared in the course of CATI research inhibiting cooperation was too high costs (50%) of research commissioning. Entrepreneurs pointed out that the solution could be to introduce a larger subsidy for research conducted with the participation of scientific and research units with lower or zero entrepreneur's own contribution. Another considered solution is the introduction of a voucher system for innovations that entrepreneurs could obtain as part of simplified procedures. Respondents emphasized that in many cases smaller funds are sufficient for the study (in the interviews and panels survey, amounts from PLN 15 to PLN 30 were indicated). In the case of SMEs, these may be block amounts, and the possibility of obtaining them non-returnable could significantly affect the level of their innovativeness and thus the innovativeness in the region.

About 42% of respondents who know INB believe that the institution's offer is not attractive or is not addressed to their company. Such attitude may be related to low knowledge about the institution's offer or lack of flexibility and willingness to cooperate on the part of INB.

According to the conducted research, entrepreneurs are more willing to cooperate with research institutes than with universities. This is due to complicated procedures, mismatch to the market, lack of a special cell for cooperation with entrepreneurs at Lower Silesian universities.

In addition, the uncertainty of results is a factor that influences the reluctance of entrepreneurs to conduct research. Just as for a scientific and research institution, every research result is valuable knowledge, the entrepreneur is interested only in the result of the research that will allow the implementation of a new technology, product or service in the future, which will bring profits and will cover the costs related to the research.

During the interviews, the entrepreneurs also pointed out the lack of response to their inquiries about the possibility of conducting research or the lack of interest in their implementation. The time of formalities is also quite important. Entrepreneurs realize that running the research itself is a time-consuming process, however, indicates that too much time is taken by formal stages leading to cooperation.

Among the factors that could encourage cooperation with INB, entrepreneurs first of all mentioned clear cooperation conditions and easier contact, ready-made solutions prepared by scientific research institutions for the entire industry, and therefore a better understanding of the problems faced by the industry and attempts to solve them.

1.2. Clusters

(1.1) The main determinants of Lower Silesia's economic development and the characteristics of the smart specialization industry - natural and secondary raw materials
--

In 2016, the Polish Agency for Enterprise Development issued the "Cluster Inventory Report in Poland 2015". The aim of the inventory was to determine the number of clusters in Poland and to deepen the knowledge about their condition and functioning *PARP based on the conducted research and collected data pointed out in the study that there are 134 clusters and 106 entities operating in Poland, which in the present state did not meet all the criteria, but have features that indicate their development potential and were termed potential clusters.* Among the inventoried clusters, the largest number is located in the Silesian Region - 28, while the Lower Silesian Voivodship has 11 clusters and is in the fourth position with the Lublin Region. All clusters of the Lower Silesia Voivodship comprise 554 entities. The cluster structure is dominated by enterprises, it is 78% in the whole country, the remaining institutions are scientific units and business environment institutions.

Clusters in Poland are a relatively young form of enterprise activity. In Lower Silesia the first cluster of entrepreneurship was established in 2007. Lower Silesian clusters represent the following areas of smart specialization: Chemical and pharmaceutical industry, spatial mobility, high-quality food, natural and secondary raw materials, production of machinery equipment, material processing, information and communication technologies (ICT).

1.1.1. Description of existing clusters and their status

In the Lower Silesia region, 5 clusters can be distinguished from the sector of natural and secondary raw materials, they are:

- about the Kamienarski Cluster,
- for the "Wałbrzych Surowce" cluster,
- for the Lower Silesian Raw Cluster,
- for the SIDE-CLUSTER wood cluster,

- about the "Nefryt" cluster.

The Kamieniarski Cluster operates in the raw materials industry. It started its activity in 2013, and the "Bazalt" Foundation is currently the coordinator of the cluster. Cluster members include Wrocław University of Environmental and Life Sciences, Poltegor-Institute, D & J GROMIEC, Strzegom Municipality.

The cluster works to strengthen the economic potential of the stone industry enterprises from Lower Silesia, primarily through seeking new sales markets, developing new concepts of products made of stone, promoting the use of natural stone. Cluster goals include:

- integration of SME communities, research centers and the business environment,
- linking an innovative knowledge-based economy with the development of technology in the stone industry,
- training of specialists employed in this sector of the economy,
- introduction of innovative solutions and popularization of technological achievements,
- promotion of the use of natural resources of the region (source: klasterkamieniarski.pl).

Cluster "Wałbrzyskie Surowce" - raw materials for advanced material technologies was founded in 2013, and its coordinator is Agencja Rozwoju Regionalnego "AGROREG" SA. Currently, it has 15 members, including two research units cooperating with the University of Environmental and Life Sciences in Wrocław and the "Poltegor - Institute" Institute of Opencast Mining. The cluster conducts activities integrating the environment. It helps you find new sales markets and develop new products. From the beginning of its operation, the cluster has been operating to promote natural stone and its correct use. Cluster goals include:

- organization of the companies from the raw materials industry of the Wałbrzych Agglomeration around pro-development processes, including the program of the 2014-2020 support period;
- including the potential of the raw material industry of the Wałbrzych Agglomeration in the process of building and implementing national smart specializations and regional smart specializations;
- creating legal and organizational grounds for obtaining financial support for cluster business projects;
- dissemination of goals, tasks and expectations of the results of the "Wałbrzych Surowce" cluster.

The Lower Silesian Raw Cluster is a cluster of the raw materials industry. The founder of the cluster is KGHM Cuprum Centrum Badawczo-Rozwojowe - a research unit of the KGHM Polska Miedź. The cluster's coordinator is the Foundation for the Lower Silesian Raw Cluster, which was established in

2007. The basic objective of the cluster's activity is to develop and strengthen the region's competitiveness as well as economic entities from the raw materials sector operating in the Lower Silesia Voivodship. To achieve this goal, the Lower Silesian Raw Cluster seeks to move from traditional industry to modern industry, based on knowledge and new technologies, introduction of new products and elimination of emissions and waste.

Potential areas of the cluster's activities in the raw materials sector include:

- Nickel - production of pure nickel and other metals
- Copper - old basin, metal recovery from copper products scrap, further exploration of existing resources to check the possibility of starting copper production and production
- Lignite - possibilities of checking and launching new technologies of coal gasification underground
- Rock salt - evaluation of resources and commissioning of exploitation after obtaining a concession
- Rock raw materials - development in accordance with the principles of sustainable development
- Industrial waste - management in accordance with the principles of sustainable development
- Revitalization of historical sites associated with mining and metallurgical activities in Lower Silesia (source: www.cuprum.wroc.pl).

The SIDE-CLUSTER timber cluster established in 2009 operates in the field of construction and architecture. It brings together over 50 members, mainly small and medium-sized enterprises from the construction and wood sector as well as research and development institutions and centers supporting regional development. The cluster's goal is to stimulate technological progress in the construction industry. SIDE-CLUSTER supports companies in introducing innovative solutions and popularizing technological, social and organizational achievements in the field of wooden construction and its surroundings. The cluster's offer includes products, services, trainings, assistance in establishing economic cooperation in the country and abroad, and the use of research facilities in scientific centers in the field of energy-saving wooden construction. The cluster introduces an innovative product to the market, which is a mobile energy-saving wooden house and a public building (source: side-cluster.pl).

The "Nephrite" cluster began its activities on November 26, 2014. The cluster brings together 22 members from the Lower Silesia region. The originator of the cluster, its founder and coordinator is the Academy of Artistic and Management Crafts, which is also a research and development unit supporting the research and financial cluster. Other members are business entities, mainly small enterprises, craft workshops. The aim of the cluster is to start production of products from raw materials in Lower Silesia: silver, stone - mainly jade and copper. The production would include ornamental and functional products as well as elements used in the revitalization of monuments. Currently, the cluster's activity is focused on obtaining funds for the promotion of craft products, strengthening its position against market competitors, increasing the level of product innovativeness.

1.1.2. Financing of clusters

The method of financing clusters varies depending on the cluster's internal policy and the time of its activity on the market. The basic method of obtaining funds for the current activity of the cluster are membership fees of entities operating within the organization. It is dependent on the ability of financial enterprises and their size. In the case of the "Nefryt" cluster, whose members are mainly small craft workshops, it is financed only by the coordinator, which is the College of Artistic and Management Crafts. Some of the clusters declare that they are financed from the public funds of the Lower Silesian Voivodship or use both ways of obtaining funds, seeking support for both cluster development and ongoing operations.

1.1.3. Identification of problems

The basic problem of clusters activity in both Lower Silesia and the country is the lack of region strategy supporting their development, and thus lack of support from public funds. Clusters in Lower Silesia could apply for co-financing and business development, as the Region Self-government implemented the Cluster Support Program from its own resources (from 2010). However, clusters, as relatively new creations in the Polish reality, need external support for ongoing operations and further promotion of cooperation for innovation. The current financing method is insufficient because it is not able to ensure the continuation and effective implementation of planned, often long-term processes.

In addition, research units are not always interested in research in the area of individual clusters. Contacts between enterprises and the world of science are based more on personal contacts and development of their own interests by scientists, for example in the stone processing or wood processing industry. Hence the need for additional resources to support R & D activities, which would allow greater interest of centers in the subject of clusters' activities.

Among the clusters operating in the area of the Lower Silesian Voivodship, 5 natural and secondary raw materials operating in the area of industry were identified. However, getting to the information about functioning clusters is difficult. Many of them do not have websites, often even missing information about the cluster coordinator. Some of the clusters, in spite of the information about the activity, do not carry out any activities, which is the case, for example, in the case of the Ceramic Cluster in Bolesławiec.

1.2. Analysis of the effectiveness of public intervention

<p>(I.10) Analysis of the effectiveness of public intervention in areas of smart specialization.</p>
--

In order to analyze the effectiveness of public interventions among entities operating under the specialization, the results of research on the current fund raising and the research on the expectations and tendencies of entrepreneurs were used. Both during the CATI survey and in-depth interviews and focus meetings, one could notice a big dissonance between the expectations of entrepreneurs and the realities of applying for funds. This applies to both the offer of available public support and the procedures for its provision.



Unfortunately, in the course of the analysis of the existing data, it was not possible to get to the information collected by the institutions dealing with spending EU funds, which would allow the analysis of the funds spent divided into sectors.

1.2.1. The use of business support by smart specializations

The majority of respondents (61.5%) in the CATI survey replied that in the last 10 years they did not introduce innovative services, processes or products. Positively, 34.5% responded to the question, and the others refrained from answering. As for the origin of funds for implementing innovations, 76.8% declared that they were own funds, while public external funds accounted for 24.6%, and non-public ones (eg from cooperation with other companies) - 8.7%. The description of financing innovation is included in chapter 5.5.

The sources of public funds are mainly the Regional Operational Program (52.9%) and other national Operational Programs (35.33%). Subsidies for research and preferential loans accounted for 5.9%, and other sources not mentioned in the survey are 11.8% ().

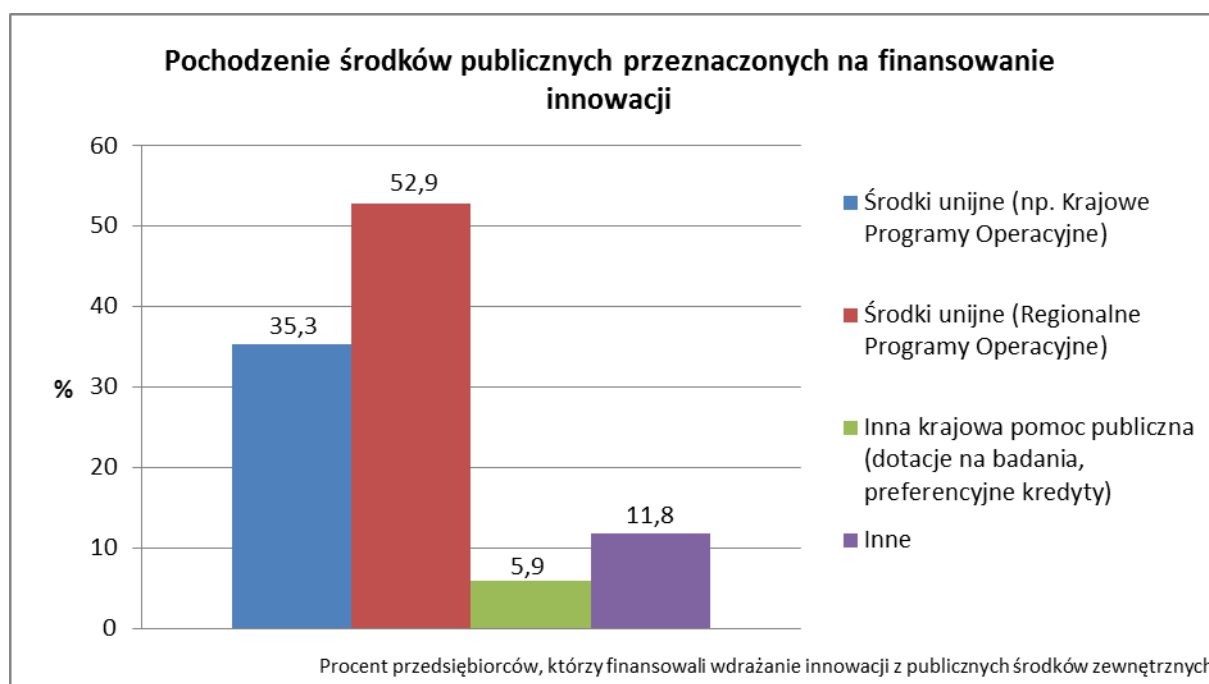


Figure 48 Origin of public funds allocated for financing innovation (based on CATI research)

The percentage set out above, expressed in absolute terms, looks as follows: out of 200 respondents, 69 responded that in recent years they have introduced innovations in processes, services and products. 53 of them put their own resources on innovation. Only 17 companies used public assistance. The results obtained show that despite the high potential in terms of innovation (1/3 of respondents implement innovations), entrepreneurs do not use public funds allocated for this purpose.

Only 17 companies out of 200 surveyed, as well as the disproportion in financing innovations from public funds and own resources may be an indicator of entrepreneurs' reluctance to use external sources of financing. Since 3/4 of entrepreneurs who implemented innovations preferred to lecture



their own funds for research than to apply for external support, it means that the current system is not entrepreneur-friendly. This conclusion was confirmed by the respondents during the focus meetings and in-depth interviews, claiming that the application procedures are so time-consuming and complicated that commercial credit is more profitable for the company, which is available faster and has a less complicated procedure for obtaining.

It should be noted that beneficiaries of support appreciate its importance, need and effectiveness. Among 17 entrepreneurs who benefited from the support, the effectiveness of the intervention was assessed positively (high or medium). Only a small percentage believed that the support had low effectiveness (Figure 49).

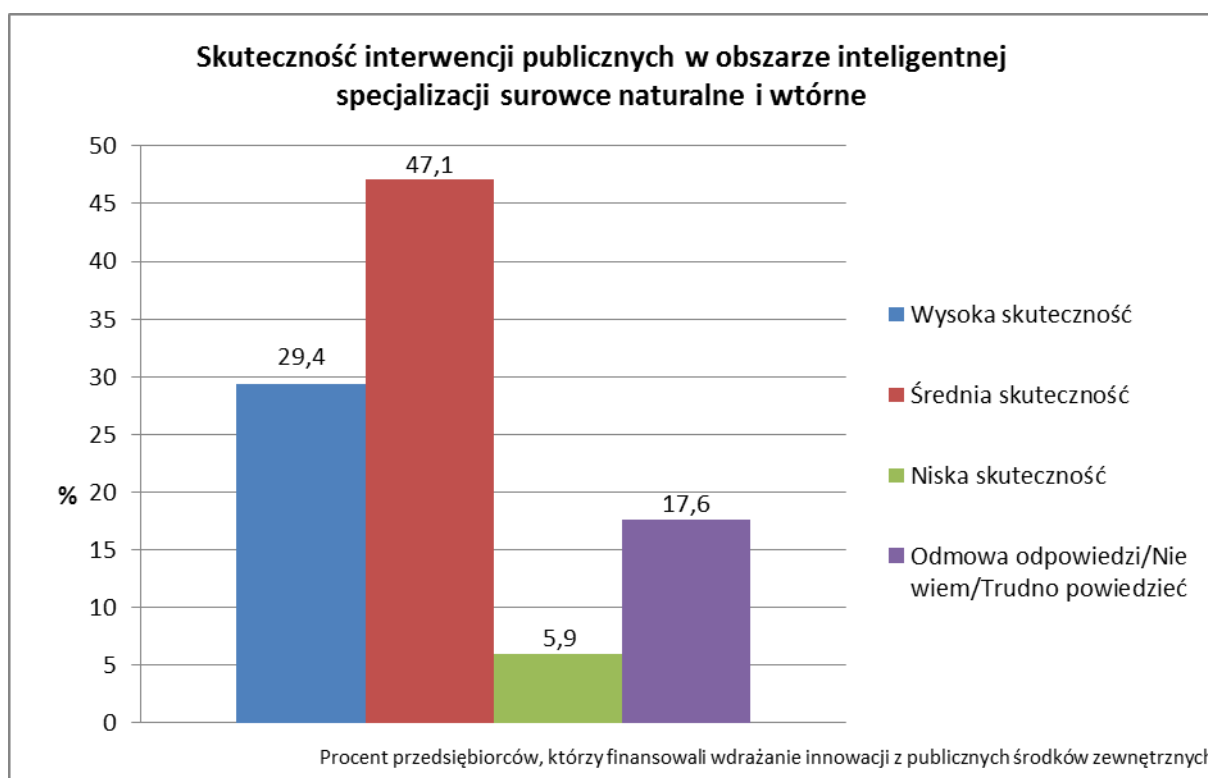


Chart 49 Assessment of the effectiveness of public intervention by entities to which support was granted (based on CATI surveys)

As one of the positive effects of receiving public support, respondents mentioned an increase in sales (64.7%). 64.7% of them pointed to the increase they achieved thanks to public intervention, and only 17.6 percent did not notice the change.

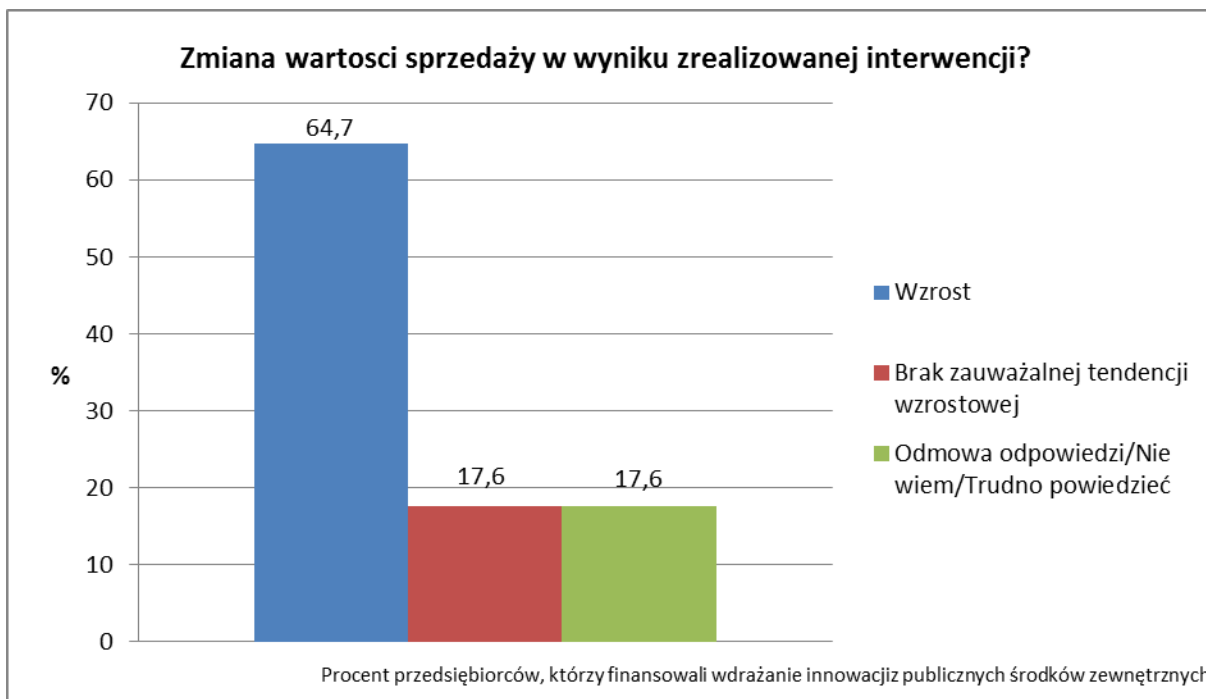


Chart 50 Change in the value of sales as a result of the implemented intervention (based on CATI research)

Another positive effect of the support was the demonstration by entrepreneurs of funds spent on R & D (Figure 51). Over 3/4 of respondents showed such expenditures.

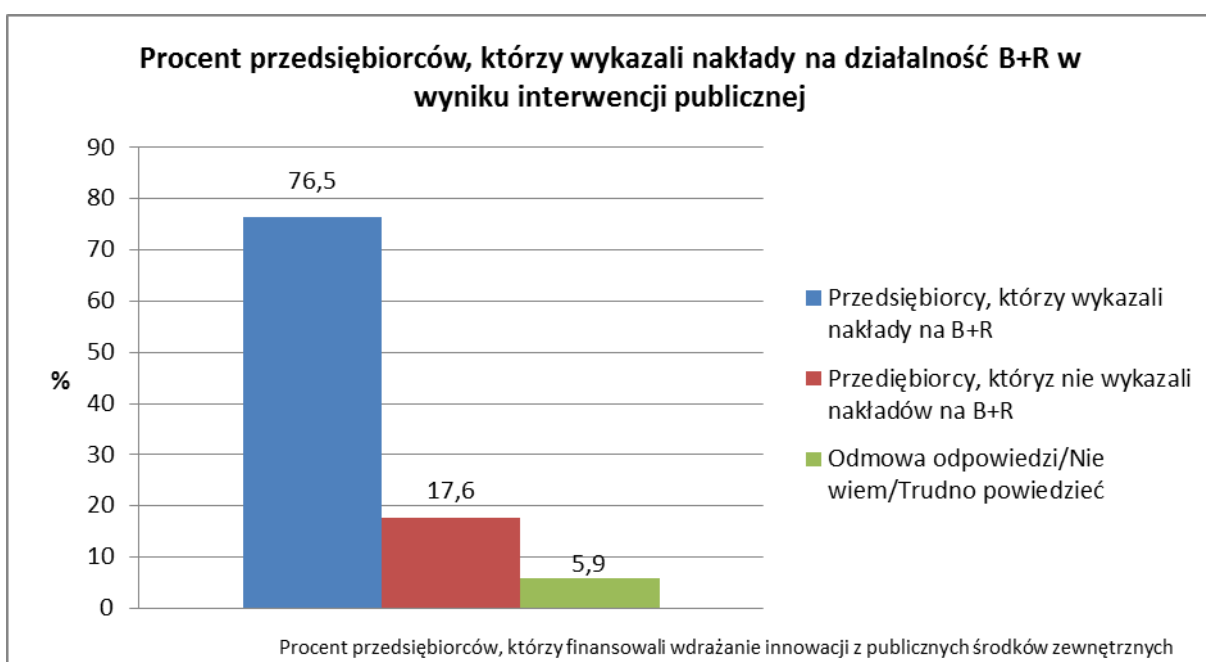


Chart 51 Percentage of entrepreneurs who showed expenditures on R & D activity as a result of public intervention (based on CATI research)

The respondents also declare a very large increase in cooperative relations thanks to receiving subsidies (Figure 52). Nearly 60% of entrepreneurs confirm establishing such relationships thanks to the support received. This may indicate the role of public funds in improving cooperation within the DIS, as well as establishing contacts with the scientific environment.

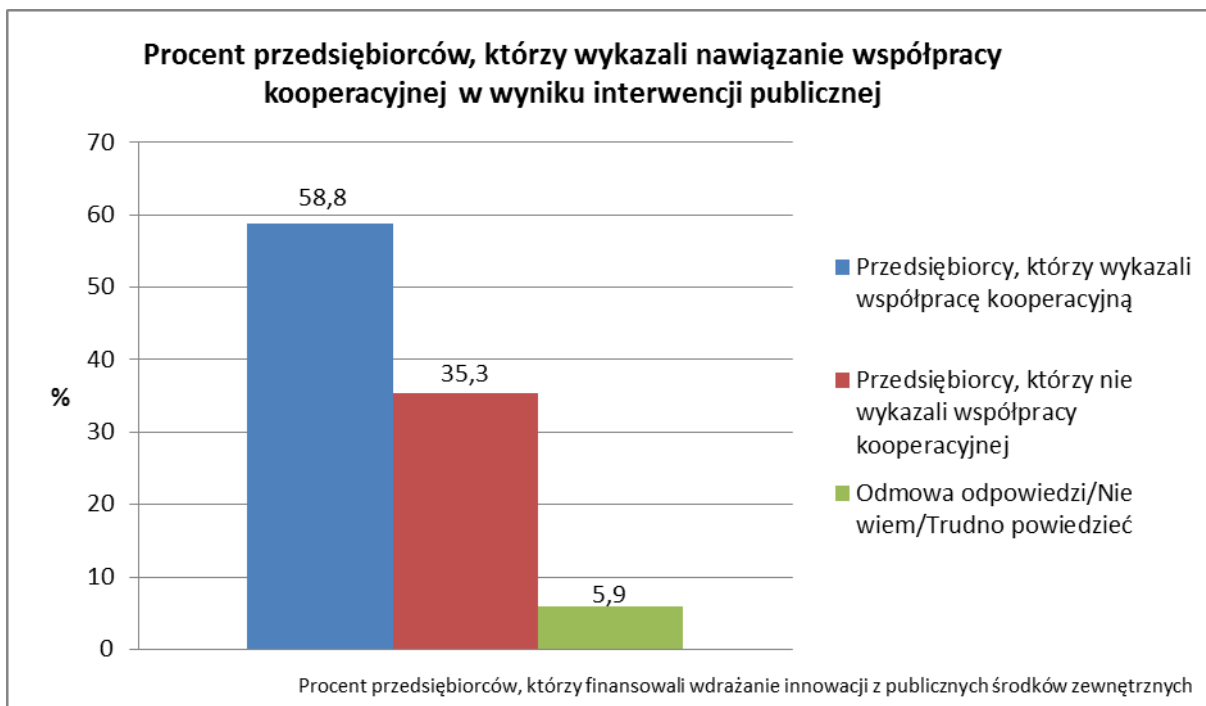


Chart 52 Percentage of entrepreneurs who started cooperation as a result of public intervention (based on CATI research)

The situation is much worse when it comes to public support for implemented patents and utility models (Fig. MMM). Only 12.5% of respondents submitted a patent application as a result of a subsidized project. However, this result may be statistically disturbed because over 90% of respondents declared that in the last 10 years they did not report patents and utility models.

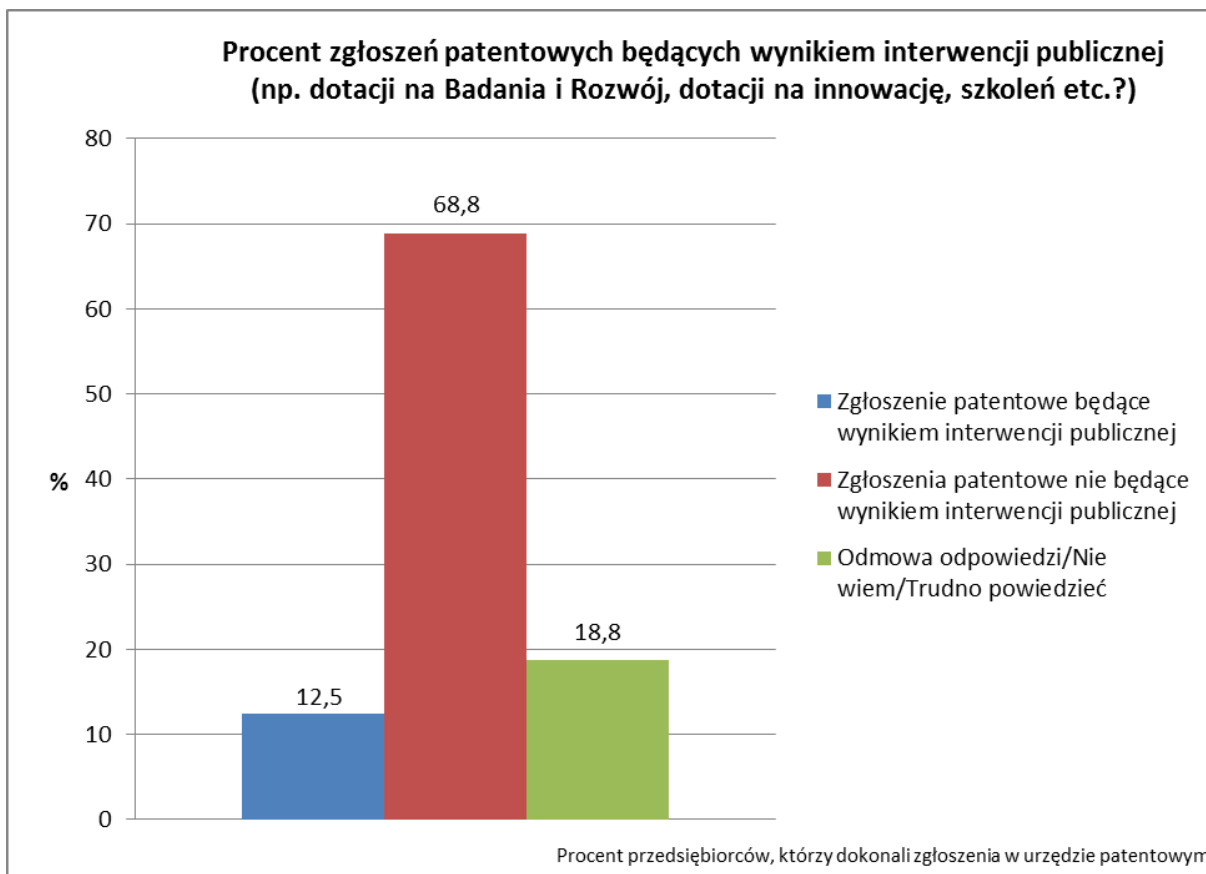


Chart 53. The relationship between public intervention and patent application (based on CATI research)

The relationship between public intervention and patent application according to the CATI survey

During focus meetings and in-depth interviews, entrepreneurs emphasized the difficult application procedure and complicated provisions related to the settlement of obtained subsidies. A large part of the companies declared that they were interested in obtaining support for research, but, undermined by the necessary expenditures of time and financial resources and personnel, resigned from applying. The second issue raised is the minimum value of projects, which in some cases significantly exceeded both the needs and the financial capacity of SMEs.

Some entrepreneurs decided to finance the research and implementation procedure from their own resources. The other respondents postponed or completely gave up innovation in their companies. In conversations with entrepreneurs, it was often stated that applying for non-returnable support is so procedurally complicated and time-consuming that a commercial loan is more profitable. On the occasion, it was argued that support in the form of low-interest-rate credits for research and development would be attractive, provided that the loan term would last several years. Even those entrepreneurs who received support and settled the subsidy, replied that they are not sure if they would decide again for another project.

A completely different issue is the level of entrepreneurs' awareness of building a market advantage based on technology and the level of innovation, the ability to acquire and penetrate new markets, expand the public. Half of the surveyed entrepreneurs declared the international reach of their companies, but most of them turnover in international trade is estimated at less than 10%. It may be

related to the small demand of foreign customers for products created using anachronistic technologies.

1.2.2. Interest in support in the current perspective

Due to the lack of official data on the type and level of support provided in the current perspective, this study was prepared only on the basis of surveys, in-depth interviews and meetings with entrepreneurs. As part of the CATI survey, nearly 1/4 of the surveyed DIS natural and recycled materials showed knowledge about the use of development niches in their industries (Figure 54). Most of these companies intend to use niches to create new innovative products or services. (Chart 55) Out of 49 respondents who see a chance to implement innovation, 20 declare their intention to apply for public funds (Figure 56).

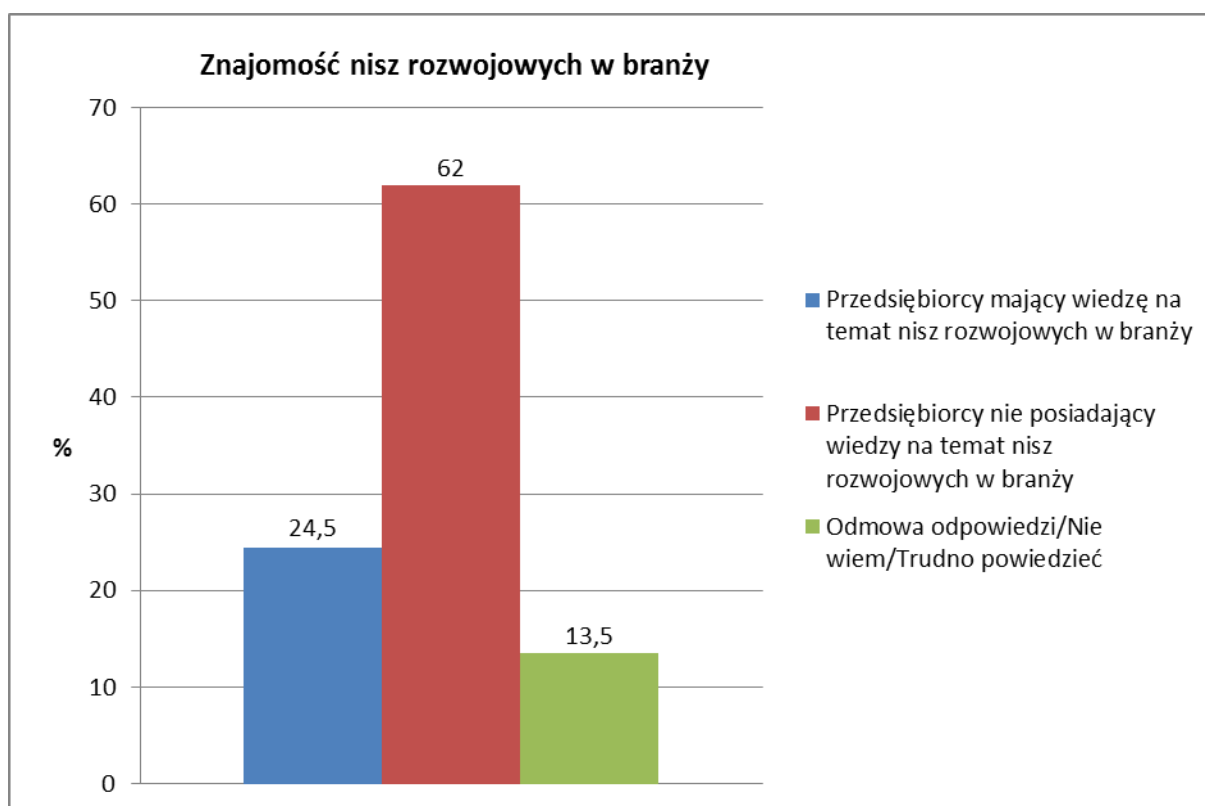


Chart 54 Knowledge of possible development niches in the industry (based on CATI research)

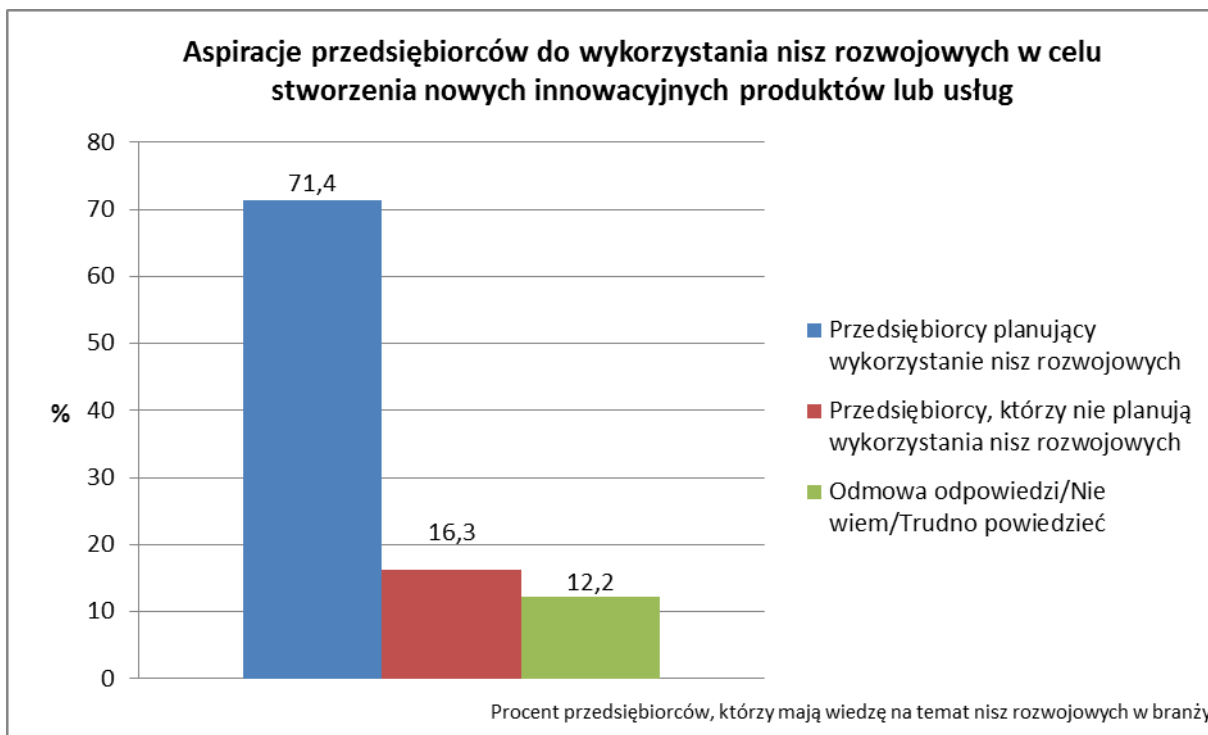


Chart 55 The level of propensity of surveyed entrepreneurs to create innovative products or services within development niches (based on CATI surveys)

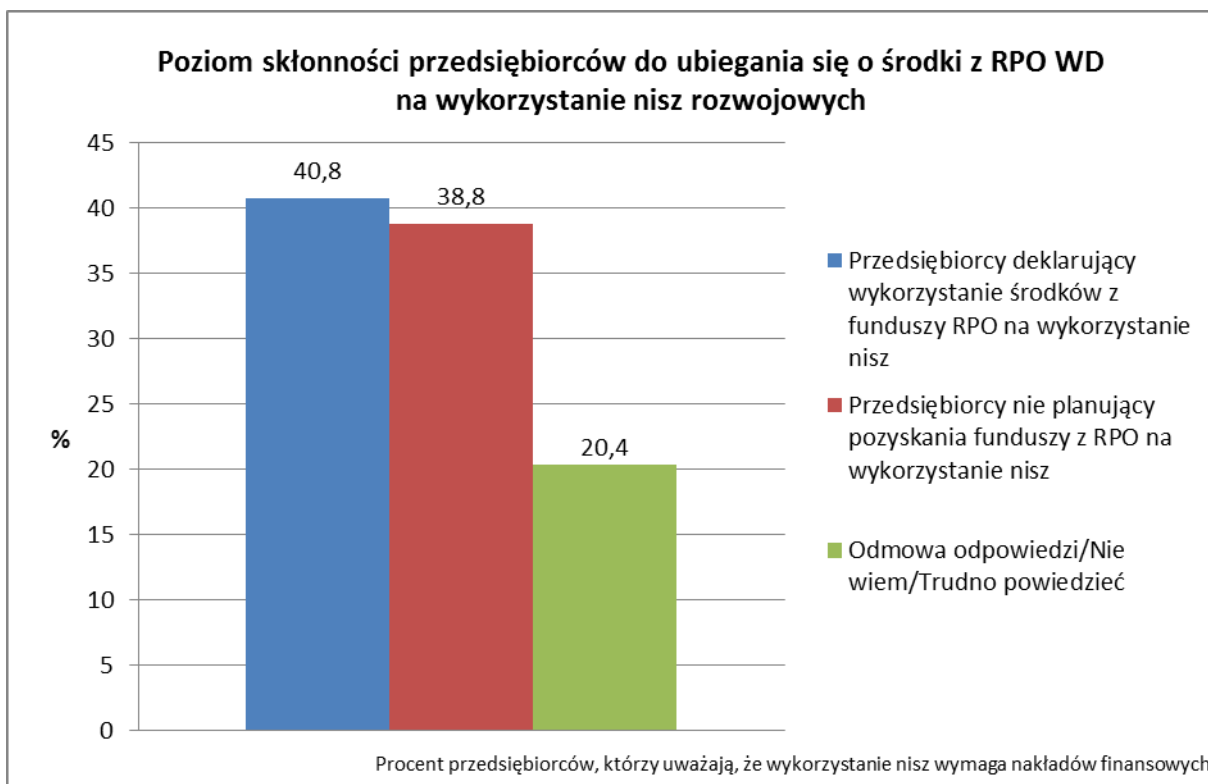


Chart 56 The level of entrepreneurs' tendency to apply for funds from the ROP WD for the use of development niches (based on CATI research)

Such a result corresponds more or less to the level of application in the last 10 years. It can therefore be assumed that enterprises interested in support are enterprises that have already applied for

subsidies, so investing in research and development is not a problem for them. The interviews show that these are generally large enterprises with research facilities, laboratories and branches for obtaining external funds. Most often, they also have experience in cooperating with research units and commissioning research to research centers. These enterprises also have the appropriate financial resources necessary to apply for funds with a certain minimum project value ceiling.

During in-depth interviews and focus meetings, smaller entrepreneurs emphasized that they also have ideas for innovations in their companies, and that they are bottom-up initiatives resulting from practice and experience, and not conducting outside research. Faint contact with few existing R & D units and the lack of specialized centers and institutions for IS branches other than mining were emphasized. It was also raised the fact that most manufacturers of machinery, equipment and tools used in the industry come from abroad, which also negatively affects the flow of technical thought and positive stimulation of development.

1.2.3.

1.2.4. *Indication of possible support schemes*

(I.11)
Indication of possible support schemes for entities of Lower Silesian smart specialization, the natural and secondary raw materials sector in order to increase their competitiveness and innovation;

The analyzes of results obtained during CATI surveys, interviews and focus studies presented in the above chapter indicate a disturbingly low interest in implementing innovations (25%). It is also worth emphasizing the diversification of the sectors of the studied specialization and the disproportions in the size of individual enterprises. Large enterprises with experience in applying for external research funds declare their interest in public aid and investing in innovation. Small entrepreneurs who do not have support in the form of European funds and research units departments, as well as non-cooperating research centers are very skeptical about the possibility of obtaining support. It is also worth emphasizing that inside the DIS there are areas for which there is no possibility of support under the ROP WD. An example of this is the innovation in the form of re-use of waste collected in heaps.

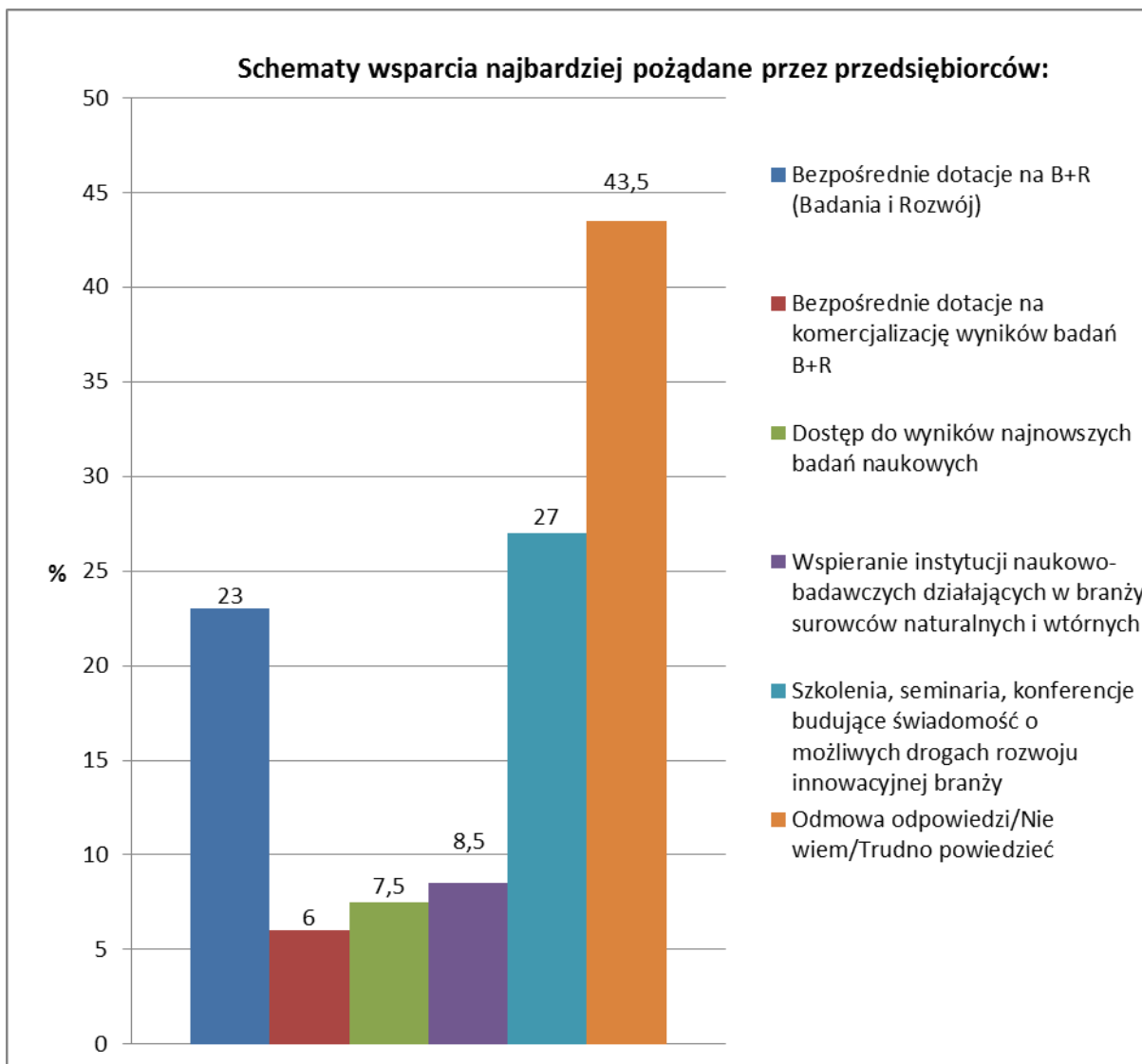


Chart 57 Most desirable support schemes (based on CATI research)

During the survey, the respondents were asked which support schemes are the most interested (). The highest result (27%) was obtained by "Training, seminars, conferences building awareness about possible ways of innovative industry development". Only in the second place (23%) the respondents mentioned "Direct subsidies for R & D". The remaining schemes, ie "Direct subsidies for commercialization of R & D research results", "Access to research results" and "Supporting scientific and research institutions", obtained a similar, several percent result. Such an opinion of the respondents may indicate a great need to intensify contacts and increase the possibilities of information flow between the industry and the world of science. During the research, interviews and meetings, both sides - that is, scientists and entrepreneurs - repeatedly emphasized their readiness to cooperate, but they did it in a way unilaterally, from their point of view. They emphasized the lack of opportunities for mutual meetings, conversations and sharing their ideas.

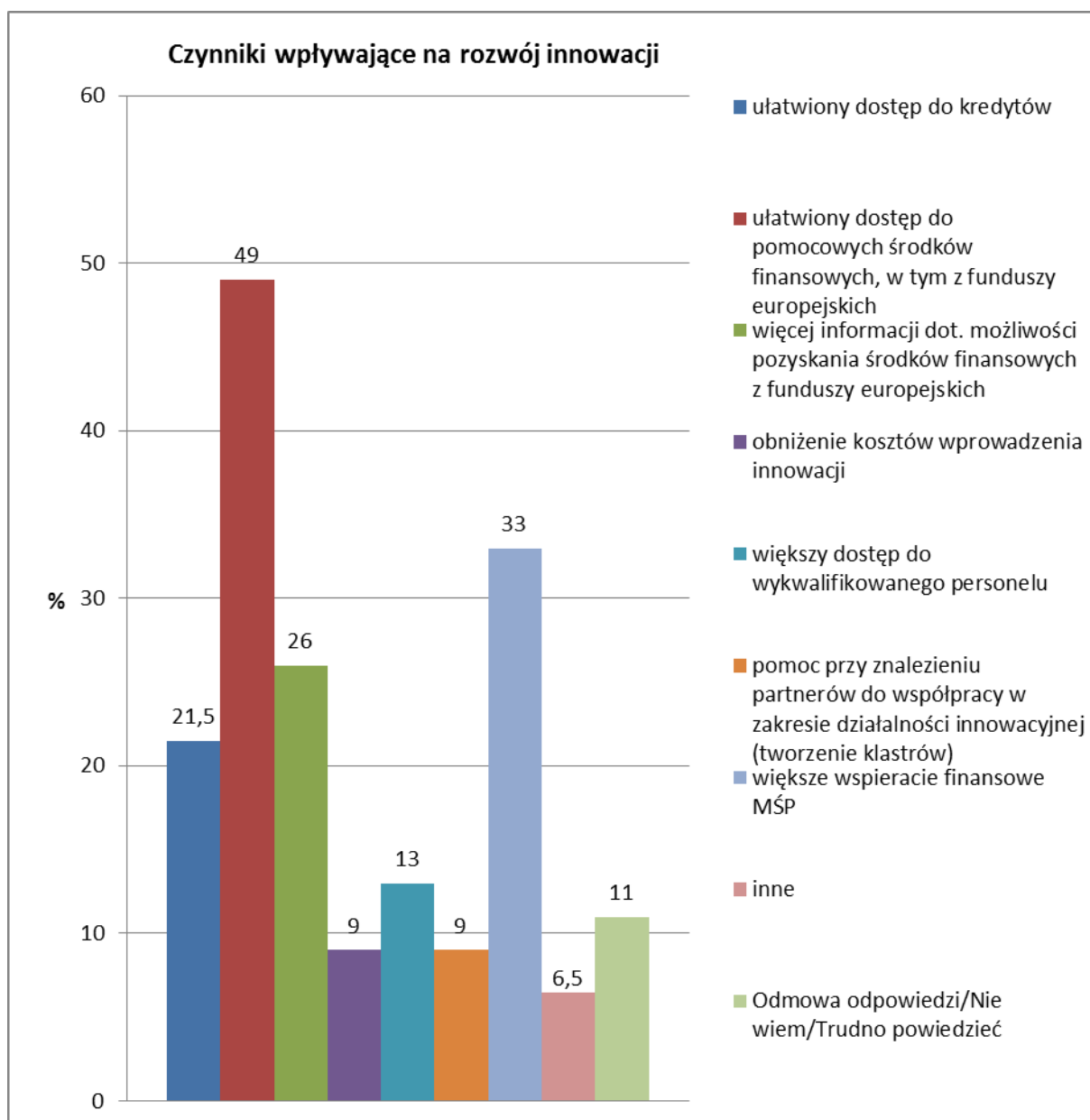


Chart 58 Factors that could affect the development of innovation (based on CATI research)

Proposals for improving the situation that occurred during research, meetings and talks with entrepreneurs, and concerning factors that affect the development of innovation are primarily the simplification of application procedures (.). In the opinion of many of the respondents, the application path is complicated and bureaucratic. Similar opinions were expressed about the settlement of applications. The excessive role of officials and their discretion in interpreting the regulations was accused. Examples were given of multiplying the number of documents necessary to obtain support which effectively discouraged applicants. The issue of the risk of failure to achieve research goals and, as a consequence, problems with settlement of subsidies was raised.

In turn, entrepreneurs spoke positively about returnable instruments, with the proviso that they must be long-term and low-interest.

A focus study conducted with members of the Kamieniarski Cluster shows that entrepreneurs are interested in jointly carrying out research and development works on subjects relevant to the entire industry, and impossible to implement by single (often small) companies. This would solve the problem of the lack of specialists both from implementations and fundraising, would save time and resources necessary for individual application.

In order to increase the innovativeness of DIS natural and recycled materials, it would be recommended to create or further develop the following support schemes described below:

Subsidies for the BE sector of the DIS sector natural and secondary raw materials - Subsidies for scientific and research institutions and BEIs as well as stable clusters for the organization of conferences, seminars, study visits, etc. serving the presentation of results from research work, existing innovations as well as opportunities (facilities) to conduct research. They should be dedicated to entrepreneurs in order to increase the possibilities of cooperation. During such events, entrepreneurs should present their needs in the field of development research and at the same time present their technical facilities. This support scheme can also be linked to targeted subsidies for the participation of enterprises in selected (by the entrepreneur) external scientific and scientific-implementation conferences. Enabling support (eg in the form of a voucher) for the entrepreneur's participation in a trade conference or trade fairs would allow for establishing closer contacts on the industry - science line. It could ultimately become a platform for mutual understanding of the needs and possibilities, and as a result be an impulse to jointly conduct research and development works within the framework of cooperative relations.

This type of support should be developed and modified by adapting to regional needs. For example, funds from PO IR are available for Key Clusters, and none of DIS clusters. Natural and secondary raw materials is not a key cluster. Developing this support scheme, one should consider the possibility of co-financing projects of low value (minimum value of the project at the level of PLN 10,000), so that it is possible to implement a specific project.

Reverse financial instruments - Costs related to the implementation of research works and then their implementation and commercialization are a significant barrier for entrepreneurs. In addition to the obvious expectation of direct public support as definitely significant entrepreneurs indicated the extension of the repayment period of liabilities incurred and the reduction of interest or the possibility of redemption of the loan in the case of patenting and implementing innovations.

Competitions addressed directly to specific smart specializations of the region - An interesting solution could be to create competitions in which the BSA (including clusters) could be applied after the development of the relevant Development Strategy of the smart specialization industry. As part of these competitions, these entities could obtain funds to achieve the objectives of the strategy. Such a solution could be particularly effective for industries that have a fragmented ownership structure (eg, timber, masonry) and in which individual enterprises are unable to apply for effective support themselves. As part of these competitions, it would be promoted to run system projects targeted at individual sub-organizations and to identify areas of possible innovations (also in cooperation with national and foreign scientific centers).

Innovation voucher obtained through simplified procedures public support instrument supporting the initiation of R & D cooperation between SMEs and research units. The subject of cooperation funded by means of a voucher could be research commissioned to research units as well as consultancy in the field of product or technology development support. The value of vouchers could, for example, amount to PLN 20,000, the system should allow the possibility of combining vouchers by two or more entrepreneurs wishing to jointly or as part of a cluster carry out one research project. The functioning of this support scheme should be strengthened by disseminating information on how entrepreneurs can use it

Specific support for SME group enterprises - SME group entrepreneurs indicate that the process of applying for aid from the structural funds is for many of them a high financial burden and competition for funds with large companies that can employ specialist consulting companies often condemns attempts to obtain support by smaller companies for failure. The solution could be to change the target group of beneficiaries so as to increase the availability of aid measures for the sector of smaller companies (SMEs). The Lower Silesian Intermediate Chamber has, however, created contests for companies existing on the market for up to two years - it seems, however, that such a solution from the point of view of supporting innovation is not appropriate. The more so because the period of incubation of the DIS industry and natural resources takes about 4 years. What is more, it is exclusive for companies that have been in the industry for more than two years and for whom financial constraints and costs of expenditure on innovations are burdened with too high financial risk. It seems that a good solution would be to create a competition dedicated to the SME sector in which the possibility of applying would depend on the obtained specific revenues.

2. INNOVATION POTENTIAL IN THE INDUSTRY

(I.4) Assessment of the level of innovation of enterprises representing the "natural and secondary raw materials" industry

The entire following chapter has been developed based on CATI and IDI research carried out on entities representing the "natural and secondary raw materials" sector

2.1. Types of innovation and their range

(I.4.1) Types of innovations in enterprises over the last 10 years and their range

The natural and secondary raw materials sector in Lower Silesia has quite a significant development potential, also in the directions of the so-called smart specializations. Both the exploitation of natural resources and their processing as well as wood processing are historically related to these areas. Entrepreneurs using technological heritage see its possible imperfections and try to counteract them. The research shows that in the last 10 years, over 1/3 of enterprises (34.5%) have introduced some innovations into their activity. The highest percentage of innovative enterprises is observed in the recovery and reclamation sub-sector, where half of the companies declare such changes. Surprisingly, the smallest percentage concerns the sub-range of advanced materials. This is related to the natural state of the art in this industry, so the subsequent modernization of products or processes is expensive and difficult to carry out or is not regarded as innovations by the entrepreneurs themselves

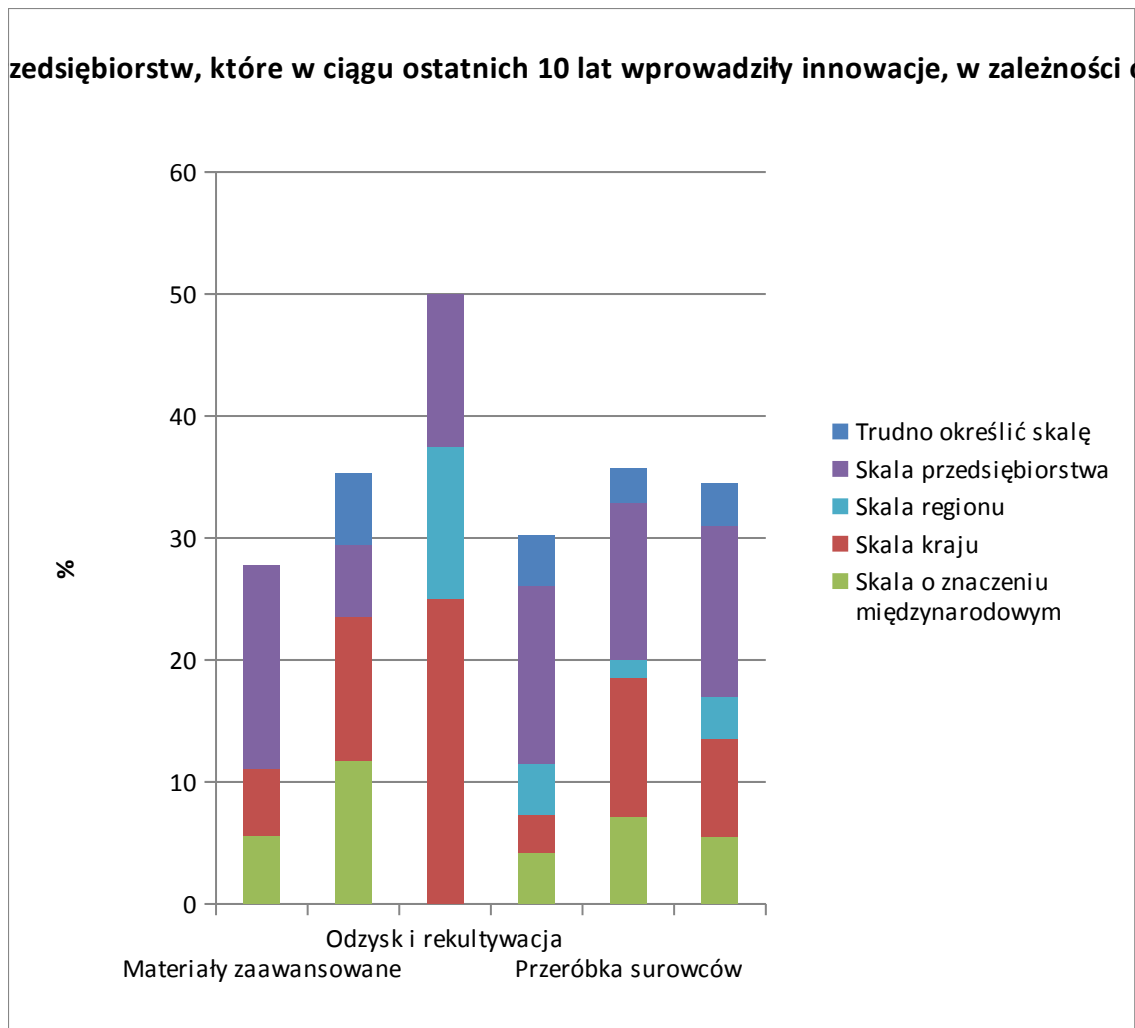


Chart 59 Percentage of enterprises that introduced innovations over the last 10 years, depending on their scale (based on CATI research)

Among entrepreneurs declaring their innovativeness in the last 10 years, the largest percentage (41%) defines the scale of these innovations only as related to the enterprise. These are therefore improvements that are innovative and modern in a given company, but in the perspective of the entire market, they do not have to be that way. 23% and 16% of surveyed companies declare innovativeness, respectively on the national and international scale. The largest share of domestic innovations can be observed in the case of recovery and reclamation (50% of the total), while those with an international reach in the use of rock raw materials (33%). This may be evidence of the modernity of this sector, as the introduced innovations are not only copies of solutions introduced successfully in other countries.

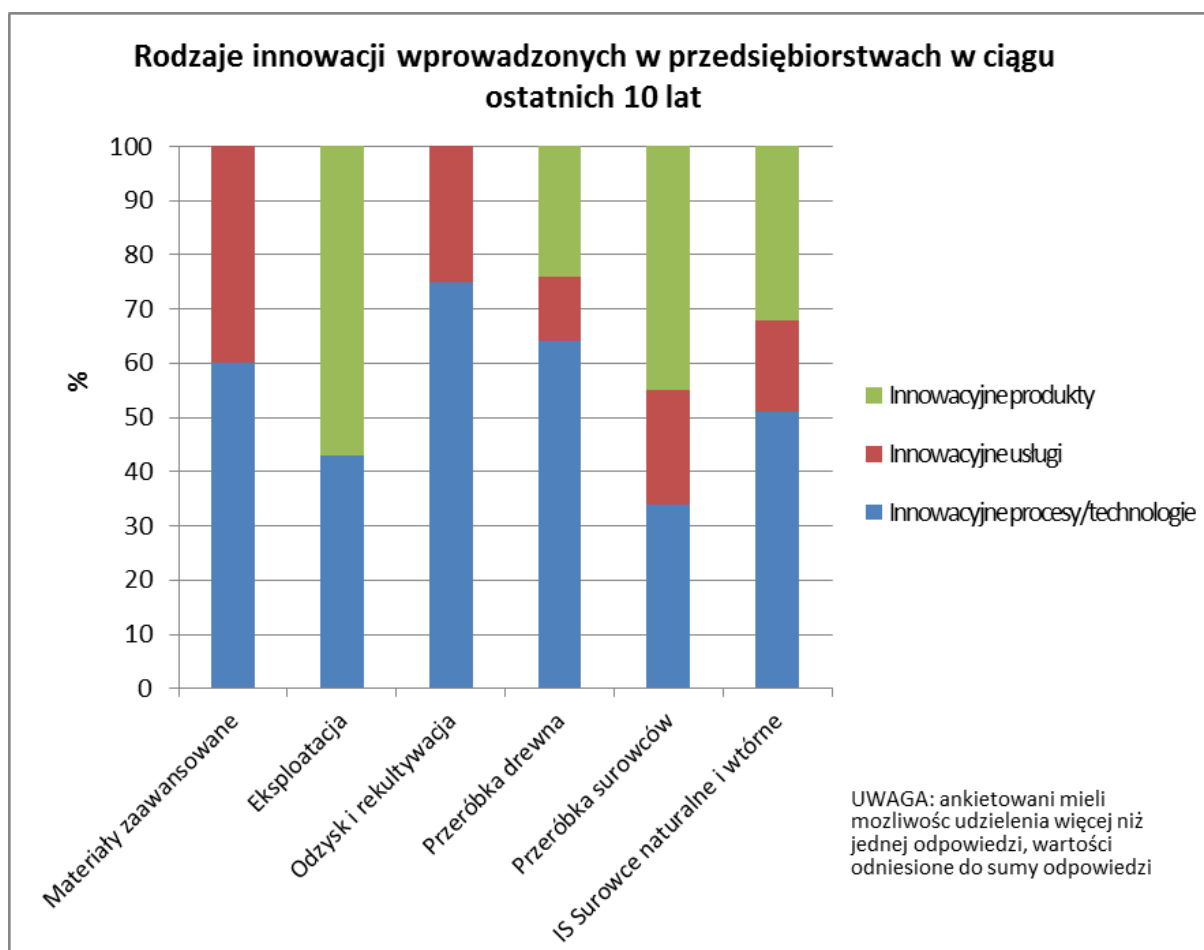


Chart 60 Type of innovations introduced in enterprises over the last 10 years (based on CATI research)

The basic types of innovations in enterprises can be divided into three main groups presented and described below:

Process or technological innovations are changes that entrepreneurs introduce in order to reorganize operating, manufacturing or sales processes. Changes in these processes are aimed at offering customers a new type of product or upgrading existing ones. New products would not have had a chance to exist if it were not for innovations introduced in the process of their creation or sale. This group of changes also includes those that serve to improve the efficiency of production lines. The potential of this type of innovation in the specialization Natural and secondary raw materials is quite significant. From among the surveyed enterprises that introduced innovations in the last 10 years, 58% have just declared innovative processes or technologies. This percentage fluctuated among individual sub-sectors from 40% in the case of raw materials processing, up to 75% in the case of recovery and reclamation. At the same time, the entrepreneurs in the focus study (panel of experts) pointed out that this type of innovation is the easiest to prove in application processes for funds under EU assistance programs.

Innovative products are an assortment whose features are significantly better than those offered so far or it is a new, modern product with the characteristics of market uniqueness. By introducing such products, producers can gain new market segments or maintain their position in the event of

significant competition. In the case of specialization Natural and secondary raw materials, 36% of innovative enterprises declare the introduction of this type of innovation. The highest percentage is observed in the case of companies that use raw materials, which, by introducing modern products, are trying to meet the growing expectations of markets and competition of foreign raw materials. No one from the advanced materials and recovery and reclamation sub-branch has declared the introduction of such innovative improvements in the range of products within the last 10 years. It should be noted, however, that companies from these sub-branches declared instead of product innovations, service innovations. The focus study (expert panel) showed that entrepreneurs find this type of innovation the most difficult to implement. Launching a new, innovative product on the market generates significant costs with considerable investment risk.

Service innovations is a group of improvements offered by entrepreneurs services. Similarly as in the case of innovative products, also such services must have significantly better features than those offered so far. As the companies from DIS Natural and secondary raw materials are focused mainly on the production of products and not services, only 19% of those declaring innovation confirm the introduction of this type of innovation. The surveys show the complementarity of product and service innovations. Industries oriented to service activities, such as recovery and reclamation, have introduced innovative services without offering such products. The highest percentage of this type of innovation can be seen in the case of companies dealing with advanced materials.

Acquiring the knowledge and technology needed to improve its offer and launch innovative solutions on the market is one of the areas that many entrepreneurs deal with in an insufficient manner. Most enterprises do not have their research divisions, so they must be based on external sources of knowledge acquisition and innovative technologies. The highest percentage of surveyed companies declaring innovation benefited from scientific and technical advisory of research and development institutions or universities (32%). The greatest desire for this type of cooperation concerned entrepreneurs from the raw material exploitation sector. It results from the wealth of research institutions dealing with this field in the region of Lower Silesia. Only 16% of the surveyed companies used information in scientific and technical publications, which may indicate a poor availability of this type of studies. Many companies had difficulty identifying the source of their knowledge and innovation or refused to answer this question. This particularly applies to entrepreneurs involved in wood processing. This information is presented in the chart below.

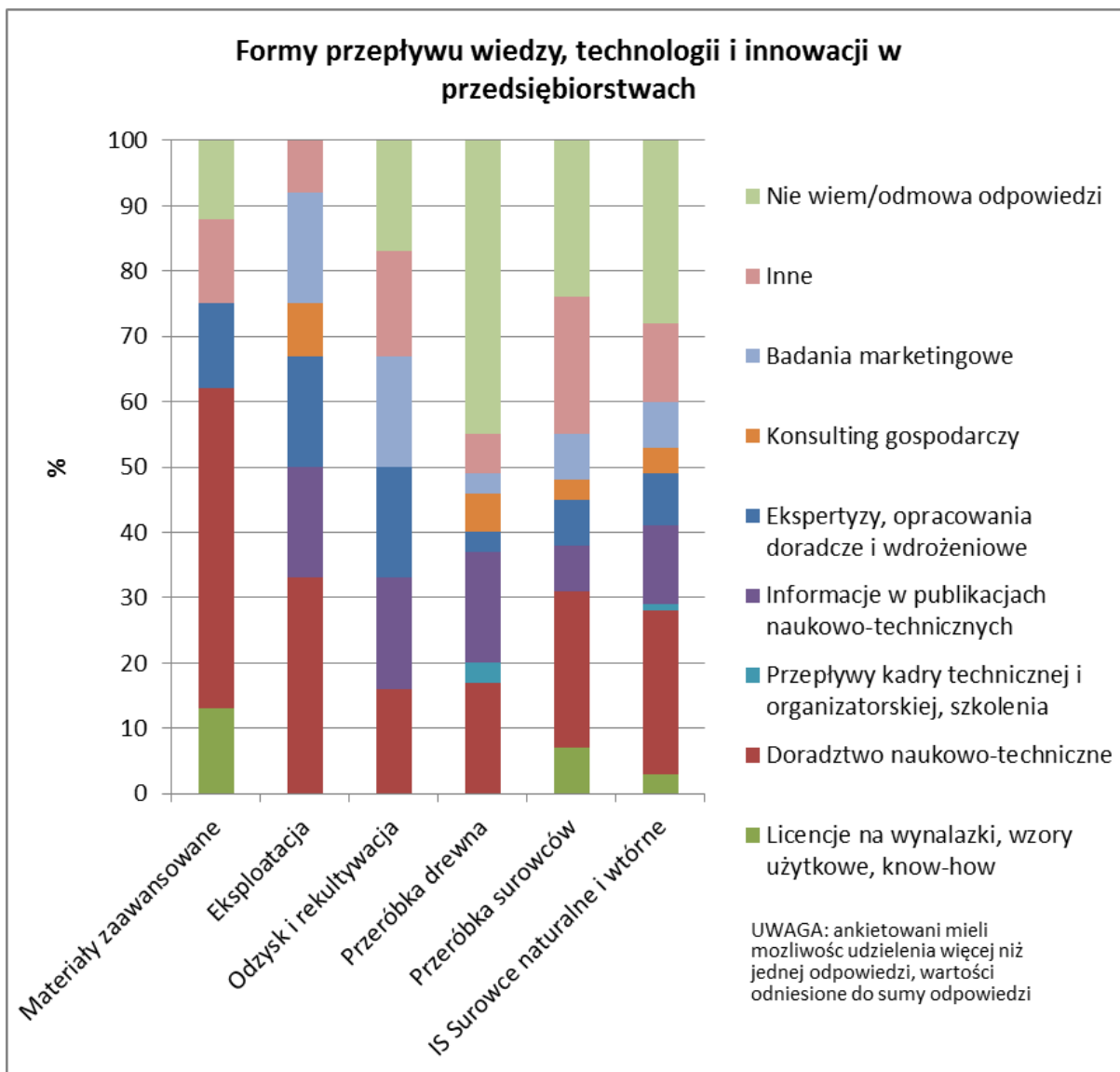


Chart 61 Forms of knowledge, technology and innovation flow in enterprises (based on CATI research)

2.2. Expenses of enterprises for research and development

(I.4.2) Expenses of enterprises for research and development

Smart specialization Natural and secondary raw materials, like any other, need innovation. Enterprises, wanting to stay on the market or expand their sphere of influence, should develop, offer new products and services. The financial resources invested in research and development should pay off in the form of increasing the company's sales. However, the costs of such work often outweigh the current financial possibilities, especially for small and medium-sized enterprises. Of the total number of entrepreneurs surveyed, only 11% of them declare the allocation of funds for research and development. From individual sub-branches only in the sub-operation of raw materials exploitation there is a clear attitude towards this type of work (35%). The recovery and reclamation (0%) and wood processing (3%) sub-branches are worst in this comparison. The main reason for the

lack of financing of R & D works by entrepreneurs is the lack of such a business need (67%). Too large research costs are also a big obstacle to conducting development works (20%). The positive fact is that few of the surveyed entrepreneurs (2.5%) explain the lack of interest in these works of ignorance about modern solutions in the industry. This shows the potential knowledge of innovative solutions, which entrepreneurs give up, mainly due to the reasons given above.

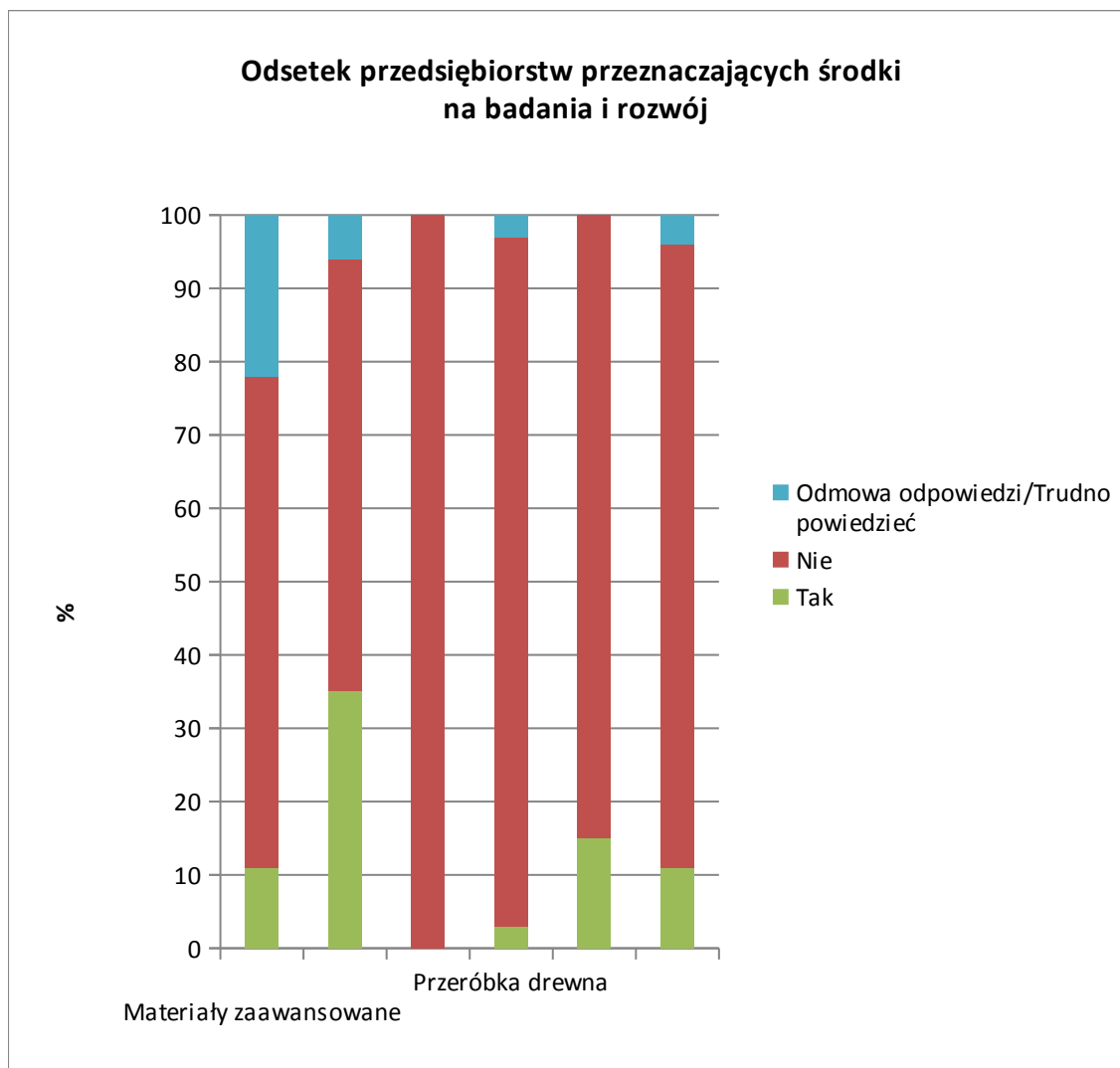


Chart 62 Percentage of enterprises allocating funds for research and development (Based on CATI surveys)

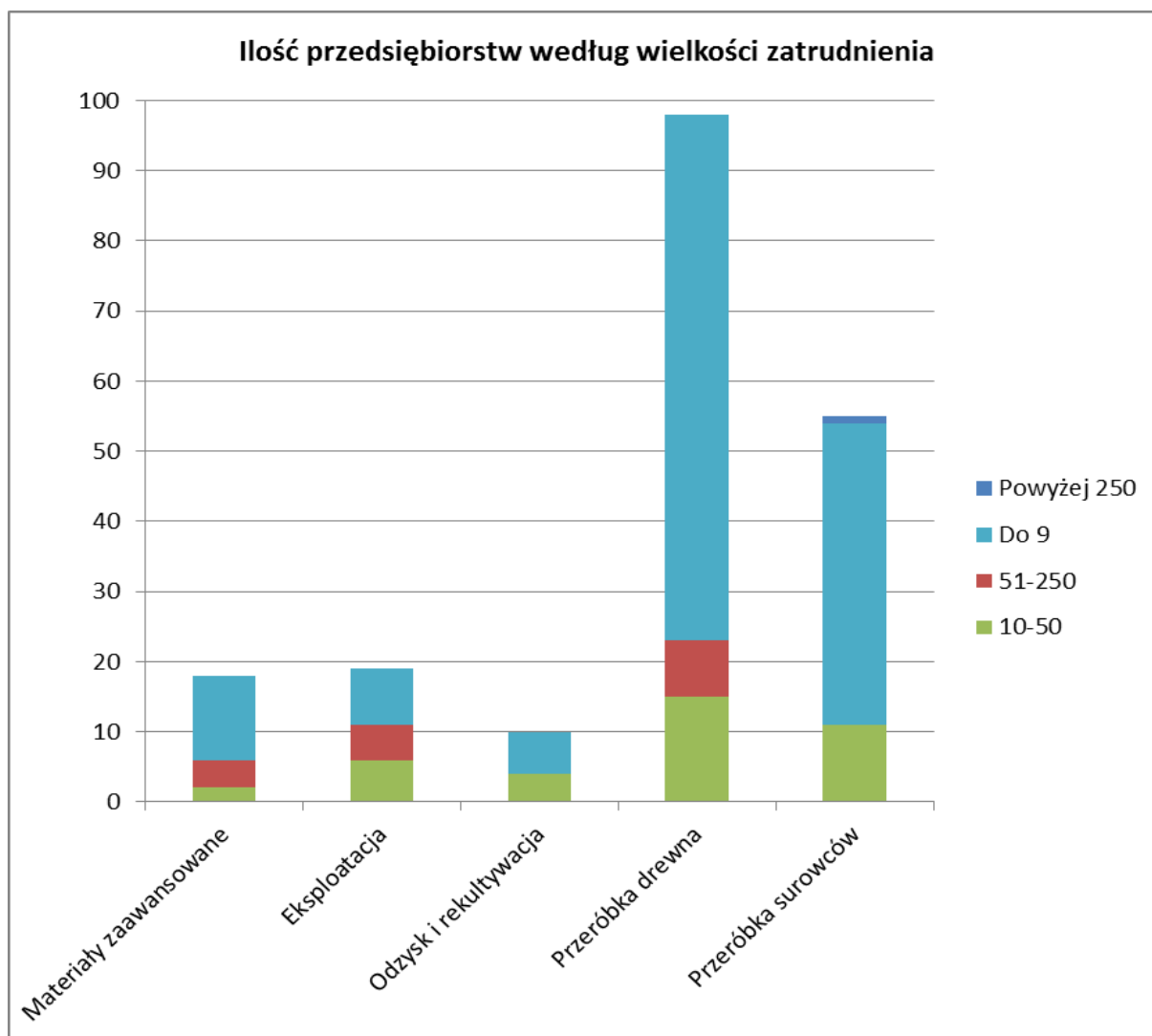
Among entrepreneurs declaring the allocation of funds for research and development works, most of them (48%) specify expenses incurred for this purpose to the range below 100,000. zł. These amounts are relatively small, not leading to innovation at the supra-regional level. This correlates with the advantage of innovations defined only on the scale of the enterprise.



2.3. Employee potential

(I.4.3) The size and characteristics of employment, including the employment of high-class specialists;

Highly qualified and experienced employees constitute the potential of every enterprise, regardless of the scale of its operations. The staff at all levels have a direct impact on the quality of the products offered and, consequently, on the condition of the company.

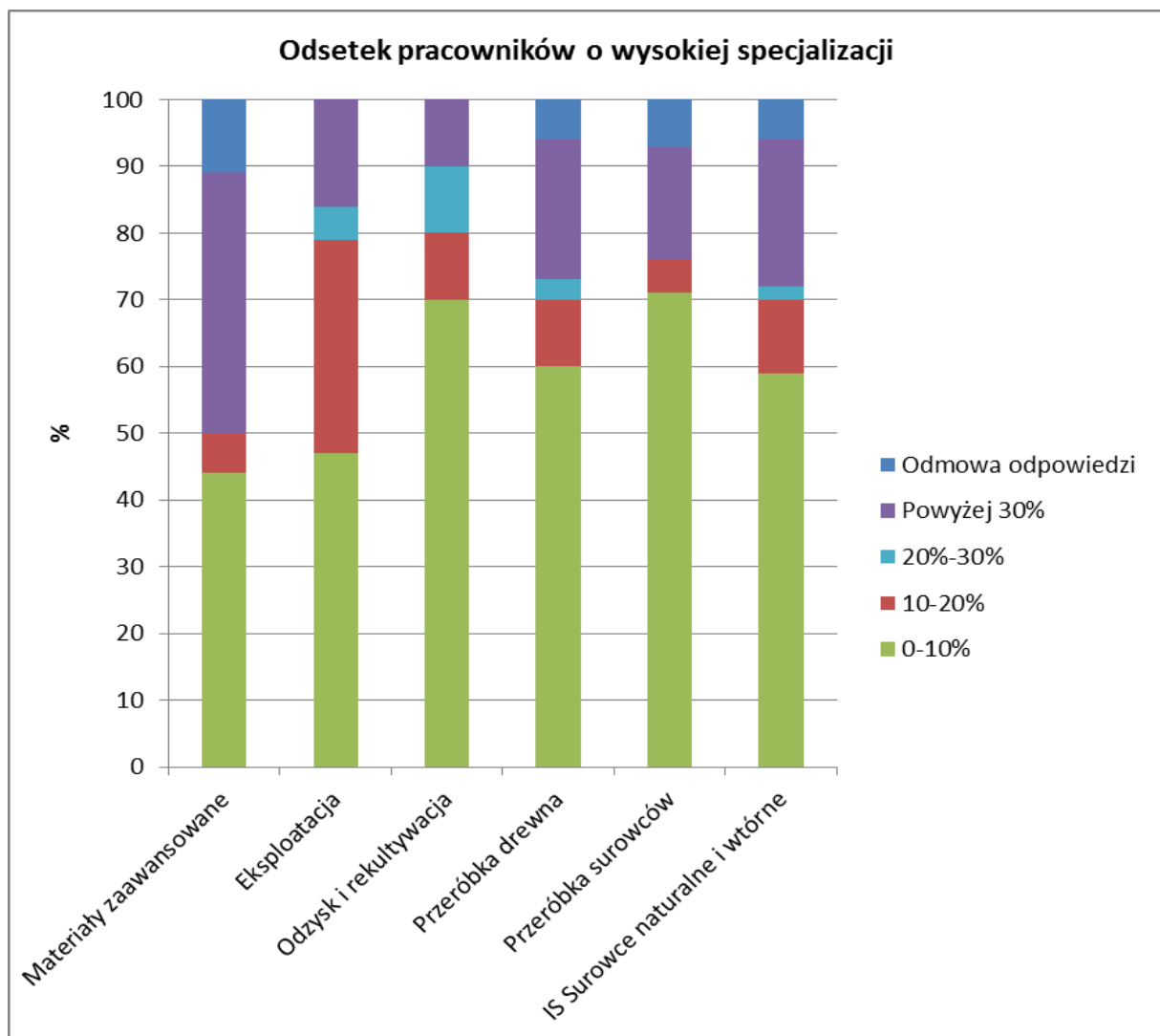


Number of enterprises by employment size

The natural and secondary raw materials surveyed for the purpose of this study are in the majority of micro-enterprises (71%), whose employment is below 10 people. Such companies, due to their size and relatively small turnover, have little potential for introducing costly innovations of a supra-regional scale. 19% are small enterprises with employment in the range of 10-50 people, while 10% of the total amount are medium-sized enterprises with employment at the level of 51-250 people. Only one company that did not qualify for the sector of small and medium-sized enterprises replied to the questionnaires, that is, employing over 250 people (CHOFUM Mechanical Plant Factory from

Chocianów). Such a size structure results from the wide presence in the list of small wood processing companies (mainly furniture) and raw materials (stone processing plants).

Employed highly specialized employees constitute a potential source initiating the company's drive to introduce innovative processes or products. Therefore, one should strive for a situation where this percentage will be as high as possible in enterprises. It is possible to achieve this by promoting appropriate directions of vocational and higher education, as well as the construction of support programs for employees' professional development.



Graph 64 Percentage of employees with high specialization (based on CATI surveys)

In the specialization Natural and secondary raw materials, the employment of highly specialized staff at the level above 10% was recorded in 35% of enterprises. This result is satisfactory and certainly does not constitute a limitation for increasing the industry's innovativeness. It is not surprising that the largest number of specialists are noted in the sub-sector of advanced materials that need significant resources of specialist knowledge.

From the point of view of geographical distribution, the highest percentage of the indicator "employment of specialists above 10%" was recorded in Legnica-Głogów (90%), slightly less in Jelenia

Góra (40%) and Wrocław (37%) and least in Wałbrzych (20%). Even when looking through the prism of the largest representation of enterprises from the Wrocław sub-region, these results testify to the increasing mobility of highly specialized employees who follow their work even to smaller centers.

It is necessary to pay attention to the problem reported by a significant part of the surveyed entrepreneurs, namely the increasingly inferior availability of employees. These deficiencies are evident at all levels of qualification. The growing demands of employees towards employers, economic emigration, the increasing willingness of young people to follow their work even in remote parts of the country are the main reasons for this state of affairs. The specific situation prevails in the transformation of wood, where the lack of highly specialized employees is very noticeable. This is mainly due to the lack of opportunities to learn in this field in Lower Silesia both at the upper and secondary level (Technical College in Milicz does not educate in the directions of wood processing and is limited to the forestry itself). Also, none of the universities guarantees the right directional education. There are also no research and development units related to the wood industry. This situation is surprising in the region, where the tree processing industry is represented and should be one of the priorities for the local environment.

2.4. Patents and trademarks

(I.4.5) Activity in the field of protection of intellectual property, the number of patents and trademarks
--

One of the commonly accepted indicators of the innovation potential of a given industry is the number of patents obtained by enterprises, as well as the claimed designs or trademarks. During the questionnaire surveys, entrepreneurs from DIS Natural and Secondary Resources were asked about four basic types of applications to patent offices.

Patents are documented proprietary rights to use some unique technical solution or to use the invention. In Polish law, patent protection is 20 years.

Utility designs are technical solutions concerning the construction or properties of a given product, whose protective law in Poland is 10 years.

Industrial designs include structural features that give an object an individual character. The right to exclusive use of such a design is obtained in Poland for a period of 25 years.

Trademark is any graphic designation that allows to distinguish the goods of a given entrepreneur from others. The basic protection period for such a mark covers 10 years, but it may be repeatedly extended for subsequent ten-year periods.

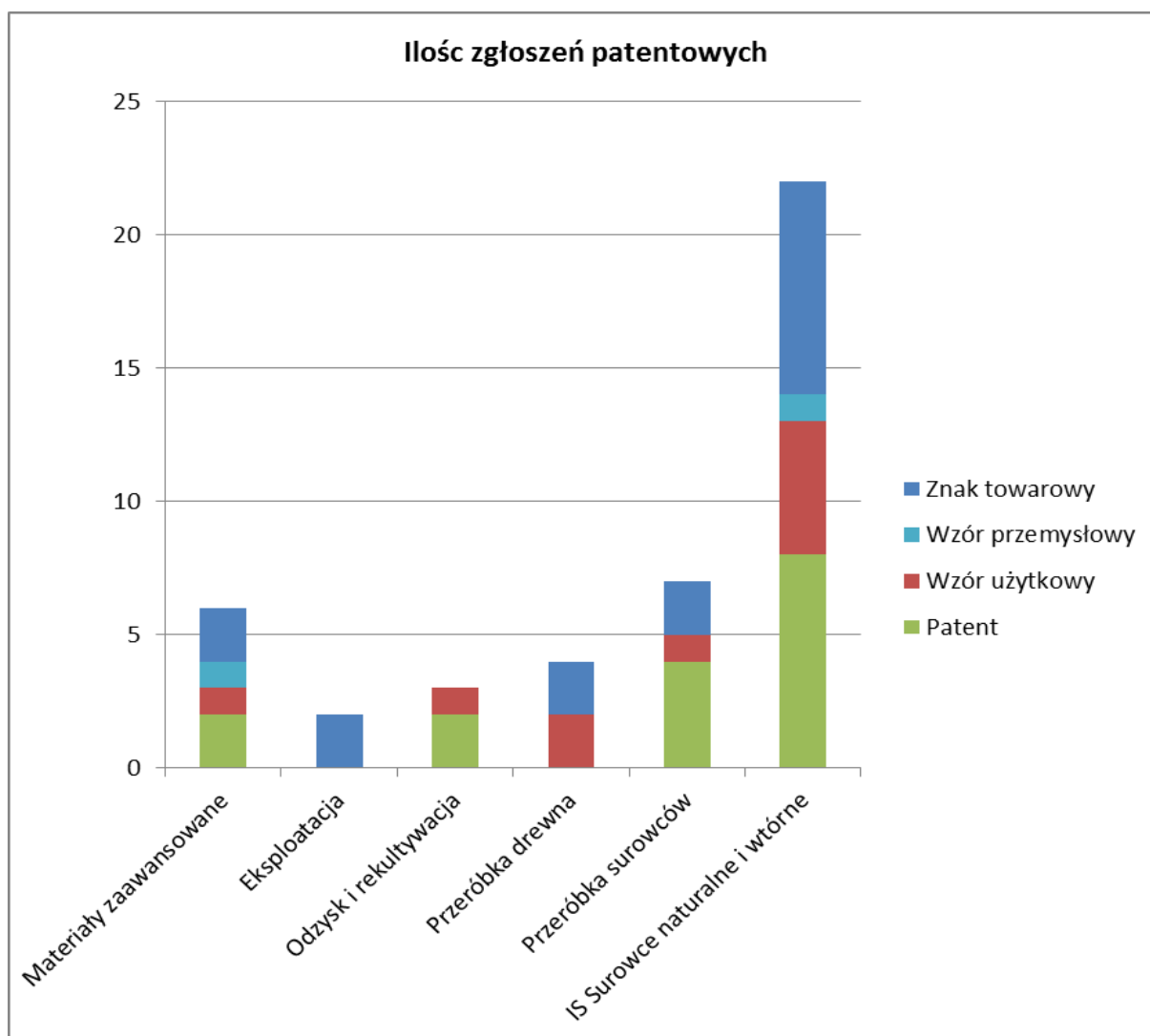


Chart 65 Number of patent applications and other protection rights (based on CATI broadcasts)

From 200 companies surveyed, the patent offices from 2000 received 22 applications. Therefore, it can be assumed, on the basis of a statistical sample, that in this period about 10% of DIS industry entrepreneurs have submitted patent applications to natural and secondary raw materials. This amount may indicate reluctance to submit their innovative solutions or products to patent offices or the lack of such possibility. However, it should be borne in mind that the survey mainly concerned enterprises from the SME sector, which, due to the scale of their activity and the lack of their own research divisions, rarely decide on a patent procedure. Entrepreneurs pay attention to the considerable costs of developing solutions that could eventually be patented. The costs of developing the invention, its commercialization, implementation and patent application itself are too high compared to the risk incurred in this type of work. From the total number of applications, according to surveys, only 2 of them were the result of public intervention, for example subsidies or other aid projects. This quantity contrasts with the general satisfaction of enterprises with public support and the declared increase in sales resulting from it. This may indicate a relatively small scale of innovation resulting from public intervention. On the other hand, these results indicate that innovations are most often innovations in the scale of the enterprise or possibly the local market. This is confirmed

by the CATI result indicating that in the number of patent applications only a small part of them concerns innovation on a national and international scale.

However, it should be remembered, as discussed in the previous chapters (3.2.2, 4.1.1), that the number of patents is not always reflected in the innovation of the company or industry. The number of implementations resulting from patents should be a more realistic indicator. It is also related to the fact that for enterprises, especially in the SME sector, research and development units should offer innovative solutions that can be implemented.

2.5. Financing innovation by entrepreneurs

The financing of innovations by entrepreneurs (I.4.6) The scope and methods of financing innovations by entrepreneurs;
--

The implementation of innovations in enterprises depends to a large extent on the possibility of obtaining financing sources. The introduction of a modern product or a significant increase in efficiency through the modernization of the production line is usually subject to significant costs. Interestingly, many of the Lower Silesian DIS natural and natural resources declaring the implementation of innovation in the last 10 years of operation decided to finance it with their own funds (77%). This could prove that the group of companies is in good financial condition, with low knowledge about alternative sources of financing or about reluctance to use external funds. In the group of companies that decided to use external funds, it can be clearly seen that the branch of exploitation of natural resources is the best at their acquisition. It may be related, among others, to the fact that innovations introduced in this sub-branch are most easily available in the Lower Silesia region due to the presence of research and development institutions, and many of the support programs require cooperation of R & D units with entrepreneurs. On the basis of this sub-branch, it can also be seen that such a model of assistance works well only in the case of the availability of support institutions on the local market. The lack of research and development institutions for the processing and wood sub-branches may in turn cause difficulties in using support programs financed from the European Union.

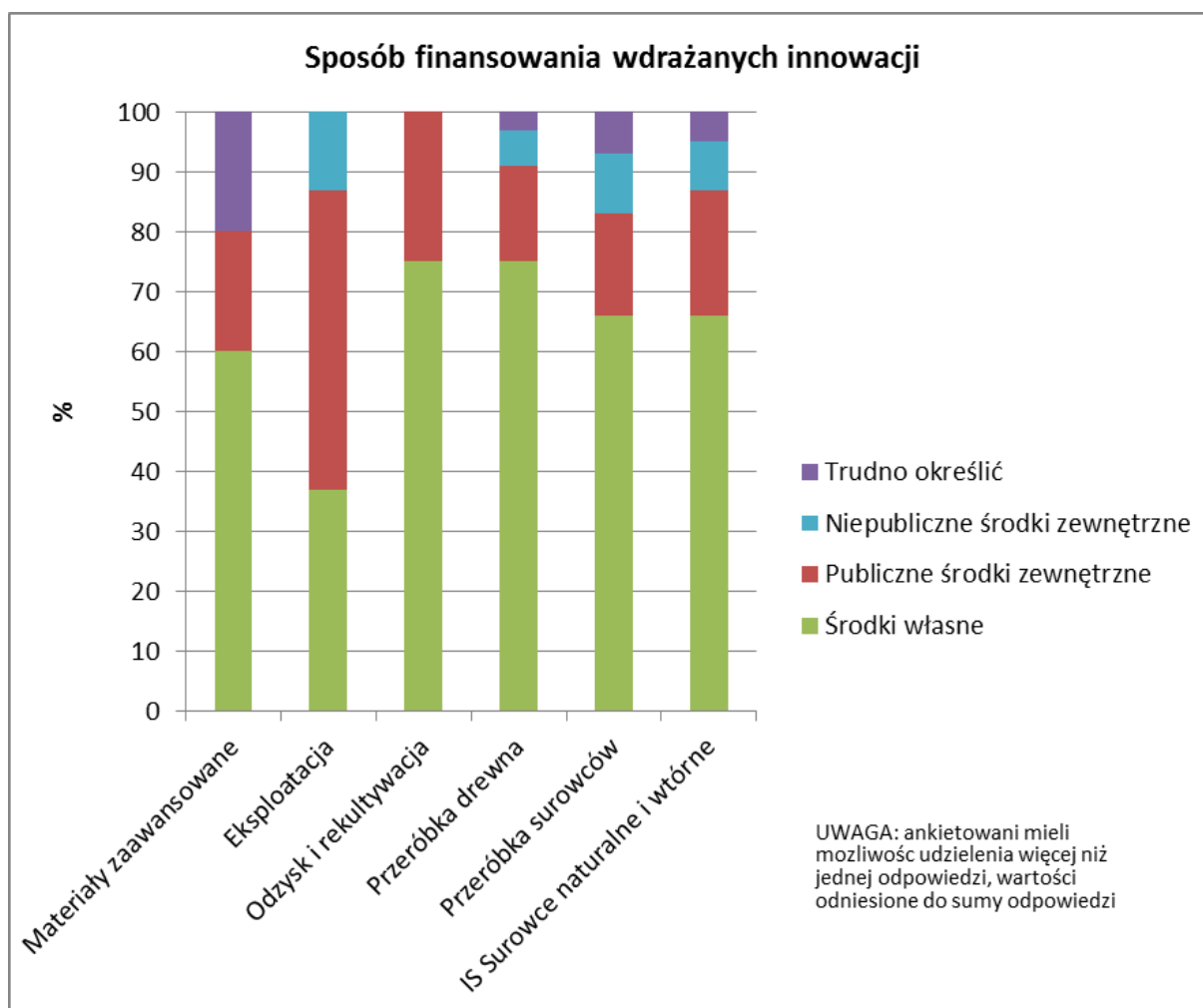


Chart 66 Method of financing the implemented innovations (based on CATI surveys)

Enterprises that managed to obtain public support for activities raising their innovativeness positively assess the effects of this intervention. Over 1/3 of the surveys recognize (69%) that public support has allowed to significantly increase the value of sales. At the same time, almost all entrepreneurs estimate the effectiveness of these activities on medium or high. Thanks to this, it can be assumed that assistance programs fulfill their task, however, it is necessary to pay attention to the greater availability of such assistance activities, especially for the sector of smaller companies (SMEs).

2.6. Plans for the development of innovative products and services

(I.4.7) Business plans for the development of innovative products and services;

Planning future production in enterprises should take into account the introduction of new products or services that, through their innovativeness, will serve to improve the competitiveness of companies. Such plans may of course be corrected, for example due to a technological breakthrough that will force companies in a given industry to introduce new solutions. From among the surveyed enterprises, 39% declare the introduction of an innovative product, service or technology in the near

future. This is a slightly larger percentage compared to enterprises that have innovated in the last 10 years (34.5%).

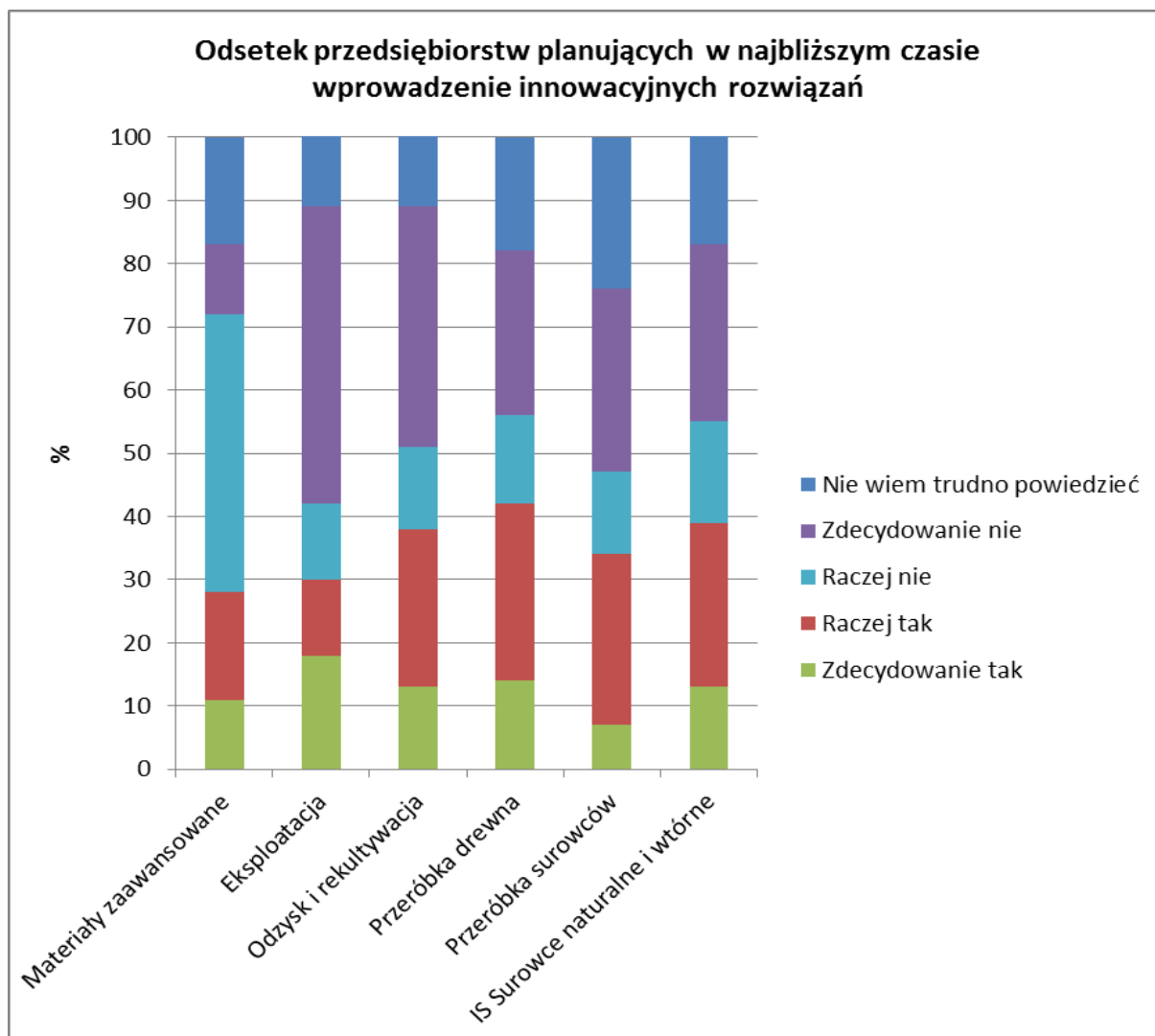


Chart 67 Percentage of enterprises planning to implement innovative solutions in the near future (based on CATI research)

Among entrepreneurs who have introduced innovations in recent years, 64% of respondents declare willingness to take further actions in this direction. However, in the group that did not decide to develop such innovations, this percentage is only 26%. This proves a certain stagnation in this area, few new enterprises are determined to spend funds on modernizing their offer. Among entrepreneurs who have not introduced innovative solutions so far, there is also greater uncertainty as to planning such activities in the future.

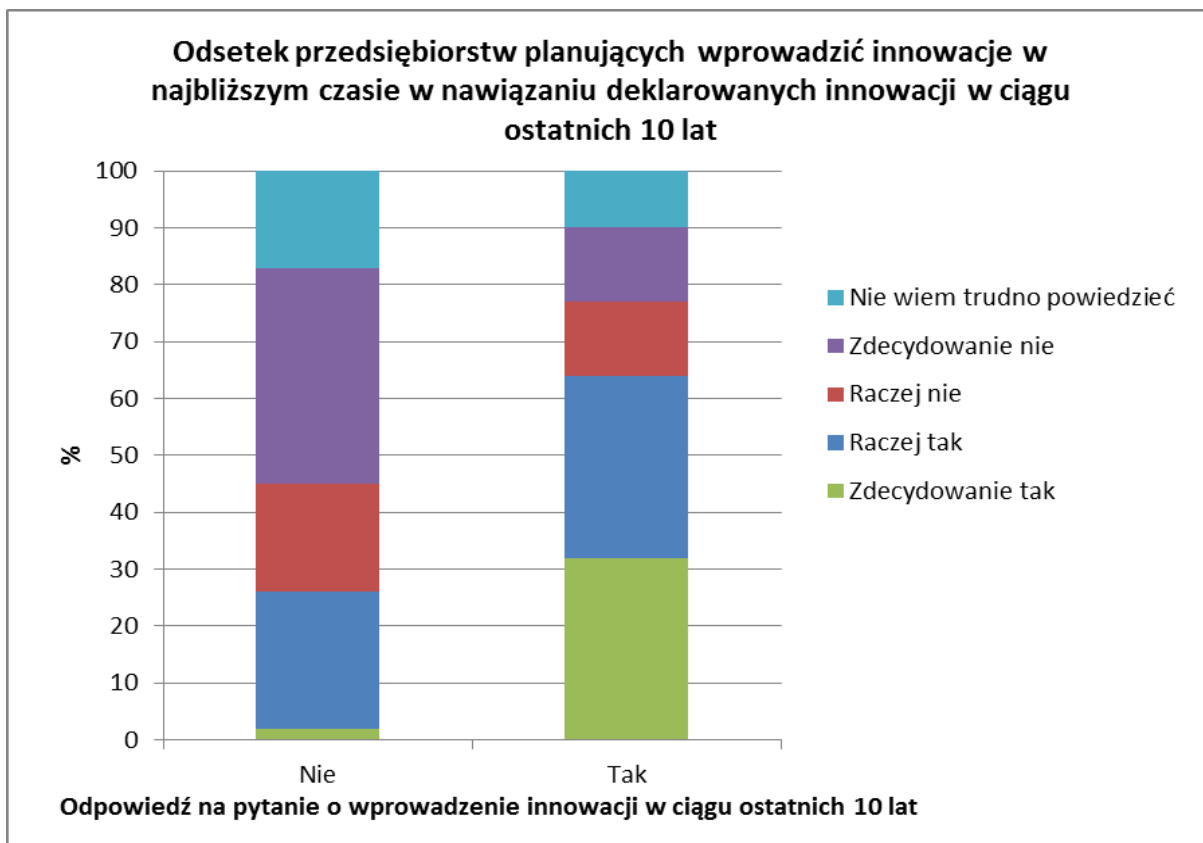


Chart 68 Percentage of enterprises planning to introduce innovations in the near future in the establishment of declared innovations in the last 10 years (based on CATI research)

(I.9) Analysis of key factors and barriers to the development of the industry;

As the main reason that inhibits the DIS natural and natural resources against innovation, respondents mention the lack of recognition of market needs (25%). They are not able to determine the market niches that they could develop thanks to modern solutions. It should be noted that an in-depth market recognition should be the basis of every business activity, not just the field of innovation. Financial aspects are another factors that discourage innovative activities. Lack of own funds (13%) or difficult access to external financing (10%), as well as generally understood too high costs of introducing innovations (9%).

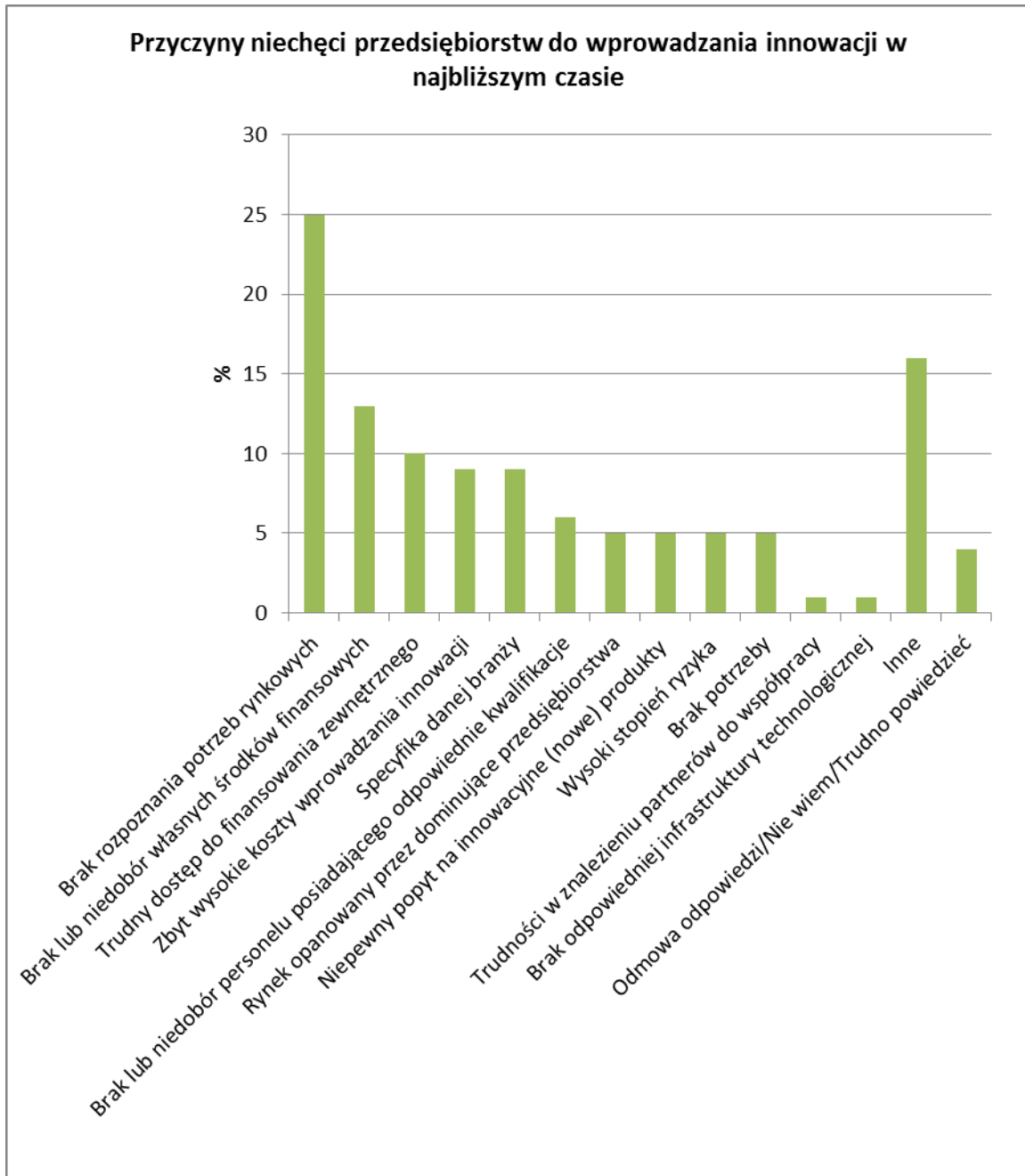


Chart 69 Reasons for companies' reluctance to innovate in the near future (based on CATI research)

3. IDENTIFICATION OF FACTORS OF SMART SPECIALISATION SECTOR OF NATURAL AND SECONDARY RAW MATERIALS

3.1. Evaluation of the impact on the development of the entities operating in the natural resources industry

(II.4.8.) Analysis of micro- and macro-environment factors;
(I.7) Analysis of the attractiveness of the industry development for Lower Silesia;
(I.9) Analysis of key factors and barriers to the development of the industry

Considering the interrelations of objects in space requires gathering specific data and their attribute and topological editing. For this purpose, the available spatial databases maintained by public entities were applied:

- RDOŚ - geospatial data of the protected areas,
- PIG - geospatial data from the system MIDAS - mining areas, spaces, mineral deposits;
- CODGiK - geospatial data PRG - address points, BDOO,
- OSM - data on the railway and road infrastructure.

The collected and processed data were properly processed and adjusted to carry out spatial analyses. Relating to non-spatial data - addresses of companies operating in the field of natural resources - geocoding was carried out, which resulted in the layer with the location of companies in the space.

The factors affecting the development of geographical entities operating in the natural resources can include:

- location of objects relative to the entities positively influencing on their development, e.g. large urban centres, networks, road and rail infrastructure, areas of special economic zones, proven reserves of natural resources, etc.
- the presence of areas adversely affecting the concentration of companies in the area, primarily natural, cultural, social conditions.

The first considered factor involves the distance from the urban areas. Location of the companies relative to urban areas is presented in Figure below.

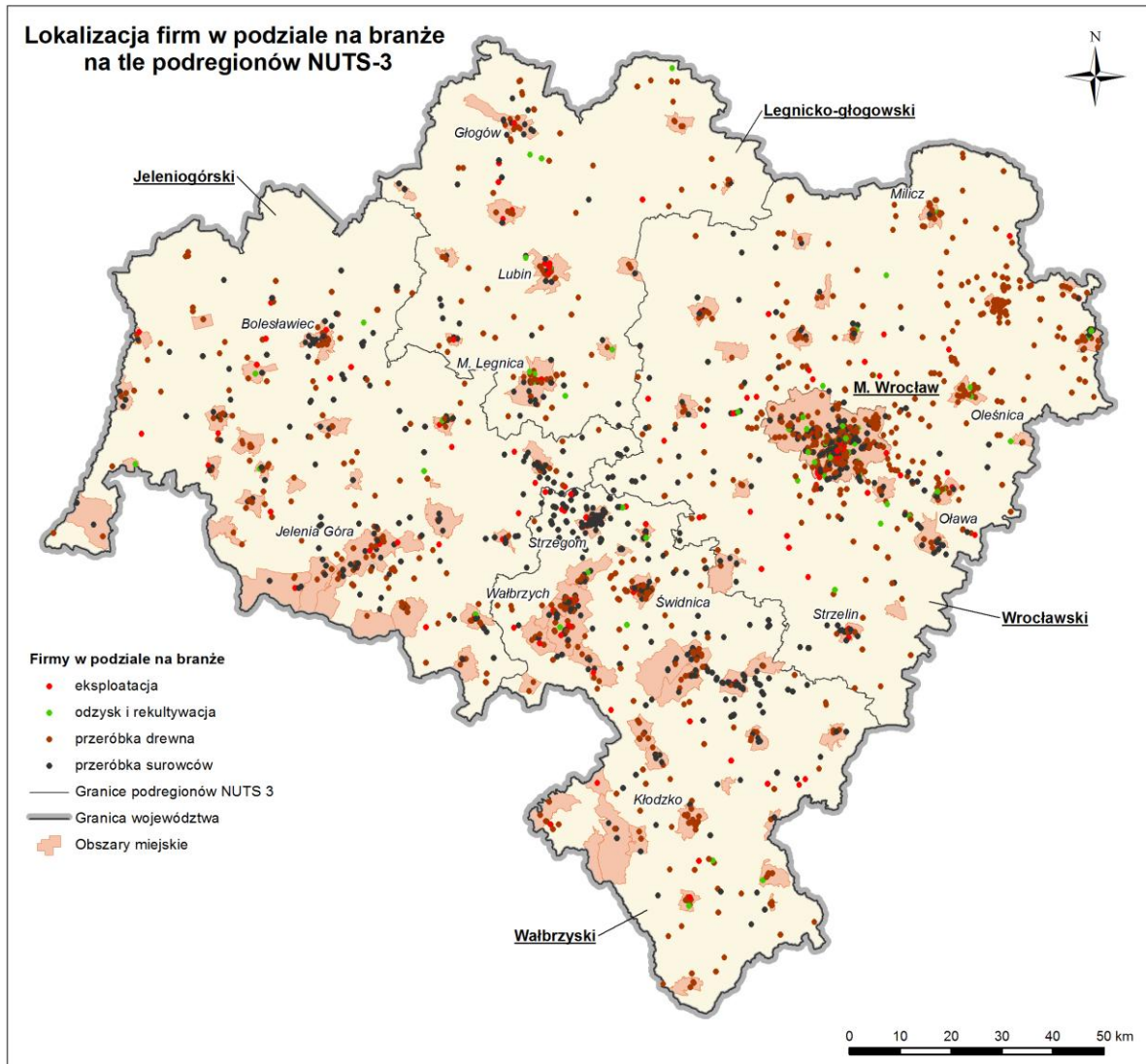


Figure 6 Location of the companies by the industry against NUTS 3 sub-regions

Figure 6 shows the tendency to concentrate the companies in the urban areas. Against the background of individual industries, the sub-area of recovery and recultivation is predominantly distinguished, where approx. 70% of the companies are located in the urban areas. In other industries, this trend decreases, ranging from wood processing and raw material processing (60%) to operating (50%). The concentration of the registered offices of the companies in the urban centres, and their spatial distribution, generally reflect the extent of economic zones in the region. Currently, the following entities operate Lower Silesia:

- Kamienna Góra Special Economic Zone (SEZ), with an area of 373.82 hectares, operating in the cities: Jawor, Jelenia Góra, Kamienna Góra, Bolków, Mirsk, Piechowice, Lubań, Zgorzelec, Ostrów Wielkopolski, and municipalities: Gryfów Śląski, Janowice Wielkie, Kamienna Góra, Lubawka, Nowogrodzic, Prusice and Żmigród.
- Legnica SEZ, with an area of over 1300 hectares, with sub-zones in: Polkowice I and Polkowice II, Głogów, Krzywa, Okmiany, Środa Śląska, Środa Śląska-Miękinia, Legnica I and

Legnica II, Legnickie Pole I and Legnickie Pole II, Złotoryja, Chojnów, Lubin, Kostomłoty, Miłkowitz, Przemków, Prochowice, Iłowa, Zgorzelec.

- Wałbrzych SEZ, with approx. 3550 ha of the investment areas, including inter alia the following cities: Bielawa, Bolesławiec, Dzierżonów, Kalisz, Kłodzko, Kudowa-Zdrój, Leszno, Nowa Ruda, Oleśnica, Oława, Opole, Piława Górna, Świdnica, Świebodzice, Wałbrzych, Wrocław, and municipalities: Brzeg Dolny, Bystrzyca Kłodzka, Długołęka, Góra, Jarocin, Jelcz-Laskowice, Kluczbork, Kłodzko, Koberzyce, Kościan, Krotoszyn, Namysłów, Nowa Ruda, Nysa, Oława, Praszka, Prudnik, Rawicz, Skarbimierz, Strzegom, Strzelin, Syców, Szprotawa, Śrem, Świdnica, Twardogóra, Wiązów, Wołów, Września, Ząbkowice Śląskie and Żarów.

The range of each zone is presented in the figure below.

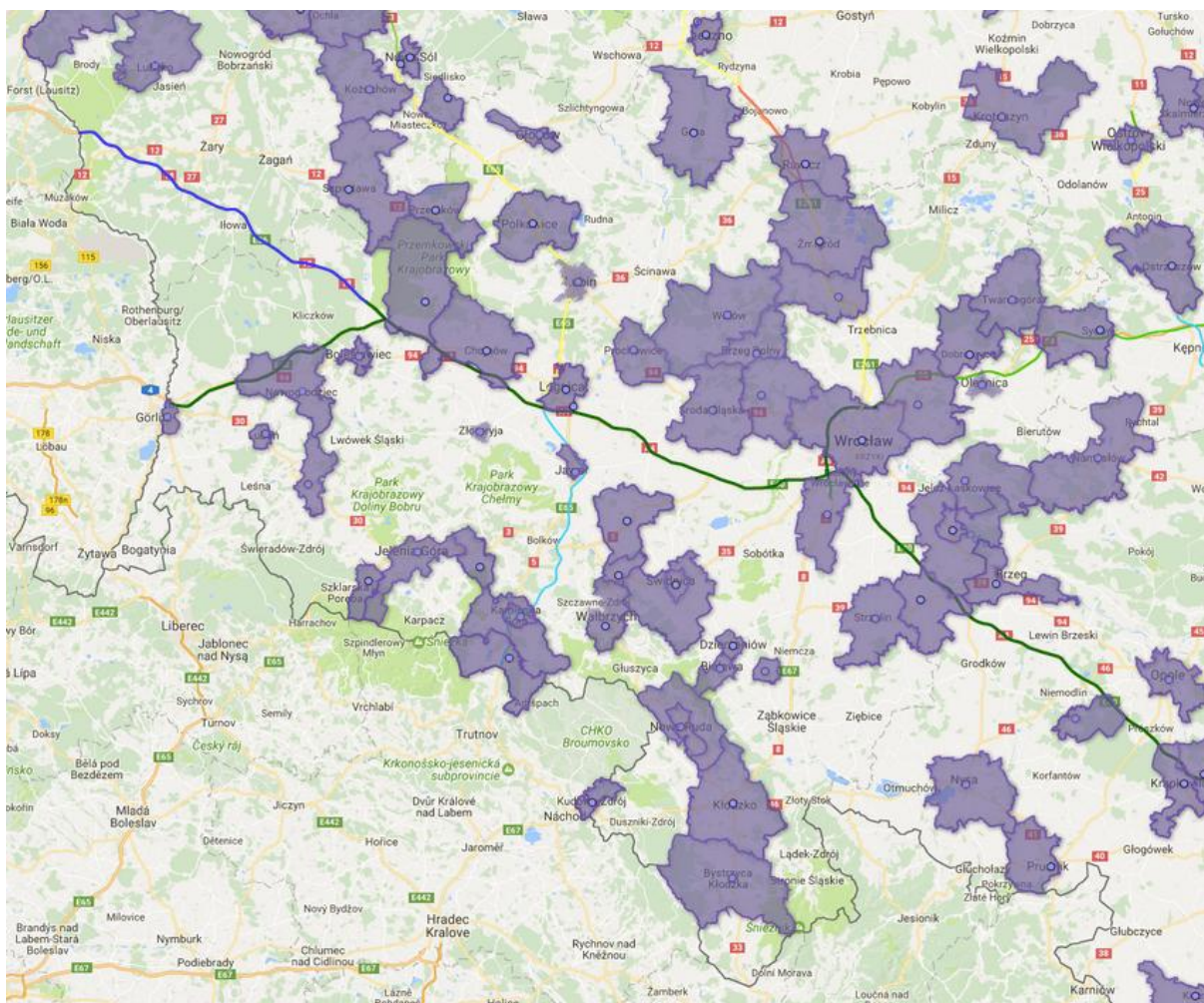


Figure 7 Location of economic zones (source: <http://sse.mapa.info.pl/>)

The disposition of the registered offices of the companies of DIS natural and secondary raw materials in the predominantly urban centres and mostly in the SEZ is subject to preferential tax conditions and extensive infrastructure. Another factor involves the concentration of potential competitors and contractors, conducive to the creation and development in the clusters.

A geometric chart showing the concentration of the companies reveals the natural potential of creating interest groups focused around a particular industry, as exemplified by the thriving stone cluster in Strzegom. (Figure 9).

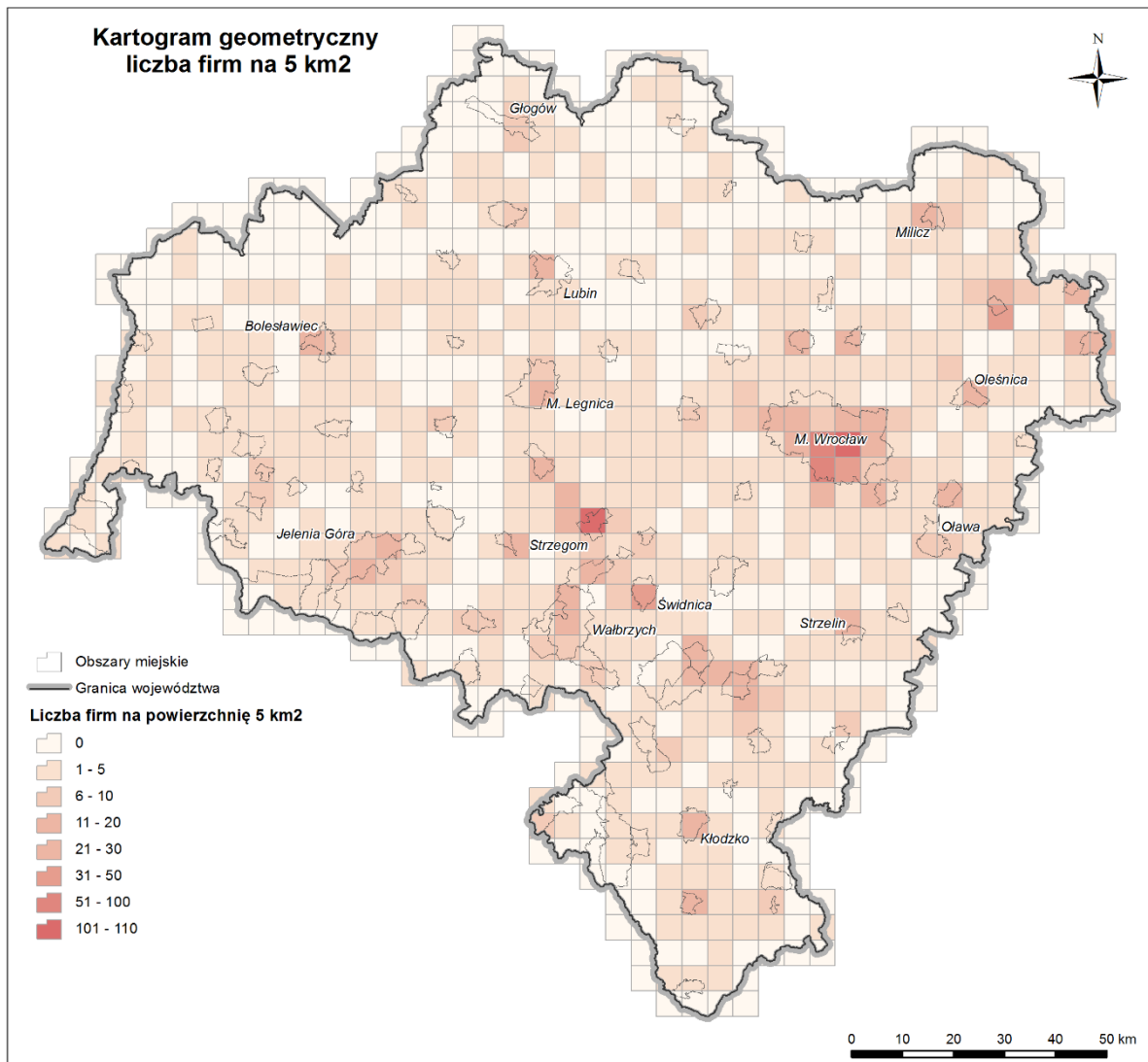


Figure 8 Companies density per area.

The location factor, apart from the economic aspect, is related to the availability of the infrastructure, in particular to the network of convenient national and international connections, both rail and road. In terms of the connections network, Lower Silesia is in a privileged position; for years, it has benefited from the logistical advantage of the A4 motorway and the recent sections of the expressway network (S3 and S8). These connections provide more efficient access to the sale markets and raw materials imported from the country and abroad. The road network is supplemented by the dense national railway network. The result of access to the EU funds involves further investments, modernizing railway transport and strengthening its competitiveness and potential.

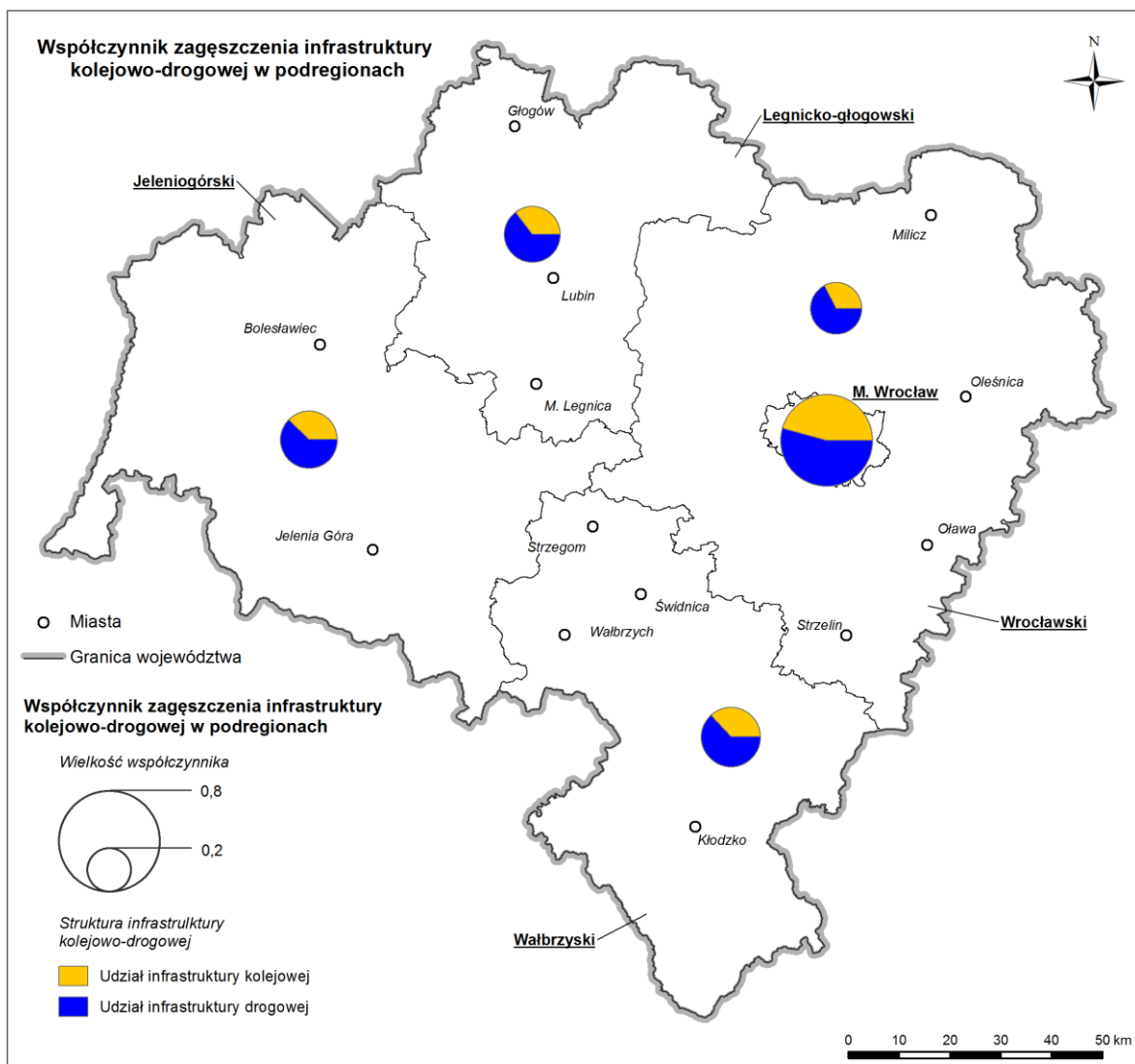


Figure 9 Density factor of the railway and road infrastructure in the sub-regions.

This cardiogram (Figure 10) represents the degree of density of the railway and road network in the region, divided into sub-regions. The calculation of the infrastructure density factor (in which the length of the railway network is summarized in relation to the bottom of the sub-region) shows that in the region, the dominant feature of the sub-urban area of Wrocław involves the dominance of the factor and the largest share of the railway infrastructure in the available network. It should be noted that the value of the factor is more than twice that of the other sub-regions and reaches 0.78 point. The remaining areas are characterized by a lower, but comparable, share of the railway transport, i.e. approx. 35%.

Based on the calculated data of distances of the registered offices of the branches to the roads of national importance, in terms of average values for the subdivisions, results that the statistically most favourable conditions associated with the availability of the road network are in Wrocław, where the distance from the network of the national roads is an average below 600 m. However, it should be remembered that the location of the companies in the capital of the region is primarily dictated by the business benefits of locating the registered offices of the companies in the centre of

the region, and does not reflect the actual availability of their production facilities. A more realistic situation can be illustrated by the availability of the road network in the subdivisions in which the registered offices of the companies are connected with their actual business. Such a situation is observed in Wałbrzych or Wrocław sub-area, where the distance to roads is statistically doubled. This does not change the fact that the average for the region and the average availability for most sub-areas (except for Wrocław) is approx. 0.9-1 km.

By comparing the values for particular industries in the sub-areas, it can be seen that the exploitation and recovery and recultivation sectors are the ones where the distance to the road network is the most important, and the regions leading here are (excluding Wrocław) sub-regions: Legnica and Głogów as well as Jelenia Góra. For the wood processing and raw material processing sub-industries, it seems that accessibility to the road network is not so important. It is estimated that this is due to the fact that they are located in places connected with the acquisition of raw materials rather than their logistics.

The above is shown by the graph on which the results are compared.

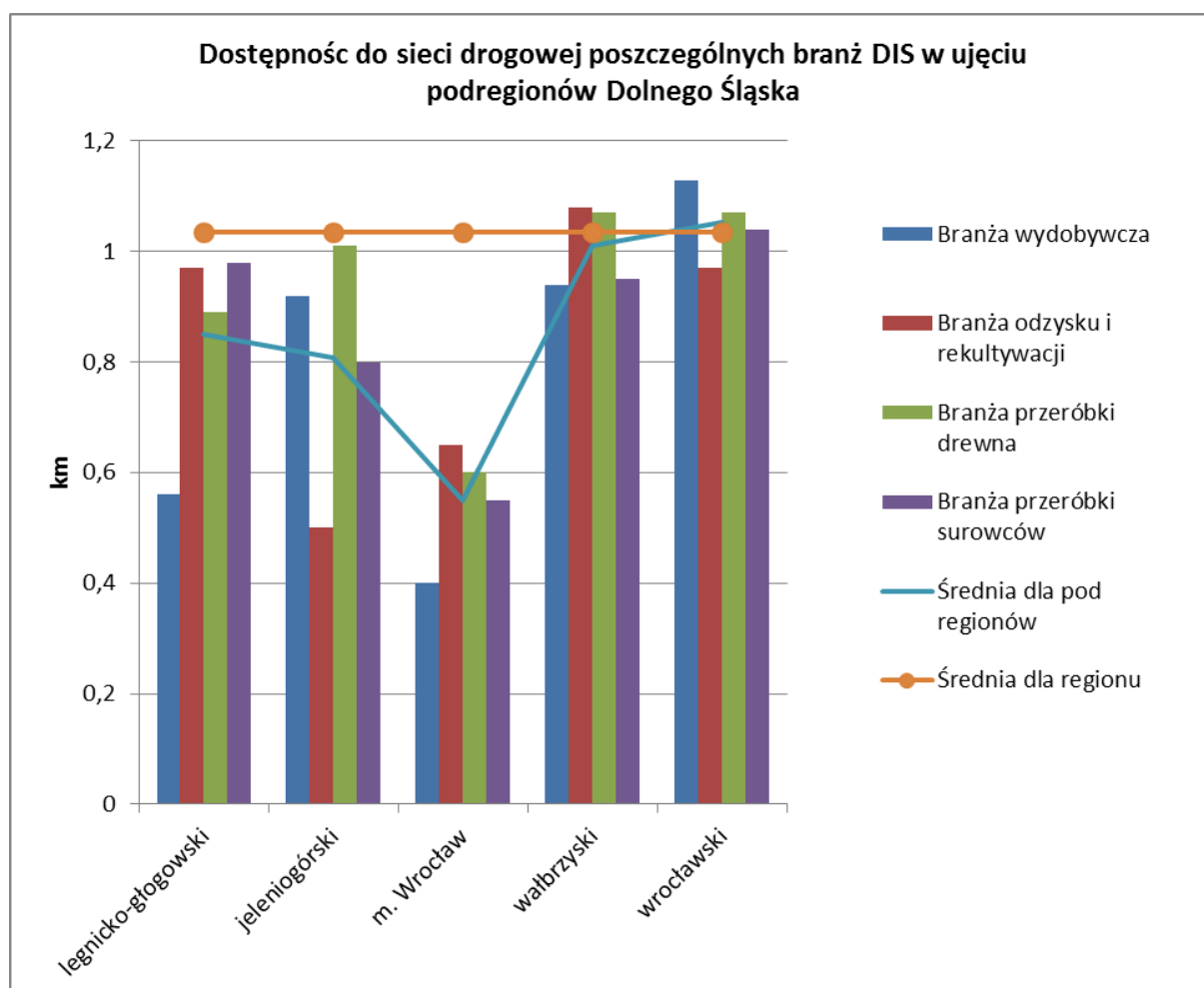


Figure 10 Access to the road network of the individual industries of DIS in the sub-regions of Lower Silesia.

By analysing the development factors of the infrastructure, it is important to remember about the direct synergies between the road construction and the industries of DIS natural and secondary raw

materials. The map below (Figure 11) shows how the development trends of the road infrastructure take into account the natural conditions of the occurrence of natural resources, providing the necessary communication.

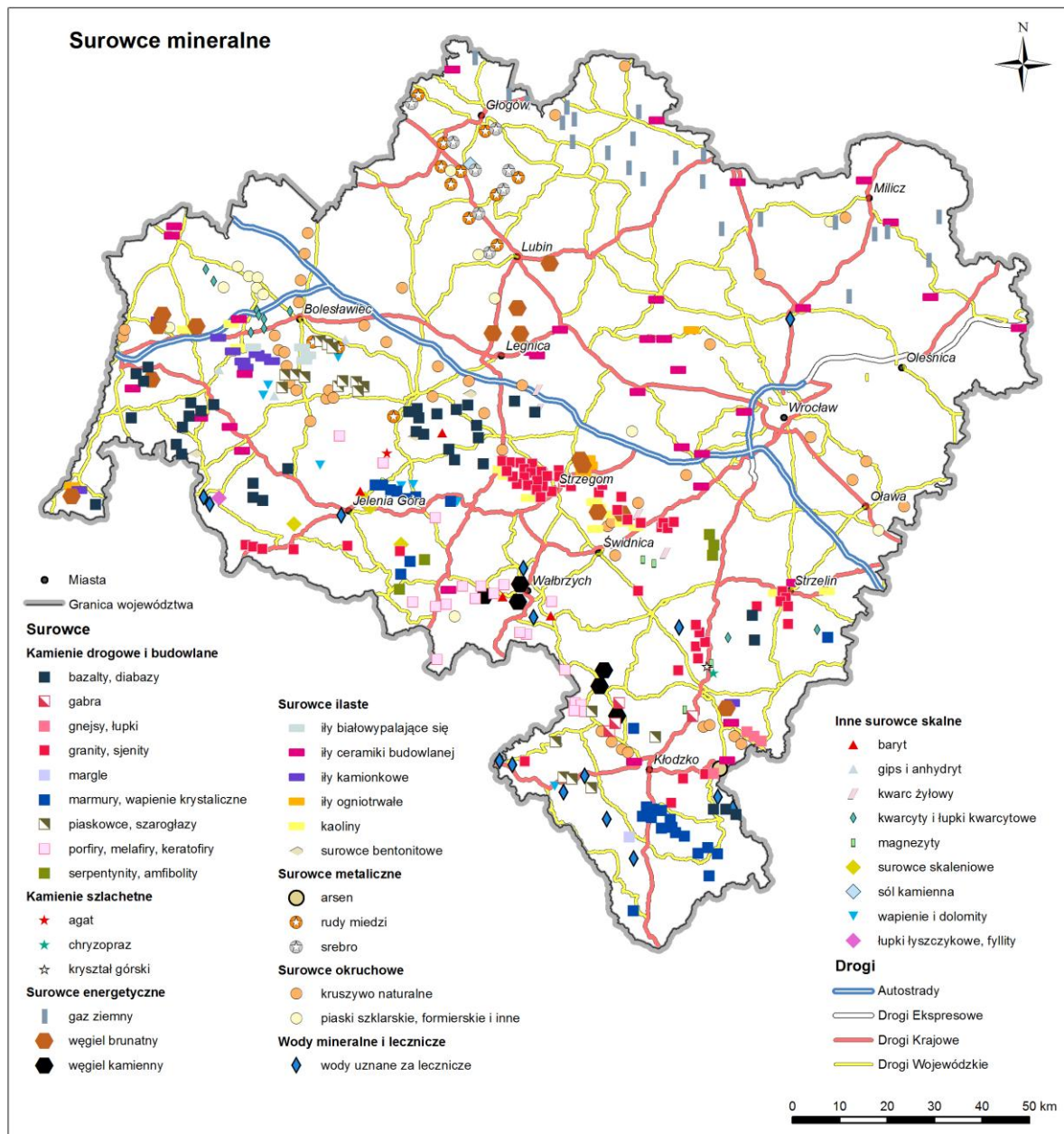


Figure 11 Presence of natural resources in the region, divided into the categories of minerals (source: The assessment of the environmental impact of the ex-ante conditionality plan for transport investments under ERDF 2014-2020 funds for Lower Silesian Region within the Regional Transport Policy for Lower Silesian Region 2015).

Infrastructural aspects, most of which are decisive for the attractiveness of locating the registered offices of the companies, are limited by the environment, which is a resource, but also a barrier to the development of individual industries.

The two most important factors that give the concept of opportunities and threats of the natural origin involve the presence of natural resources and protected areas. The potential areas of Lower

Silesia, where free access to natural resources is difficult or excluded are connected with the hills of the Sudetes. As shown in the following figure, most deposits are generally located on the protected areas. The stone industry is an example of the industry, the potential of which is limited by this condition, this mainly relates to granite extraction, operating on the Sudetes Foreland, where the reserves are many times lower than the ones available due to the protection of the precious natural resources associated with the Karkonosze or Śnieżnik Massifs.

Individual conditions result in the fact which elements will be protected, will be affected by the mining industry, e.g. as a result of exploration mining or deep mining. Therefore, the coexistence of exploitation and forms of protection is not excluded, but only conditioned by the protective measures.

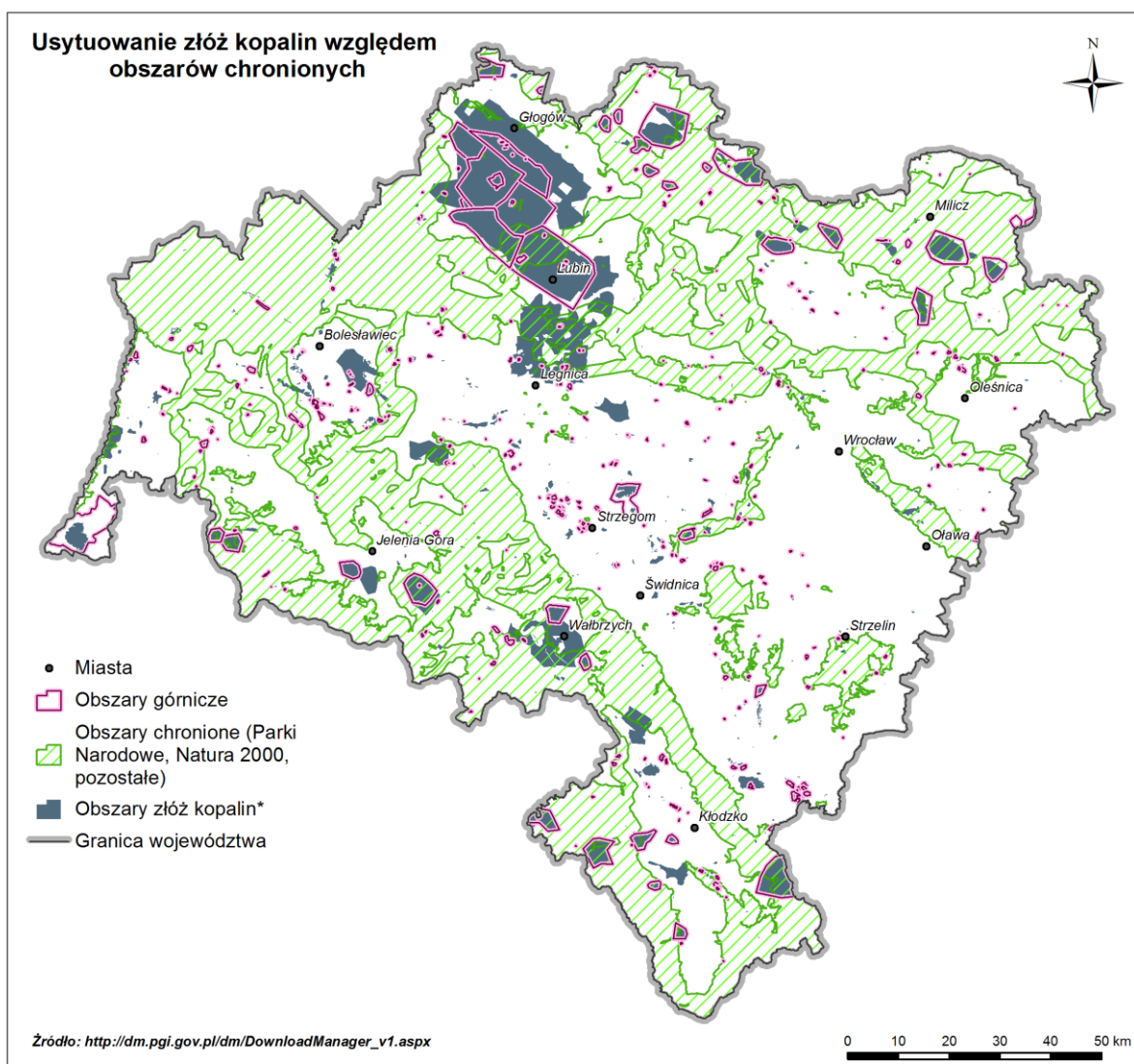


Figure 12 Location of mineral deposits with respect to the protected areas

Taking into account the statistics resulting from the spatial location of the companies of DIS natural and secondary raw materials in all areas protected by the Polish law (44% of the area), it was noted that only 11% of all DIS entities are located on the protected areas, 61% of which represent the wood processing industry and 28% represent the raw material processing industry.

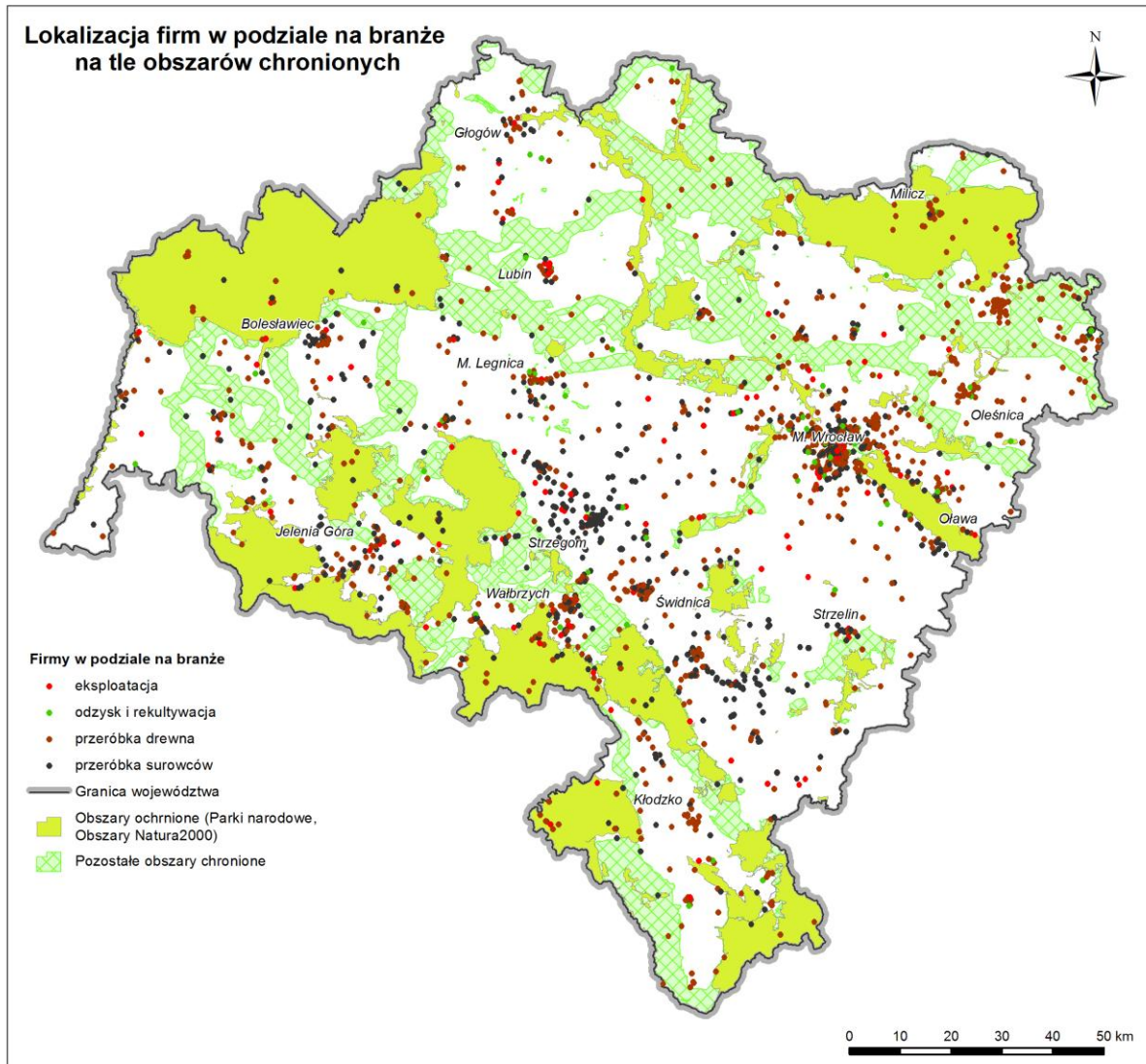


Figure 13 Deployment of the companies belonging to DIS natural and secondary raw materials on the protected areas.

The situation is even worse when we look at the distribution of the companies of DIS in the region, in terms of their location on Natura 2000 areas (Figure 13), which occupy approx. 32% of whole Lower Silesia region. A marginal number of the companies (only 5%) have their own offices on Natura 2000, most of which are related to the wood processing industry (65%) and the raw material processing industry (27%).

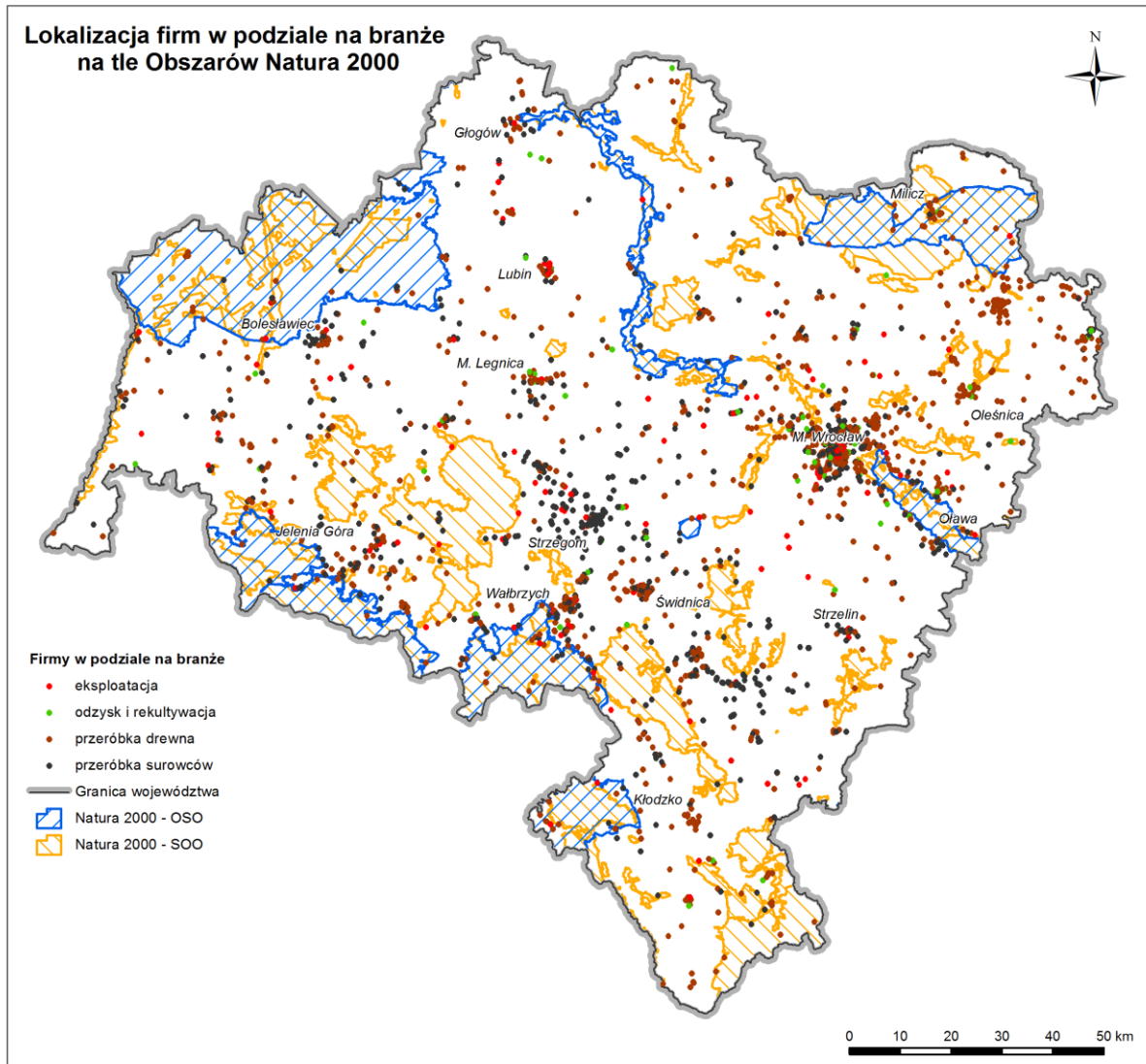


Figure 14 Deployment of the companies belonging to DIS natural and secondary raw materials on Natura 2000 areas.

The activities of the companies on the protected areas, including on Natura 2000 areas, are subject to a number of legal and technological conditions, which determine the low availability of these areas for businesses. At the same time, these areas are not readily available in terms of infrastructure (poor roads, technical and social facilities).

Summarizing the spatial analysis of the companies located in the sectors centred around DIS natural and secondary raw materials, the factors determining their distribution are taken into account, divided into:

- supporting factors such as economic zones, road network density, capital concentration and potential contractors in large urban centres,
- limiting factors, related to the determinants of the environmental protection, the presence of raw materials.

The importance of the wood processing companies on the protected areas and Natura 2000 areas can be attributed to the relatively low impact of small wood processing plants on the environment.

The exploitation of aggregate deposits is quite strongly correlated with the restrictions resulting from the legal regulations on the protected areas. The extraction and processing of energy and metallurgical raw materials is located mostly outside the protected areas.

3.2. Identification of the micro- and macro-environment factors based on the CATI research

(I.4.8.) Analysis of micro- and macro-environment factors;

The companies of DIS natural and secondary raw materials, like all other operators, operate under certain conditions. The factors that influence on their market situation can occur both on a micro scale and on a macro scale.

The micro-environment, also called the nearer environment, is a series of different types of business entities and local groups of people who are in direct contact with a company. They are both suppliers of raw materials, competing companies and customers. Local communities and local governments can also have a significant impact on their business activity (this is seen the best in the case of mineral extraction). In the case of the wood processing sub-sectors, the main problem facing the entrepreneurs involves a high price of the raw material, which does not always meet the quality requirements. In the opinion of the entrepreneurs, this is largely due to the monopoly of the State Forests, i.e. the main and actually the only raw material supplier in the country. However, such a structure of the market results from the state systemic conditions. The entrepreneurs from the extraction sub-industry of rock raw materials do not identify significant problems in their micro-environment, they only pay attention to the unfair competition resulting from illegal extraction, which, according to them, is on a fairly large scale. In the case of raw material processing, the problem identified by the entrepreneurs involves the increasing availability of good quality raw materials. Easily accessible reserves are running low, and the difficulty of extraction of worse geological and mining conditions is translated to the price of raw materials. It also does not encourage the development of this industry competition of the companies using imported (mainly from China) mineral resources. It should also be noted that Lower Silesia is a region with large mining traditions and significant rock resources in the country.³³ This raises a lot of competition, both on the extraction and processing industry.

The macro-environment is another factor that has a wide range of impacts, independent of the company. It can be classified as demographic, general economic, political and legal as well as natural or technical.

The entrepreneurs from all sub-industries of DIS natural and secondary raw materials pay attention to the increasingly availability of employees, regardless of their qualifications. There is not enough number of experienced employees and high class specialists. This is related to the overall increase in wealth in the country, a decrease in unemployment and increasing expectations of employees towards employers. The proximity of German and Czech companies and the freedom of movement of employees between Lower Silesia and those countries also impact on the lower availability of

³³

See Chapter 3.1 "Sub-industries of DIS natural and secondary raw materials against Poland, Europe and the World"

qualified personnel. In connection with the difficult accessibility of employees, the entrepreneurs perceive the labour costs as a growing barrier to their companies.

The further environment, in which the entrepreneurs operate, is largely shaped by the state law. For the sake of the market, it should be predictable over a longer time horizon and facilitate activities in particular industries. However, the experience of the researched companies provides a weak assessment of this aspect of the Polish reality. Taking in general DIS natural and secondary raw materials, more than 40% of the respondents consider legal requirements to operate as a barrier, not a chance. If one looks at a particular sub-industry, the result is even worse. In the case of the companies exploiting raw materials, 70% of the entrepreneurs negatively assess the development opportunities created by the law in Poland. This is slightly better in the case of wood processing (34%), but a negative assessment prevails here, as well.

The above approach to the general assessment of the law in our country does not, however, impact on the positive assessment of the actions taken by the public administration to develop innovation (35% for the answer “chance”, 15% “barrier”, the remaining respondents do not provide their opinion or recognize this aspect as unimportant). Only in the case of raw material sub-industry, there activities are regarded as both a change and a barrier (every response was 35%). In other sub-industries, a positive attitude towards this type of activity is strongly positive (“chance” from 26% - 62%, “barrier” - 10% -25%). This can partially result from the fact that the entrepreneurs dealing with the exploitation of rock raw materials do not expect such activities, considering innovations in this area to be insufficient.

However, the availability of possible financial resources to support the market and innovation activities is perceived as an important macroeconomic factor. Both the national and European funds, as well as bank loans in all sub-industries of DIS natural and secondary raw materials provide a chance for development, which positively impacts on the assessment of the information policy in this respect, both public institutions organizing structural programmes in the region and private lending institutions. The ability to raise funds improves the competitive position of the companies that can meet the demands of a changing market more easily.

3.3. Interconnection of the factors - the cross analysis of the impacts

(I.9) Analysis of key factors and barriers to the development of the industry

During the assessment process, the cross-impact analysis was used to identify the interrelation of the key factors affecting DIS natural and secondary raw materials. For this reason, based on the results of the CATI research and the results of the individual IDI interviews, a set of factors that impact or can impact on the functioning of business entities operating in the industry:

- Possibility of obtaining public support for the investment (for research and development and for new technologies).
- Access to qualified employees (professional and highly specialised).
- Risks associated with the implementation of innovative solutions.

- Access to knowledge in terms of possible innovative solutions.
- Way of functioning of IOBs (clusters, technological parks, foundations, associations, etc.).
- Possibility to carry out research and implementation - access and efficiency of institutions capable of providing Research for Innovation Development.
- External conditions (access to infrastructure).
- Natural conditions (access to resources, social issues, environmental protection).
- Difficulties in obtaining and settlement of public support.

Choice of cross-analysis was supported by the fact that it is one of the basic analytical tools used to carry out the research aiming at assessing or forecasting a given thematic area (foresight). This method allows to examine the existing relationships that occur between a set of often seemingly unrelated factors, events or trends.

In the method, it was decided to isolate the following relations (impacts) between the factors:

- Factors for which mutual impact is weak or irrelevant
- Factors for which mutual impact is characterised by a medium degree of impact on the development of DIS natural and secondary raw materials
- Factors for which mutual impact is strong and significantly impacts on the development of DIS natural and secondary raw materials - so-called "cross-key factors"

The scale and power of correlation between the factors was determined by nine experts who presented their conclusions during two "focus" meetings. The experts individually completed the so-called cross-impact analysis matrix (see Annex 4). Then all the matrices were compiled and the arithmetic mean was derived from them, for which the relation assessment was adjusted. As a result of these activities, the following 11 key interdependencies were identified: Factors that impact one another are strong and significantly impact on the development of DIS natural and secondary raw materials:

1. The situation on the market (e.g. development of the construction industry, development of the use of rare earth elements)	-	1. Possibility of obtaining public support for the investment (for research and development and for new technologies).
2. The situation on the market (e.g. development of the construction industry, development of the use of rare earth elements)	-	2. External conditions (access to infrastructure).
3. The situation on the market (e.g. development of the construction industry, development of the use of rare earth elements)	-	3. Natural conditions (access to resources, social issues, environmental protection).
4. The situation on the market (e.g. development of the construction industry, development of the use of rare earth elements)	-	4. Difficulties in obtaining and settlement of public support.
5. Possibility of obtaining public support for the investment (for research and development and for new technologies).	-	5. Risks associated with the implementation of innovative solutions.
6. Possibility of obtaining public support for the investment (for research and development and for new technologies).	-	6. Way of functioning of IOBs (clusters, technological parks, foundations, associations, etc.).

7. Possibility of obtaining public support for the investment (for research and development and for new technologies).	-	7. Possibility to carry out research and implementation - access and efficiency of institutions capable of providing Research for Innovation Development.
8. Possibility of obtaining public support for the investment (for research and development and for new technologies).	-	8. Difficulties in obtaining and settlement of public support.
9. Risks associated with the implementation of innovative solutions.	-	9. Access to knowledge in terms of possible innovative solutions.
10. Risks associated with the implementation of innovative solutions.	-	10. Possibility to carry out research and implementation - access and efficiency of institutions capable of providing Research for Innovation Development.
11. Access to knowledge in terms of possible innovative solutions.	-	11. Possibility to carry out research and implementation - access and efficiency of institutions capable of providing Research for Innovation Development.

The factor that showed the strongest correlation with other factors is the ability to obtain public support for the investments in both research and development and implementation of new technologies. It strongly correlates with minimizing the risk of implementing such solutions on the entrepreneur side. Therefore, it seems worth considering the forms of support that will aim at minimizing these risks. An example of support can involve the innovation voucher for public support and simplified procedures that can be used for R&D. The respondents emphasized that relatively small financial resources were available in the case of the research (the amount of PLN 15 000 to 30 000). In the case of smaller SMEs, however, these can be the barrier amounts, and their non-returnable ability could significantly impact on their level of innovation and thus innovation in the region.

The possibility to obtain public support also influences the functioning of the Business Environment Institution (clusters, technology parks, foundations, associations, etc.) and the possibility to carry out research and implementation. This correlation is confirmed by the analysis of recent years where new clusters were created at the beginning of the current financial perspective - which involved the possibility of obtaining financing for their activities. At present, some of these entities are asleep or no longer function. This implies the need to direct public support for the IOB activities throughout the programming period. Single financial grants can impact on the creation of new entities, but it is expected that some of them will cease to function after the disbursement of funds. In this case, it is also possible to consider the use of these vouchers for cluster-oriented innovations, which could only be spent on R&D at the university affiliated to the cluster.

Another issue is the fact that the scientific institutions, for which access to public support is often explicit, are often the starting point for starting or continuing research into the development of innovations, which can only then be commercialized. However, it is important to note the relatively low efficiency of the scientific bodies themselves in the field of business cooperation. It is true that in Lower Silesia all entities presenting research institutions offer such opportunities, but in practice they are directed mainly to large companies, and in the case of natural and secondary raw materials industries, often to the main entity in the region, i.e. KGHM.

Taking into account the strength of the researched correlations, it seems that grants could be made through vouchers provided by entrepreneurs or clusters in return for specific research. This would contribute to the availability of knowledge in the scope of possible innovative solutions and thus to the amount of research conducted on the SME-business cooperation line.

Another strong correlation is the economic situation on the market. The entrepreneurs are more inclined to invest in innovations if they minimize their risks. Undoubtedly, this is the case in good times on the market where the companies generate revenue growth while merging this growth with the possibility of obtaining public support. Such a situation results in synergies. The key question is whether, in the short run, public support should not be made conditional on the current economic situation, and postpone calls to the periods of a better market situation within the limits of the programme³⁴. This also confirms the strong correlation of the economic situation with difficulty in obtaining and settling public support. The entrepreneurs emphasized in the research that personal and financial costs associated with obtaining public funds are still too high and are a disincentive factor. During periods of a better situation, the attitude of the entrepreneurs to take these additional costs is more favourable.

The experts also noted the significant correlation between market conditions and external conditions such as access to transport infrastructure, research, etc. In this case, it should be emphasized that the infrastructure should be a pre-emptive element, i.e. the activities carried out in its development should be prioritized so that in the prosperous period the entrepreneurs have the opportunity to decide on carrying out or implement new projects. However, there are no indications that their development was based on the development of Lower Silesia smart specialisation.

The determinants of access to resources or social issues are separate issues. In this case, similarly to the case of application for the EU funds, the financial liquidity of the companies is a determinant. During the better prosperity, the companies find it easier to undertake the implementation of risky projects. It is worth pointing out that one of the key elements influencing the implementation of the innovative solutions by the entrepreneurs is the risk associated with the costs that an entrepreneur must incur - especially in case of failure. On the other hand, the risk mitigating factor involves the access to knowledge in terms of possible innovative solutions and the possibility of carrying out research and development in institutions characterized by both availability and high efficiency. During the carried out in-depth interviews, both entrepreneurs and IOB representatives emphasized the unsatisfactory information flow between these entities. It seems that the introduction of publicly-funded information exchange platforms could increase the number of innovative implementations. Such a platform should include high-quality conferences and training, organisation of the so-called "open door to IOB", as well as creation of an information point devoted to particular smart specialisations of the region. Such points, in addition to the passive information function, should actively engage in the search and matching of business and academic partners, and special attention should be paid to the entrepreneurs of the SME sector.

³⁴

The development of the factors that could lead to such decisions would have to be covered by another specialised research.

3.4. SWOT analysis

SWOT analysis was developed on the basis of the information and the conclusions contained in this report. In addition, during focus and in-depth interviews, the respondents were asked to discuss the basic components of the SWOT analysis, the strengths and weaknesses of the Lower Silesia smart specialisation, natural and secondary raw materials, and the opportunities and threats facing this industry. As a result, a set of factors was identified and described in the SWOT analysis, and subjected to additional analyses for their mutual correlation.

The following definitions were adopted for the analysis of the key factors:

Strengths and weaknesses are the issues within the region, which impact on the ability of the companies and business environment institutions or scientific units to develop DIS natural and secondary raw materials. It was assumed that these are factors directly connected with the region and its nature or on which the region authorities can have a real impact both indirectly and directly.

Opportunities and threats are external phenomena that can impact on the development processes of smart specialisation natural and secondary raw materials or can contribute to the increased impact of DIS supporting instruments. These are the factors that will be conducive to the development of the industry or that will be important barriers to the development. It was assumed that these factors are not related to the region (e.g. national and world trends), on which the region authorities do not impact or that impact is negligible.

(II.4.8.) Analysis of micro- and macro-environment factors;
(I.5.) Analysis of the key factors for the success of innovative industry development in the region;
(I.9) Analysis of the key factors and barriers to the development of the industry;
(II.3.) Analysis of the factors (opportunities), which will be conducive to the development of innovations in the companies;
(II.4) Analysis of the factors (threats), which will be barriers to the development of innovations in the industry;
(II.1.) Analysis of forecasts and development trends in sub-areas of the specialisation of the natural and secondary raw materials in Poland and Europe;

The SWOT analysis, both directly and indirectly, responds to the selected research problems, which are the subject of “*Diagnostics and Development Trends in Lower Silesia Smart Specialisation: Natural and Secondary Raw Materials*”. Analysis of micro- and macro-environment factors (I.4.8) concerned the companies representing DIS sector “Natural and secondary raw materials”. In the SWOT analysis, the CATI results were used directly to identify the strengths and weaknesses of the whole industry (micro-environment) and the opportunities and threats (macro-environment). The analysis of the key success factors in the region's innovative industry (I.5) and the analysis of the key factors and barriers to the industry development (I.9) indirectly correlate with the SWOT analysis. The correct use of strengths and opportunities or the implementation of activities that will avoid risks and counteracting weak points indirectly allows to identify the key drivers of the success of the industry as well as the key barriers. The analysis of the factors (opportunities) that will foster innovations in the companies (II.3) and analysis of the factors (threats) that will be the barriers to innovations in the industry (II.4) are directly correlated with the SWOT analysis of opportunities and threats were identified in this analysis. Finally, the SWOT analysis indirectly correlates with the analysis of forecasts and development trends in sub-areas of specialisation natural and secondary raw materials in Poland and Europe (II.1).

3.4.1. Strengths

Access to the rich natural resources - Lower Silesian Region has very rich and above all diverse natural resources. Mineral resources are the region's potential. Wood is also important. Although the forest cover of the region is at the level of the national average, the strength of the timber industry is confirmed by the species diversity of Lower Silesia forest stands.

Strong traditions in acquiring and exploiting mineral resources. The region has a rich history in the field of exploitation of natural resources. This impacts on the number of industry entities that despite the recession-related changes now have a well-established and relatively stable position on the market.

Development potential of the industry. Both the exploitation and processing of natural resources, as well as processing of wood, are historically related to these areas. The entrepreneurs applying the technological heritage see its possible imperfections and try to counteract them. The research shows that in the last 10 years, more than 1/3 companies (34.5%) have introduced innovations to their businesses, which is the evidence of the industry's growth potential.

The effect of a strong player - KGHM Polska Miedź S.A. KGHM Polska Miedź S.A. operates on the Lower Silesia market; it is one of the largest Polish state-owned companies and one of the leading refined copper and silver producers in the world. The operation of such a strong entity is a guarantee of the development of the related companies. It also stimulates the development of the whole region.

Attractiveness of the region as a place to live for professionals -The labour market created by DIS sector is a natural magnet for highly qualified staff of senior and middle level professionals. Lower Silesia has many advantages that make it an attractive place to live, not only in purely occupational aspects, but also in the area of leisure. This is of great importance in terms of stopping the outflow to other centres of young professionals starting their careers and looking for a place to set up a family,

but also a stimulus to settle in the region and to work for professionals from other countries and regions.

Proximity of the western and southern border of Poland - In the case of many industry specialisations of the natural and secondary raw materials, transport costs are important and sometimes the most important component of the final price. The proximity of the western markets and the associated low transport costs make the regions and neighbouring countries more attractive to consumers as well, which significantly expands the purchasers and markets range. The western markets are also attractive due to the offered price level, which is often higher than in Poland, and because of a higher demand for innovative and technologically advanced products.

European funds from the current budgetary perspective - On the one hand, European funds can provide significant support to businesses under direct innovation grants and, on the other hand, they stimulate the development of the whole region by supporting business environment institutions and scientific research bodies. In addition to the regional operational programme of Lower Silesia 2014-2020, on which the authorities of the region have a direct impact, there should be national programmes such as the Smart Development Operational Programme. From the point of view of DIS natural and secondary raw materials, the key importance will involve the effective use of available resources and financial support particularly important for more dynamic development of the smart specialisation.

Range of scientific research and teaching facilities of the region - Lower Silesia has a lot of potential in the existing universities and research institutes. The factor which can be an opportunity and real support for the development of innovation is to meet the expectations of the entrepreneurs and a demand from the labour market by pursuing specific fields of study at the universities of the region.

3.4.2. Weaknesses

High diversity of all sectors of the economy within DIS natural and secondary raw materials - Natural and secondary raw materials are a very extensive and diverse specialisation. It includes: extraction, processing and treatment of rocks, production of aggregates, extraction and processing of metal ores, processing of wood, processing of secondary raw materials, acquisition, treatment and utilization of ordinary, thermal and mineral waters as well as sub-material of advanced materials (nanotechnology, composites). Individual branches of this specialisation are very different from each other: quantitative and qualitative share in the overall balance, applied technologies, technological level, enterprise size, employment level, ownership structure, traditions in the region, etc. The IS part includes first of all the state-owned and the companies which cannot be compared in terms of the scale. In other sectors, there are a fragmented private ownership and craft companies from the SME sector. It is difficult to choose universal support mechanisms or to focus a research aid on such a diverse area of the economy.

No scientific facilities for certain IS branches - Some areas, especially where state treasury and large companies dominate, have facilities in the form of research institutes, faculties and higher education institutions. The mining research centres are active in the mining industry, with particular emphasis on the extraction of copper ores. Some industries, however, cannot count on support from the research institutes and universities, e.g. the stone industry and the stone processing industry do not

have an educational offer even at secondary level. This situation is due in part to the lack of interest in the subject of technologies used in the field of wood and stone processing by the scientific centres. The fragmentation of the industry, the lack of clear leaders or representatives in the form of strong industry organizations, the beginning clusters, all of which hinder R&D&I communication. As a result, the relative low innovativeness of the industry is limited to the import of technology from outside the region and from outside Poland.

Inadequate promotion of DIS natural and secondary raw materials industry and the related companies. In the light of the challenges posed by both foreign and competitive markets, it is necessary for the region authorities to undertake much more effective and organized actions to promote the industry itself and to ensure its coherence. Currently, there is a situation where DIS natural and secondary raw materials industry is excluded from the promotional activities of DIS sector³⁶.

Competition of other regions - Despite the undoubted strengths of Lower Silesia, a part of the sub-sector IS Natural and secondary raw materials, has very strong competition in other regions of Poland and Europe. Taking into account the above factors, it is necessary to assume the possibility of the outflow of labour, capital and investors. In the case of the industries based on non-renewable raw materials, where the location of the deposits determines the location of the industry, the competition will obviously be weaker, but in the case of wood processing, the resources of which are higher in other regions than in Lower Silesia, one should expect a competition. There are regions in Poland, where the wood industry is leading and access to raw materials and human resources is definitely better. The examples of the regions with a much higher share of the area of economic forests and a significantly higher unemployment rate can be: e.g. Warmińsko-Mazurskie, Podkarpackie, Podlaskie. In the case of the advanced technologies such as composites, nanostructures, etc., the competition will be the highest, as the location of these centres depends only on the availability of the research centres, skilled staff and capital, local availability is of lesser importance.

Location of a part of the deposits on protected areas or constructed areas - Weakness of the development of the extraction sub-industry of DIS natural and secondary raw materials involve the location of a significant part of deposits on the protected areas under the Nature Conservation Act or on the constructed areas as in the case of brown coal deposits in Legnica. The entrepreneurs emphasized the problems associated with costly and time-consuming procedures for obtaining environmental permits and difficulties in ensuring good relations with local communities.

Insufficient transport infrastructure in terms of local roads - Despite significant improvements in the transport infrastructure in the period 2007-2013 and in subsequent years, the entrepreneurs still indicate that their local transport infrastructure is poor in some cases. This concerns local roads of a municipal nature, and generally does not relate only to poor road conditions but, above all, the location of roads that pass through the constructed areas, preventing non-invasive transport of waste. In turn, the construction of local bypasses is often not profitable for the local mines.

³⁶

see chapter 3.2.3. „Export of goods and services”

Low level of innovation - The entrepreneurs of Lower Silesia are often only subcontractors or recipients of world-class technology leaders in their industry. The analysis showed that a significant part of the implemented innovations consists in the use of “know-how” produced abroad. This applies in particular to the purchase of new advanced production technologies. The most frequently mentioned barrier for the entrepreneurs influencing the level of innovation was the lack of adequate financial resources for their implementation. Difficulties in their proper accounting were also pointed out, and in the case of obtaining external funds, one indicated the difficulties in due settlement. The lack of qualified staff was also important. It is worth noting that this poor situation correlates with the threat: *“Production of used machines and tools outside Poland”*.

Raw materials depletion - In the case of non-renewable rock resources, we are talking about a barrier, the final effects of which will be felt in the distant future, because at the present level of production, we are not threatened by the total lack of this raw material. The progressive mining, however, involves the depletion of individual deposits and the relocation of the companies to another place. This increases the cost of running a business, is involved with the risk of the above-mentioned phenomena, i.e. the departure of qualified staff, increase of employment costs, relocation of activities to other regions, etc. The environmental costs also arise, which can decide on the appropriateness of occupying new areas for the extraction. In the case of the renewable raw materials, it is important to manage them in order to maintain a balance between consumption and production. An unconsidered, robbery economy can upset the deliveries and threaten the industry.

3.4.3. Opportunities

(II.3) Analysis of the factors (opportunities), which will be conducive to the development of innovations in the companies;

Growing demand for innovative products/services - For many years there has been an increase in the demand for the innovative products and services in the country and in the world. Consumers are interested in new solutions, looking for an offer that improves their professional and personal life. The innovations implemented by the companies are one of the response to the dynamic changes taking place in the market environment. DIS areas can serve as the supply centres of innovation and advanced technology in the region.

Increase in wealth of the society - The innovative products, arising through the use of the modern technology as a rule have a higher price, at least in the early stages of marketing. The success of DIS depends on some degree on the wealth in the region and the whole Poland. The continuing upward trend in wages and rising GDP are the indicators of positive developments in this area.

Development of environmentally friendly technologies - The specialisation based on natural raw materials, including non-renewable raw materials, impacts on the environment as a rule. Its entities constitute potential beneficiaries and creators of solutions that improve the environment or minimize the negative impact on its condition. Such solutions are an opportunity for the development of the industry, increasing its potential and opportunities for environmentally safe extraction and processing.

3.4.4. Threats

(II.4) Analysis of the factors (threats), which will be barriers to the development of innovations in the industry;

High cost of marketing the innovation - The innovation, in an increasingly global economy, involves large expenditures for research and implementation of high-tech products. The response to this threat involves the opportunity offered by the structural funds to be absorbed.

Variables and incomprehensible legal conditions - As far as the law is concerned, the Polish economy, despite the passage of time, has faced similar problems for over a quarter century. Despite numerous attempts to rectify the situation, the entrepreneurs continue to cite problems such as interpretation of tax laws or the enforcement of intellectual property rights or legal environmental protection requirements, as well as complex and time-consuming procedures related to the implementation of the investment. In the opinion of the majority of the researched entrepreneurs, the Polish law does not favour the activity of natural and secondary raw materials and is a type of a barrier. The situation could be improved if centrally planned solutions were consulted more broadly with the representatives of business entities of the sub-industries at the regional level.

High cost of running business – The entrepreneur of DIS natural and secondary raw materials, especially the SME sector, pointed out that one of the most important issues of the industry involves high cost of running business. This is related to the costs of machines and technology lines, purchase of raw materials, labour costs and a demanding tax system which particularly hinders the operation of the SME group, for which legal and accounting services are a significant cost in their operations;

Moving a business to other countries or regions - A phenomenon difficult to eliminate due to the globalization processes taking place in the Polish economy and varied causes of the phenomena in specific cases. The reason for changing the location can sometimes involve, e.g. increasing labour costs or changing legal conditions, but this can be a planned action to use preferential conditions such as taxation in the initial period.

Moving of highly skilled professionals to other labour markets - The factor which is particularly sensitive in the sectors operating on the technologically advanced areas. The lack of attractive remuneration systems, employment instability, lack of prospects can be the impetus to change jobs or move away to other industries.

Production of used machines and tools outside Poland - The technological progress and the innovation development are also blocked by the absence of the national machine industry, which produces equipment for running business in the IS area. The vast majority of the technologically advanced machines and tools are imported, and there is no way to provide the information about the need for new technologies and undertaking R&D&I works. Research and implementation are carried out outside the country. The Polish recipient is only the user, and not the creator of new technologies. It is worth mentioning here an example of the stone industry company which is a tester of the equipment designed and produced in China. Perhaps, the solution would be to extend the concept of the smart specialisation also to the producers of the machines and technologies dedicated to DIS natural and secondary raw materials industries. Such a solution, by using the same

communication platforms, could impact on the activation of cooperation on the lines of the technology and machines producers and SME.

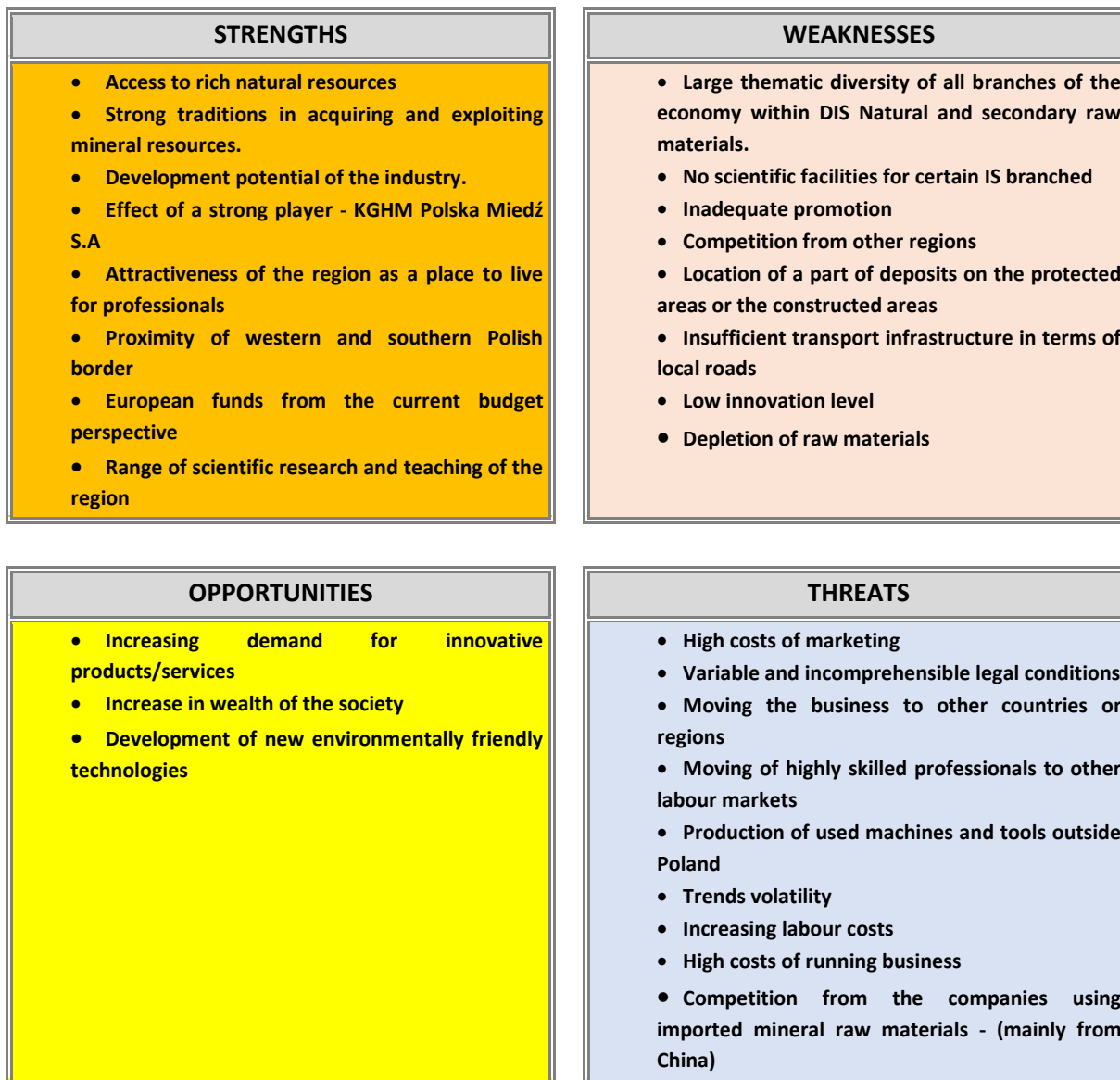
Trend volatility - This is a factor that all IS are sensitive to, but natural and secondary raw materials are particularly susceptible to market fluctuations. The cost of the product in this area is closely connected with a price of raw materials, and can be impacted by many factors completely independent of the industry and difficult to be predicted. The emergence of newer and cheaper artificial materials can lead to a complete disappearance of a demand for some natural raw materials and consequently to the economic loss of parts of the raw materials industry.

Increasing labour costs - The time of the market dominance of the Polish regions, including Lower Silesia, resulting from low labour costs in relation to productivity and quality of human capital can be considered as past. The opening of the labour markets in the EU and the natural changes occurring in the economy give rise to expectations of the employees in relation to salary levels. The situation is further complicated by the relatively high employment costs of the employee incurred by the employers.

Competition from the companies using imported mineral raw materials - (mainly from China) - One of the problems faced by the entrepreneurs of DIS natural and secondary raw materials involves the competition with the raw materials imported from abroad. As a rule, the response to this threat could be a modification of the public procurement system in order to indicate the need to use local raw materials (in justified cases) in public procurement.

3.4.5. Summary of the SWOT analysis for the most likely scenario

The carried out research was the basis to develop the key factors ³⁷ impacting on the development of the sector and underlying the SWOT analysis. They are presented schematically in the diagram below,



The strength of Lower Silesia is the richness in natural resources and strong traditions in the field of the extraction and exploitation of mineral resources, unique in the world and in the country. These two factors determine the existence of DIS natural and secondary raw materials. On the other hand, some deposits are located on the urban areas or on the protected areas under the Nature Conservation Act. These factors will always be in conflict, due to the fact that the possibilities of the extraction of raw materials without causing damage to the natural environment are limited. Perhaps the response will be to exploit the opportunities offered by the development of environmentally-friendly technologies that will allow one to minimize the amount of space needed to cover the needs

of the extraction and, on the other hand, new attractive natural remediation methods will be introduced to effectively compensate for environmental damage. In turn, the development of modern technologies in the field of the use of secondary raw materials can be a response to the weak side, which is the depletion of resources.

It is worth considering the potential of Wrocław universities - perhaps the development of environmentally friendly technologies in the natural and secondary raw materials sectors could become a specialisation of Lower Silesia. For this purpose, these aspects should be included in the Development Strategy of Lower Silesia, or create a dedicated education action plan which would cover a need for the development of the smart specialisation of the region using the opportunities which is provided by the aforementioned development of environmentally friendly technologies. The issue of education is associated with another weak side, which is undoubtedly the identified lack of scientific facilities for the stone and wood sub-industries. Certainly, the activities filling this gap would allow for better use of the strong side, which is the region's attractiveness as a place to live for professionals, and reduce the significance of the risk of moving of highly qualified professionals to other labour markets. The smart specialisation focused on the development of education would also impact on the increasing use of the potential of the region.

The access to European funds from the current financial perspectives 2014-2020, which can be applied by both the entrepreneurs and the public entities, is definitely a strong point. However, it should be noted that the amount of funds is limited, and the companies from all smart specialisations compete for direct grants. In turn, the impact of the projects implemented by the public entities is felt by the whole economy. This primarily concerns the projects involving the construction of infrastructure - especially transport. These projects, implemented at the regional level, do not take into account the development needs of individual smart specialisations³⁸. Thus, the impact on the various sub-industries is only indirect. It should be noted that the improvement in the quality of infrastructure correlates strongly with a strong side, which is the proximity to western and southern Polish border. In a systematic manner, measures supporting the Business Environment Institutions can also be in place. Although, the current experience of supporting IOBs (including clusters) is not fully positive, the continuation of this trend is one of the factors that can impact on the potential for the development of the industry. Access to the external sources of funding in relation to the observed increase in wealth and the increasing demand for innovative products/services can be a response to high costs of running business and the associated increase in prices of the final product, and indirectly to the problem of import and use of imported mineral resources - (mainly from China).

A major threat to the innovative development of the industry, as indicated by both entrepreneurs and experts, is the volatility of the economy and the risks faced by the companies implementing the innovative projects. These risks, to some extent, can be minimized by access to the EU funds. As shown above, the pool of the EU funds is limited, therefore their impact on the systemic solution to the problem situation and risks is low. It seems that the low-interest loans granted for periods of time that would allow the revenues generated by the innovative projects to be realised would be better than the direct system grants.

³⁸

See the Plan of transport investments of regional importance in Lower Silesia conducted from the funds of ERDF 2014-2020

One of the key weaknesses involved large thematic diversity of all branches of the economy within DIS Natural and secondary raw materials³⁹. It seems that taking activities towards a more coherent definition of this smart specialisation could have a profound effect on its dynamic development, and thus transform the present weakness in a strong one. For example, it would be possible to separate a separate smart specialisation for the wood sub-industry⁴⁰. This would, however, require the research to determine if such a sector has the potential to become a driving force in the region's economy. It also seems appropriate to separate as a separate smart specialisation of the sub-industry of advanced materials or consider transferring it entirely to the chemical and pharmaceutical industries. Such actions, however, require political decisions and changes in the provisions of the Regional Innovation Strategy WD 2011-2020.

3.4.6. Summary of other adopted scenarios

Optimistic scenario

The optimistic scenario assumes that the advantage will involve be strong sides, and the chances will be used. It is expected to strengthen the European integration and the maintenance of aid from the EU funds in the new financial perspective 2021-2027. The increasing demand for the products and the increase in wealth of the society should minimize the risks resulting from the ever increasing labour costs. Appropriate support for the development of the industry (including adaptation of the support to the different specificities of the sub-industries) will be hampered by the movement of highly qualified specialists to other labour markets and the need for the entrepreneurs to relocate to other countries or regions will be minimized. The creation of a scientific facilities at both the secondary and higher education level will be largely important. As a result of these activities, the region will also become more attractive to reside for highly qualified professionals. The threat involving the depletion of deposits will be minimized through the development of the environmentally friendly technologies, which will be at least a partial response to the location of reserves on the protected areas. Due to the development of the environmentally friendly technologies, the secondary raw material management should gain more importance. It is assumed that the activities taken in the area of promotion of the region will increase the competitive advantage of Lower Silesia. In the national dimension, the optimistic scenario assumes a thorough revision of the law with the use of suggestions and bottom-up initiatives, which will eventually have a positive impact on the investment climate both in Poland and in the region. In this variant, the smart specialisations become the driving force of the Lower Silesia economy.

Pessimistic scenario

In the pessimistic scenario, it is assumed that not all opportunities will be used, and the weaknesses will dominate. This option assumes the collapse of the European integration and a return to the national economies. The funds from the current financial perspective are not fully sued (due to the

³⁹

See the description in chapter 6.4.2 "Weaknesses" - the SWOT analysis as well as chapter 2.2. "Initial assumptions"

⁴⁰

technologies of the acquisition and processing, and the use of wood, vegetable raw materials in the innovative products,

disintegration of the EU or the effect of Brexit, and associated renegotiation of the cohesion fund). As a result, the development potential of the industry is not fully used. The return to the central control should have a positive impact on the functioning of KGHM Polska Miedź S.A as well as on the availability of natural raw materials on the protected areas or the constructed areas. Exit from the EU or joining the group of the countries of the so-called second speed can impact on the society's impoverishment and the consequent moving of highly qualified professionals to other labour markets. This can increase the risks associated with moving business to other countries or regions. On the other hand, inhibiting the integration can impact on the closure of western European labour markets and, consequently, the need to develop specialists on the national labour market. It is difficult to verify whether it will become a driving force for the economy which is currently suffering from the shortage of specialists or it will impact on increased unemployment. When analysing the global situation, the break-up of the EU can negatively impact on the export of Polish goods while inhibiting imports. In this scenario, the creation of the smart specialisation is of less importance, and the need for central control of the economy increases.

4. SIGNIFICANT CONCLUSIONS FROM THE RESEARCH

Based on the analysis of all available data and the results of the research and analyses carried out in the individual sections, the following conclusions were drawn.

High diversity of all sectors of the economy within DIS natural and secondary raw materials⁴¹ - Natural and secondary raw materials are a very extensive and diverse specialisation. Outside the area of acquisition, processing and use of natural and secondary raw materials, the whole sector covers advanced materials (nanotechnology, composites) and wood extraction and processing. The various branches of this specialisation differ greatly in both their quantitative and qualitative share in the whole balance, as well as the used technology, the level of technological advancement, the size of the company, and the level of employment. Too wide range of the industries that are a part of the specialisation and the lack of technological and material connections between the different branches result in huge differences in the expectations and needs of individual companies. This selection makes it difficult to manage support, and it also limits the ability to target personalised solutions for the industry.

Based on the foregoing, it is suggested to take the activities towards a more coherent definition of this smart specialisation, which could ultimately impact on the dynamic development of the individual sub-industries that belong to it. As an example, one can separate the smart specialisation for wood sub-industry⁴². This would, however, require the research to determine if such a sector has the potential to become a driving force in the region's economy. It also seems appropriate to separate as a separate smart specialisation of the sub-industry of advanced materials or consider transferring it entirely to the chemical and pharmaceutical industries. Perhaps, the solution would be to extend the concept of the smart specialisation also to the producers of the machines and technologies dedicated to DIS natural and secondary raw materials industries⁴³. Such a solution, by using the same communication platforms, could impact on the activation of cooperation on the lines of the technology and machines producers and research and training institutions. Such actions would, however, require political decisions and related changes to the provisions of the Regional Innovation Strategy WD 2011-2020 and the Lower Silesia Executive Plan.

Inadequate promotion of DIS natural and secondary raw materials industry and the related companies. In the light of the challenges posed by both foreign and competitive markets, it is necessary for the region authorities to undertake much more effective and organized actions to promote the industry itself and to ensure its coherence. Currently, there is a situation where DIS natural and secondary raw materials industry is excluded from the promotional activities, and DIS natural and secondary raw materials is omitted in total⁴⁴.

⁴¹ See chapter 6.4.2. “Weaknesses” and Chapter 2.2. “Initial assumptions”

⁴² technologies of the acquisition and processing, and the use of wood, vegetable raw materials in the innovative products,

⁴³ See point Production of used machines and tools outside Poland in chapter 6.4.4. “Threats”

⁴⁴ see chapter 3.2.3. „Export of goods and services”

Lack of appropriate courses of education in some specialisation sub-industries in the region of

Lower Silesia at all levels of education⁴⁵ - The lack of opportunities for future specialist education, both on a higher level and a medium level, is visible in Lower Silesia, especially in the case of the wood processing industry and the stone industry (Forest Technical Secondary School in Milicz does not educate in the directions of wood processing and is limited to forestry itself, and Technical Secondary School in Strzegom educates technicians of open pit mining, who are not prepared for work in the stone industry). As a result, none of the universities guarantee adequate education in these sub-industries.

There are also no research and development units related to the wood and stone industries. It should be noted that the wood processing can count on the support of such centres in other regions (in Poznań, there is a Faculty of Wood Technology at the University of Life Sciences in Poznań). The stone processing industry, 25% of all Polish companies of which are located in Lower Silesia, does not have such a centre in general. It seems that the lack of suitable educational offer and the lack of research and development institutions aiming at cooperation with widely represented stone companies, and the poor availability of such institutions for the wood and secondary processing sub-industries hinders the innovative development of the whole industry. One should find solutions that will repair such a situation, e.g. by expanding the educational offer of the regional universities and the interest in carrying out the missing research in Lower Silesia research institutions. A good solution would be to develop a regional strategy to support education and training, one of the main objectives of which would be to support the development of the smart specialisation in the region.

Poor availability of employees at all levels of specialisation⁴⁶ - Almost whole DIS natural and secondary raw materials industry face the shortages of employees. The increasing on employees, work emigration and the increasing desire of young people to work in remote parts of the country are the main reasons. Particularly difficult situation prevails in the wood and stone processing sub-sector, where the lack of highly specialised employees is very noticeable. The aforementioned lack of educational offer adapted to the needs of these sub-industries is important in this case. It seems that one cannot solve the problem of the shortages of employees in a different way than through systemic support of the targeted education. Thus, it is a long process that should be reflected in the strategic documents of the region.

Export support at the national level⁴⁷ - The respondents pointed to the need to support their expansion plans on the foreign markets. Formal and legal aid in the foreign economic and cultural sphere can facilitate this development and help the economy of the region in the era of globalization. Therefore, it is advisable to support SMEs in DIS natural and secondary raw materials by targeting the activities aiming promotion of the products and services specific to Lower Silesia related to the sectors concerned outside the country, and help the entrepreneurs on the emerging markets through the inclusion of DIS natural and secondary raw materials in the operations of the DAWG investor and exporter in Lower Silesia.

⁴⁵ See also chapter 5.3. "Employees potential"

⁴⁶ See also chapter 5.3. "Employees potential"

⁴⁷ See chapter 3.2.3 „Export of goods and services”

Relatively low scale of the implemented innovations - Many of the innovative solutions that are declared by the entrepreneurs, has the scale of the company⁴⁸. Mostly, they are new machines or technologies that are the easiest to be implemented, as well as the easiest to be documented when applying for funding from the European Union. It seems that the natural functioning of the authorities in such a case should involve the pursuit of support for innovative solutions at the national or international level. Such a solution could be right, but it must be remembered that for many Polish companies the first step is still to invest in the innovations of the lowest scale (company). Only the alignment of the development opportunities will allow the Polish companies to implement the innovations of the national or international scale.

Small interest of the entrepreneurs in carrying out R&D works⁴⁹ - In addition to the “exploitation” and “processing of raw materials” sub-industry, a low proportion of the entrepreneurs from DIS natural and secondary raw materials allocate funds to carry out works leading to their innovation. Basically, this is due to four reasons:

- Unavailable research and development institutions under the stone and wood sub-industry in Lower Silesia.
- Financial risk associated with the implementation of new solutions. In particular, this applies to the innovative products or services
- The lack of such a business need (“business as usual”) or the lack of awareness of how such activities can lead to increased company profits.
- Lack of knowledge about operating the research institutions and their offer of possible cooperation of the companies.

The research also shows that the companies, which did not implement the innovative solutions in the past, do not usually plan to do so in the future. One of the conclusions of the research is the creation of a co-operative platform, based on, inter alia, consultative meetings (“smart labs”), in which the representatives of the regions, research institutions and entrepreneurs (in particular SMEs) will take part. The platform will allow to become familiar with the research institutions offer, their abilities and the scope of the research, and will review the research institutions with real problems of the industry (not just of large companies, but also problems faced by small companies, which have not used such aid so far). The next step should be the establishment of such a platform based on virtual resources and its connection with the promotion of the region.

Low number of patent applications - The companies of DIS natural and secondary raw materials do not show the activity of research and development supported by patent applications, and the implemented innovations largely characterise the company scale. However, it is worth considering whether the number of patents actually reflects the innovation scale. The number of patents applications does not imply the information on the possibilities of their commercialisation. It is also

⁴⁸

See also chapter 5.1. “Types of innovations and their scope”

⁴⁹

See chapter 5 Innovative potential of the industry

worth raising the issue of the value of the commercial information itself. Obtaining a patent is time-consuming, and at the same time it makes a part of it public, which impacts on the ability of the competition. Therefore, it seems that a better factor would involve the information on the number of patents that were implemented⁵⁰.

Support and promotion for mineral raw materials coming from the region - One of the problems faced by the entrepreneurs of DIS natural and secondary raw materials involves the competition with the raw materials imported from abroad. Generally, the response to this threat could involve the modification of the public procurement system. For this reason, one should clearly interpret whether the designer's indication in the design documentation of the need to use natural resources of regional origin and to specify such a requirement in the tender dossier can be regarded as unfair competition and thus not meet the formal financing requirements of the project.⁵¹

Improved effectiveness of the use of public funds⁵² - In order to improve the efficiency of public funds to increase the innovation of the companies of DIS natural and secondary raw materials, it is recommended to create, modify or further develop the following supporting schemes:

- Various supporting forms and instruments to the size of the companies - In DIS natural and secondary raw materials, there are very various companies in terms of employment, turnover, own research infrastructures, etc. In addition to large companies such as KGHM, there are numerous SMEs that are of the craft family businesses nature. The results of the research indicate that for the small companies' sector, the constraints associated with using public support are a barrier to develop. For this reason, one should shape the forms of support to make it attractive for large and small companies. It is suggested to consider changing the mode of recruitment and distribution of competitions so that a low part of the funds for innovation in the companies is allocated to support smaller SMEs. The Lower Silesia Intermediate Chamber has competitions for the companies existing on the market for up to 2 years - this solution is not sufficient to support the innovations. Especially since the incubation period of the companies in this industry lasts approx. 4 years. It seems that it would be better to make it possible to apply in some of the competitions depending on the turnover (revenue) and the size of the company, and in this way some of the funds would be guaranteed to smaller SMEs.⁵³
- The competitions for the activities defined in the IOB Development Strategies dedicated to particular branches of Lower Silesia Smart Specialisation - One of the new ways of support could involve the creation of the competitions whereby the IOB (including clusters) could be applied to the development of the respective Smart Specialisation Sector. Within these competitions, the entities would be able to obtain funds for the achievement of the objectives of the strategy (carrying out research, organizing conferences, promotional activities, etc.) This support scheme could be connected with the targeted grants for the participation of the companies in selected

⁵⁰ See also chapter 3.3.2. "Innovative potential of the Region" - information at the end of the chapter concerning the indicator of the patents number

⁵¹ See chapter 6.4.4 "Threats"

⁵² See chapter 4.3.3 "Indication of possible to use supporting schemes"

⁵³ See chapter 4.3.3 "Indication of possible to use supporting schemes"

(external) scientific and scientific-implementation conferences. Granted support (e.g. in a form of a voucher) for the participation of the entrepreneur in an industry conference or trade would allow for closer contacts on the industry and knowledge line. Such a solution could be particularly effective for the industries that have a partial ownership structure (e.g. wood, stone industry) and where individual companies are not able to provide effective support themselves. Within these competitions, it would be possible to conduct systematic projects aiming at individual sub-industries and to identify areas of possible innovation (also in cooperation with national and foreign research centres).

- Repaid financial instruments - The costs related to the realization of research works and their implementation and commercialisation are a significant barrier for the entrepreneurs. In addition to the obvious expectation of direct public support, significant entrepreneurs pointed to an increase in the repayment period of liabilities, a decrease in interest rates or a possibility of redemption of loans in the case of patents and implementation of the innovations. It would be worth to consider the creation of a regional innovation loan system that would be characterized by preferential conditions and even where justified the possibility of receiving redemption for the innovative projects of the national or international range.
- Voucher for innovation in Lower Silesia Smart Specialisations - The voucher system for the innovation granted in simplified procedures and supporting the initiation of R&D between SMEs and research institutions is one of the innovative solutions for the innovation development. In order to support DIS industry more efficiently, it is possible to consider modifying the current system to include the obligation to demonstrate compliance with the innovation criteria for one of Lower Silesia Smart Specialisations. Such applications should receive preferential conditions for obtaining a voucher. The modified system should also allow for the possibility of connecting the values of vouchers by two or more entrepreneurs to jointly carry out one major research project.

5. WYKAZ TABEL, RYSUNKÓW I WYKRESÓW

Wykaz tabel

<u>Tabela 1 Suma zasobów i wydobycia z 14 złóż węgla brunatnego na Dln. Śląsku (na podstawie BZK2015)</u>	23
<u>Tabela 2 Suma zasobów i wydobycia z 25 złóż gazu ziemnego na Dln. Śląsku (na podstawie BZK2015)</u>	25
<u>Tabela 3 Suma zasobów i wydobycia z 5 złóż helu na Dln. Śląsku (na podstawie (na podstawie BZK2015)</u>	25
<u>Tabela 4 Suma zasobów i wydobycia z 4 złóż gipsu na Dln. Śląsku (na podstawie BZK2015)</u>	31
<u>Tabela 5 Suma zasobów i wydobycia z 5 złóż glin biało wypalających się na Dln. Śląsku (na podstawie BZK2015)</u>	32
<u>Tabela 6 Suma zasobów i wydobycia z 11 złóż glin kamionkowych na Dln. Śląsku (na podstawie BZK2015)</u>	32
<u>Tabela 7 Suma zasobów i wydobycia z 4 złóż glin ogniotrwałych na Dln. Śląsku (na podstawie BZK2015)</u>	32
<u>Tabela 8 Suma zasobów i wydobycia z 3 złóż bentonitu na Dln. Śląsku (na podstawie BZK2015)</u>	33
<u>Tabela 9 Suma zasobów i wydobycia z 14 złóż magnezytu na Dln. Śląsku (na podstawie BZK2015)</u>	34
<u>Tabela 10 Suma zasobów i wydobycia z 14 złóż kaolinu na Dln. Śląsku (na podstawie BZK2015)</u>	34
<u>Tabela 11 Suma zasobów i wydobycia z 68 złóż surowców ilastych ceramiki budowlanej na Dln. Śląsku (na podstawie BZK2015)</u>	35
<u>Tabela 12 Suma zasobów i wydobycia z 9 złóż skalenia na Dln. Śląsku (na podstawie BZK2015)</u>	35
<u>Tabela 13 Suma zasobów i wydobycia z 8 złóż piasków szklarskich na Dln. Śląsku (na podstawie BZK2015)</u>	36
<u>Tabela 14 Suma zasobów i wydobycia solanek, wód leczniczych i termalnych z 19 złóż na Dolnym Śląsku (przeliczone na podstawie BZK2015)</u>	37
<u>Tabela 15 Międzynarodowe kongresy ESPA w XXI wieku</u>	38

Wykaz rysunków

<u>Rysunek 1 Pozyskanie drewna w Polsce według województw w 2014 r. (Źródło danych: TOTAL;</u>	43
<u>Rysunek 2 Współczynnik lokalizacji przedsiębiorstw (źródło danych GUS)</u>	52
<u>Rysunek 3 Nakłady wewnętrzne na B + R ogółem oraz w relacji do PKB (źródło danych: TOTAL;</u>	59
<u>Rysunek 4 Udział przychodów netto ze sprzedaży produktów nowych lub istotnie ulepszonych (innowacyjnych) w przedsiębiorstwach przemysłowych w przychodach netto ze sprzedaży ogółem (źródło danych: TOTAL;.....</u>	63
<u>Rysunek 5 Liczba udzielonych patentów na wynalazki krajowe przez Urząd Patentowy RP oraz patenty udzielone przez UPRP na 1 mln mieszkańców w roku 2015 (źródło danych: TOTAL;</u>	64
<u>Rysunek 6 Lokalizacja firm w podziale na branże na tle podregionów NUTS-3</u>	115
<u>Rysunek 7 Lokalizacja stref ekonomicznych (źródło: http://sse.mapa.info.pl/)</u>	116
<u>Rysunek 8 Gęstość firm w przeliczeniu na powierzchnię</u>	117
<u>Rysunek 9 Współczynnik zagęszczenia infrastruktury kolejowo-drogowej w podregionach</u>	118
<u>Rysunek 9 Dostępność do sieci drogowej poszczególnych branż DIS w ujęciu podregionów Dolnego Śląska</u>	119
<u>Rysunek 10 Występowanie surowców naturalnych w regionie w podziale na kategorie kopalin (źródło: Prognoza oddziaływania na środowisko Planu wypełnienia warunkowości ex-ante w zakresie inwestycji transportowych w ramach funduszy EFRR 2014 – 2020 dla województwa dolnośląskiego w ramach Regionalnej Polityki Transportowej dla Województwa Dolnośląskiego 2015)</u>	120
<u>Rysunek 11 Usytuowanie złóż kopalin względem obszarów chronionych</u>	121
<u>Rysunek 13 Rozlokowanie firm branż należących do DIS Surowce naturalne i wtórne na obszarach chronionych</u>	122
<u>Rysunek 14 Rozlokowanie firm branż należących do DIS Surowce naturalne i wtórne na obszarach N2000</u>	123

Wykaz wykresów

<u>Wykres 1 Światowa produkcja miedzi rafinowanej wg raportu ICSG World Copper Factbook 2016</u>	15
<u>Wykres 2 Ceny i zasoby miedzi w latach 2001- 2015 wg. wg raportu ICSG World Copper Factbook 2016</u>	16
<u>Wykres 3 Procentowy udział Polski w światowej produkcji miedzi górniczej w latach 2000-2013 (na podstawie danych USGS)</u>	17
<u>Wykres 4 Wydobycie Cu w Europie w latach 2000-2013 (tony metalu) wg. European Mineral Srebro</u>	17

<u>Wykres 5 Produkcja hutnicza miedzi w Europie (blister i anody, także z rud importowanych wg. European Mineral Statistics)</u>	18
<u>Wykres 6 Kierunki eksportu miedzi elektrolitycznej z Polski</u>	19
<u>Wykres 7 Procentowy udział Polski w światowej produkcji srebra w latach 2000-2014 (na podstawie danych USGS)</u>	20
<u>Wykres 8 Procentowy udział Polski w światowej produkcji renu w latach 2000-2014 (na podstawie danych USGS)</u>	21
<u>Wykres 9 Ceny renu USD/kg w latach 2009-2013 (na podstawie BGSMPiŚ2013)</u>	22
<u>Wykres 10 Produkcja węgla brunatnego w Europie w mln. ton w latach 2000-2013 na podstawie danych BGSMPiS</u>	23
<u>Wykres 11 Polskie wydobycie w latach 2004-2013 skał zdalnych do produkcji kamieni budowlanych i drogowych (tys. ton) BGSMPiS 2008, 20013</u>	27
<u>Wykres 12 Bilans eksport/ import kamieni blocznych wg. BGSMPiS 2013</u>	27
<u>Wykres 13 Wydobycie kruszyw w Polsce mln ton w latach 2009-20013 wg BGSMPiS 2013</u>	28
<u>Wykres 14 Produkcja kruszyw żwirowych i łamanych (mln. ton) w krajach europejskich w latach 2000-2004 wg. European Mineral Statistics</u>	29
<u>Wykres 15 Produkcja kruszyw żwirowych i łamanych (mln. ton) w krajach europejskich w latach 2004-2008 wg. European Mineral Statistic</u>	29
<u>Wykres 16 Produkcja kruszyw żwirowych i łamanych (mln. ton) w krajach europejskich w latach 2009-2013 wg. European Mineral Statistics</u>	30
<u>Wykres 17 Światowa produkcja piasku i żwiru tys. t w latach 2000-2014 wg. USGS (produkcja USA w niektórych latach przekracza skalę)</u>	30
<u>Wykres 18 Struktura produkcji gipsu i anhydrytu (tys. ton) w Polsce w latach 2000-2013 CN 2520 10, PKWiU 08112030 wg. BGSMPiS</u>	31
<u>Wykres 19 Europejska produkcja itów ceramicznych i ogniotrwałych (tys. ton) w latach 2000-2013 na podstawie danych BGSMPiS</u>	33
<u>Wykres 20 Produkcja skaleni w Polsce i Europie w latach 2000 – 2012</u>	36
<u>Wykres 21 Produkcja szkła w Europie w latach 2005-2015 (mln ton)</u>	37
<u>Wykres 22 Pozycja Polski wśród znaczących producentów wody mineralnej (mln. litrów) w Europie w roku 2015</u>	38
<u>Wykres 23 Udział kontynentów w światowej produkcji drewna w 2015 (źródło: FAO)</u>	41
<u>Wykres 24 Produkcja drewna w Europie w latach 2000 - 2015 (źródło: FAO)</u>	41
<u>Wykres 25 Produkcja drewna w Polsce w latach 2000 - 2015 (źródło: FAO)</u>	42
3	
<u>Wykres 26 Produkcja drewna w krajach Unii Europejskiej w roku 2015 [m] (opracowanie własne na podstawie FAO)</u>	42
3	
<u>Wykres 27Produkcja tarcicy w woj. dolnośląskim [w dam] (źródło: Rocznik Statystyczny Województw Dolnośląskiego 2016)</u>	44
<u>Wykres 28 Produkcja mebli w Polsce w latach 2000 – 2015 (źródło: Produkcja wyrobów przemysłowych w 2015 r. GUS)</u>	45
<u>Wykres 29 PKB na 1 mieszkańca (w cenach bieżących) w latach 2000 – 2015 (źródło danych: FAO)</u>	50
<u>Wykres 30 Wartość produkcji sprzedanej przemysłu w roku 2015 (źródło: GUS)</u>	53
<u>Wykres 31 Liczba zakładanych firm posiadające PKD wzięte pod uwagę na terenie Dolnego Śląska w poszczególnych latach od 2000 do 2016</u>	54
<u>Wykres 32 Ilość firm DIS surowce naturalne i wtórne ze względu na stan aktualnego zatrudnienia w ogólnym zestawieniu</u>	54
<u>Wykres 33 Ilość firm DIS surowce naturalne i wtórne ze względu na stan aktualnego zatrudnienia na rok 2016 w ogólnym zestawieniu w rozbiciu na rok rozpoczęcia działalności</u>	55

<u>Wykres 34 Ilość firm DIS surowce naturalne i wtórne zatrudniających aktualnie 1 pracownika (samo zatrudnienie) założonych w poszczególnych latach w okresie od 2000 do 2016.</u>	55
<u>Wykres 35 Ilość firm DIS Surowce naturalne i wtórne zatrudniających aktualnie do 9 pracowników założonych w poszczególnych latach w okresie od 2000 do 2016.</u>	56
<u>Wykres 36 Ilość firm DIS surowce naturalne i wtórne zatrudniających aktualnie do 49 pracowników założonych w poszczególnych latach w okresie od 2000 do 2016.</u>	56
<u>Wykres 37 Ilość firm DIS Surowce naturalne i wtórne zatrudniających aktualnie do 249 pracowników założonych w poszczególnych latach w okresie od 2000 do 2016.</u>	57
<u>Wykres 38 Ilość firm DIS Surowce naturalne i wtórne zatrudniających aktualnie powyżej 249 pracowników założonych w poszczególnych latach w okresie od 2000 do 2016.</u>	57
<u>Wykres 39 Sumaryczna ilość osób zatrudnionych w firmach DIS surowce naturalne i wtórne, które rozpoczęły działalność w danym roku w latach 2000 – 2016.</u>	58
<u>Wykres 40 Udział nakładów na działalność B+R finansowanych z sektora przedsiębiorstw w nakładach na działalność B+R ogółem (źródło danych: FAO)</u>	60
<u>Wykres 41 Odsetek przedsiębiorstw współpracujących w zakresie działalności innowacyjnej w ogóle przedsiębiorstw aktywnych innowacyjnie; dane w % na rok 2015 (źródło danych: GUS)</u>	61
<u>Wykres 42 Udział przychodów ze sprzedaży produktów innowacyjnych dla rynku w przychodach ogółem przedsiębiorstw przemysłowych na rok 2015 (źródło danych: GUS)</u>	62
<u>Wykres 43 Wartości współczynnika lokalizacji wg danych z roku 2015 (źródło danych GUS)</u>	65
<u>Wykres 44 Odsetek przedsiębiorstw o zasięgu międzynarodowym w poszczególnych podregionach (na podstawie badania CATI)</u>	66
<u>Wykres 44 Odsetek przedsiębiorstw o zasięgu międzynarodowym na podstawie badań CATI</u>	67
<u>Wykres 45 Rozkład procentowy przedsiębiorstw zarejestrowanych na Dolnym Śląsku (stan na 2016 r.) w podziale na podobszary DIS Surowce naturalne i wtórne (opr.: własne, na podstawie danych Załącznika nr 2 do Raportu)</u>	68
<u>Wykres 46 . Dynamika produkcji sprzedanej (ceny stałe), odniesione do wartości z 2005 r. (źródło: Mały rocznik statystyczny Polski, 2016 r.)</u>	71
<u>Wykres 47 Pochodzenie środków publicznych przeznaczonych na finansowanie innowacji (na podstawie badań CATI)</u>	86
<u>Wykres 48 Ocena skuteczności interwencji publicznej przez podmioty, którym wsparcie udzielono (na podstawie badań CATI)</u>	87
<u>Wykres 49 Zmiana wartości sprzedaży w wyniku zrealizowanej interwencji (na podstawie badań CATI)</u>	88
<u>Wykres 50 Procent przedsiębiorców, którzy wykazali nakłady na działalność B+R w wyniku interwencji publicznej (na podstawie badań CATI)</u>	88
<u>Wykres 51 Procent przedsiębiorców, którzy nawiązanie współpracy kooperacyjnej w wyniku interwencji publicznej (na podstawie badań CATI)</u>	89
<u>Wykres 52 Związek pomiędzy interwencją publiczną a zgłoszeniem patentowym (na podstawie badań CATI)</u> ..	90
<u>Wykres 53 Znajomość możliwych do wykorzystania nisz rozwojowych w branży (na podstawie badań CATI)</u> ...	91
<u>Wykres 54 Poziom skłonności badanych przedsiębiorców do tworzenia innowacyjnych produktów lub usług w ramach nisz rozwojowych (na podstawie badań CATI)</u>	92
<u>Wykres 55 Poziom skłonności przedsiębiorców do ubiegania się o środki z RPO WD na wykorzystanie nisz rozwojowych (na podstawie badań CATI)</u>	92
<u>Wykres 56 Najbardziej pożądane schematy wsparcia (na podstawie badań CATI)</u>	95
<u>Wykres 57 Czynniki które mogłyby wpłynąć na rozwój innowacji (na podstawie badań CATI)</u>	96
<u>Wykres 58 Odsetek przedsiębiorstw, które w ciągu ostatnich 10 lat wprowadziły innowacje, w zależności od ich skali (na podstawie badań CATI)</u>	100
<u>Wykres 59 Rodzaj innowacji wprowadzonych w przedsiębiorstwach w ciągu ostatnich 10 lat (na podstawie badań CATI)</u>	101
<u>Wykres 60 Formy przepływu wiedzy, technologii i innowacji w przedsiębiorstwach (na podstawie badań CATI)</u>	103

<u>Wykres 61 Odsetek przedsiębiorstw przeznaczających środki na badania i rozwój (Na podstawie badań CATI)</u>	104
<u>Wykres 62 Ilość przedsiębiorstw według wielkości zatrudnienia</u>	105
<u>Wykres 63 Odsetek pracowników o wysokiej specjalizacji (na podstawie badań CATI)</u>	106
<u>Wykres 64 Ilość zgłoszeń patentowych i innych praw ochronnych (na podstawie badań CATI)</u>	108
<u>Wykres 65 Sposób finansowania wdrażanych innowacji (na podstawie badań CATI)</u>	110
<u>Wykres 66 Odsetek przedsiębiorstw planujących w najbliższym czasie wprowadzenie innowacyjnych rozwiązań (na podstawie badań CATI)</u>	111
<u>Wykres 67 Odsetek przedsiębiorstw planujących wprowadzić innowacje w najbliższym czasie w nawiązaniu deklarowanych innowacji w ciągu ostatnich 10 lat (na podstawie badań CATI)</u>	112
<u>Wykres 68 Przyczyny niechęci przedsiębiorstw do wprowadzenia innowacji w najbliższym czasie (na podstawie badań CATI)</u>	113

6. LITERATURA

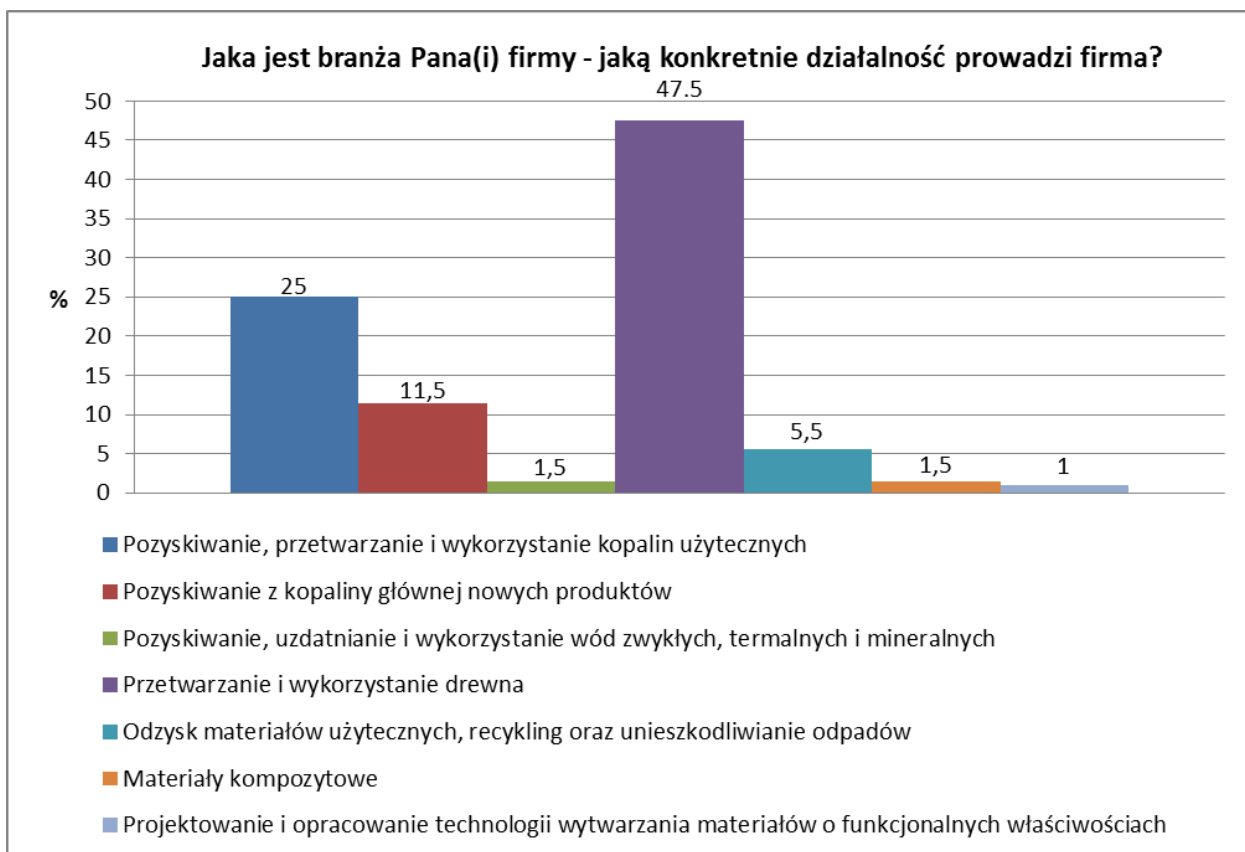
- „Foresight technologiczny przemysłu. Insight 2030. Streszczenie analizy końcowej”, Warszawa 2011
- „Foresight w drzewnictwie” – Polska 2020, Obszar badawczy: kompozyty drzewne, Poznań 2011
- „Przemysł cementowy w Polsce - perspektywy i zagrożenia” – Andrzej Ptak (20.04.2016)
- 20 LAT KRUSZYW W POLSKIEJ GOSPODARCE. HISTORIA, TERAŹNIEJSZOŚĆ, PRZYSZŁOŚĆ Aleksander Kabziński, Górnictwo i Geoinżynieria, Rok 34, Zeszyt 4, 2010
- Analysis of the competitiveness of the non-energy extractive industry in the EU. Commission Staff Working Document. SEC(2007) 771.
- Bilans Gospodarki Surowcami Mineralnymi Polski i Świata 1999-2003 PAN IGSMiE Kraków
- Bilans Gospodarki Surowcami Mineralnymi Polski i Świata 2001-2005. PAN IGSMiE Kraków
- Bilans Gospodarki Surowcami Mineralnymi Polski i Świata 2008 PAN IGSMiE Kraków
- Bilans Gospodarki Surowcami Mineralnymi Polski i Świata 2012 PAN IGSMiE Kraków
- Bilans Gospodarki Surowcami Mineralnymi Polski i Świata 2013 PAN IGSMiE Kraków
- Bilans perspektywicznych zasobów kopalin Polski wg stanu na 31 XII 2009 r. Państwowy Instytut Geologiczny, 2008
- Bilans zasobów kopalin i wód podziemnych w Polsce wg stanu na 31 XII 2000 r. - 31 XII 2015 r. Państwowy Instytut Geologiczny, 2001 - 2016
- Communication from the Commission to the European Parliament and the Council „The Raw Materials Initiative – Meeting Our Critical Needs for Growth and Jobs in Europe”. COM (2008) 699.
- Dokumenty konferencyjne: Górnictwo jako branża strategiczna - Bariery i Szanse Rozwoju w Gospodarce Globalnej. Sesja - Strategia Surowcowa; PAN; Warszawa 19.XI 2014 r. Inicjatywy i programy UE szansą dla rozwoju i przemysłu wydobywczego w Europie.
- Dziennik Urzędowy Unii Europejskiej 2011. (2011/696/UE). Zalecenie Komisji z dnia 18 października 2011 r. dotyczące definicji nanomateriału.
- European Mineral Statistics 2000-2004, BGS
- European Mineral Statistics 2001-2005, BGS
- European Mineral Statistics 2002-2006, BGS
- European Mineral Statistics 2003-2007, BGS
- European Mineral Statistics 2004-2008, BGS
- European Mineral Statistics 2007-2011, BGS
- European Mineral Statistics 2008-2012, BGS
- European Mineral Statistics 2009-2013, BGS
- Factors that influence the price of Al, Cd, Co, Cu, Fe, Ni, Pb, Rare Earth Elements, and Zn. by John F. Papp, E. Lee Bray, Daniel L. Edelstein, Michael D. Fenton, David E. Guberman, James B. Hedrick, John D. Jorgenson, Peter H. Kuck, Kim B. Shedd, and Amy C. Tolcin. USGS Open-File Report 2008–1356
- GALOS, K. 2009. Zmiany na rynku kruszyw naturalnych łamanych w Polsce po 2000 roku. Prace Naukowe Instytutu Górnictwa, Politechniki Wrocławskiej, Nr 125
- Główny Urząd Statystyczny 2015. Nanotechnologia w Polsce w 2014 r. Warszawa, grudzień 2015;
- Główny Urząd Statystyczny 2015; Działalność innowacyjna przedsiębiorstw w Polsce w latach 2012-2014, Warszawa, wrzesień 2015.
- Główny Urząd Statystyczny 2016; Mały rocznik statystyczny polski 2016
- Gospodarka zasobami złóż węgla kamiennego w Polsce w latach 1990 – 2015, E.J. Sobczyk, J. Kicki, J. Jaros, Zeszyty Naukowe Instytutu Gospodarki Surowcami Mineralnymi i Energią Polskiej Akademii Nauk
- Kelsall R.W., Hamley I.W., Geoghegan M. Nanotechnologie. WN PWN, Warszawa 2012.
- Kozioł, W, Ciepliński A., Machniak L., Janaszek C., Borcz, A. 2014. Wydobywanie i produkcja kruszyw naturalnych w Polsce i w Unii Europejskiej. Przegląd Górniczy. CAS 10



- Krajowa Strategia Innowacyjności i Efektywności Gospodarki.
- Mineral Commodity Summaries 2002 - 2016 U.S. Department of the Interior U.S. Geological Survey
- Nanonauka i Nanotechnologia. Narodowa Strategia dla Polski, MNiSW, 2006.
- Odpady wydobywcze z górnictwa miedzi w Polsce – bilans, stan zagospodarowania i aspekty środowiskowe, I. Kotarska, Cuprum nr 4 (65), 2012 r.
- Polityka Surowcowa Polski, Fundacja Gospodarki i Administracji Publicznej, 2015.
- Przemysł wydobywczy w Polsce, Czasopismo Naukowo-Techniczne Górnictwa Rud, Ner 2 (63)/2012.
- Raport z inwentaryzacji klastrów w Polsce, PARP, Warszawa 2016.
- Regionalna Strategia Innowacji Województwa Dolnośląskiego na lata 2011-2020;
- Rozporządzenie Komisji (WE) NR 450/2009 z dnia 29 maja 2009 r. w sprawie aktywnych i inteligentnych materiałów i wyrobów przeznaczonych do kontaktu z żywnością.
- Rozporządzenie Komisji Europejskiej dot. nowej perspektywy finansowej 2014-2020.
- Rozporządzenie Ministra Nauki i Szkolnictwa Wyższego z dnia 13 lipca 2012 r. w sprawie kryteriów i trybu przyznawania kategorii naukowej jednostkom naukowym
- Schulenburg M.S. Nanotechnologia. Innowacja dla świata przyszłości. Komisja Europejska. 2007.
- Strategia Unii Europejskiej Europa 2020.
- Studia nad rozwojem Dolnego Śląska nr 1/56/2015 Informacja o działalności dolnośląskich klastrów, Wrocław 2015.
- The World Copper Factbook International Copper Study Group 2016
- Ustawa z dnia 14 grudnia 2012 r. o odpadach;
- Ustawa z dnia 27 kwietnia 2001 r. - Prawo ochrony środowiska;
- Ustawa z dnia 9 czerwca 2011 r. — Prawo geologiczne i górnicze;
- Wałbrzyskie tereny pogórnice po 15 latach od zakończenia eksploatacji węgla, J. Kosmaty, Górnictwo i geologia T.6.Z.1
- Wody termalne na Dolnym Śląsku, W. Ciezkowski, M. Michniewicz, T. Przylibski, Wrocław 2011
- Złoże węgla brunatnego w rejonie Legnicy-Ścinawy i technologie ich zagospodarowania, A. Stachowiak, J. Nowak, E. Sztormwasser

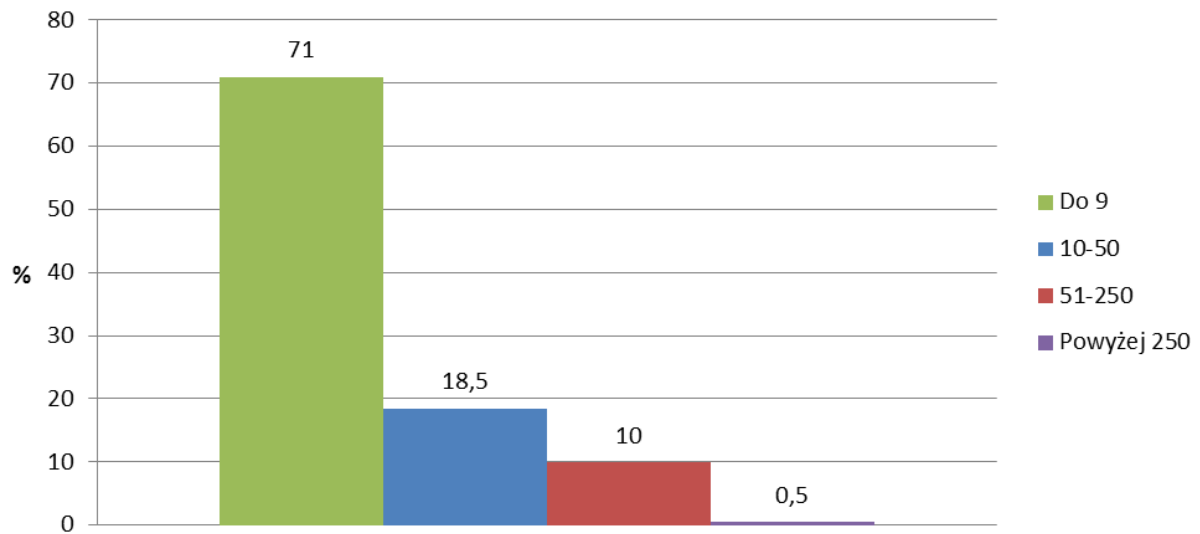


ZAŁĄCZNIK 1. WYBRANE WYNIKI BADANIA CATI

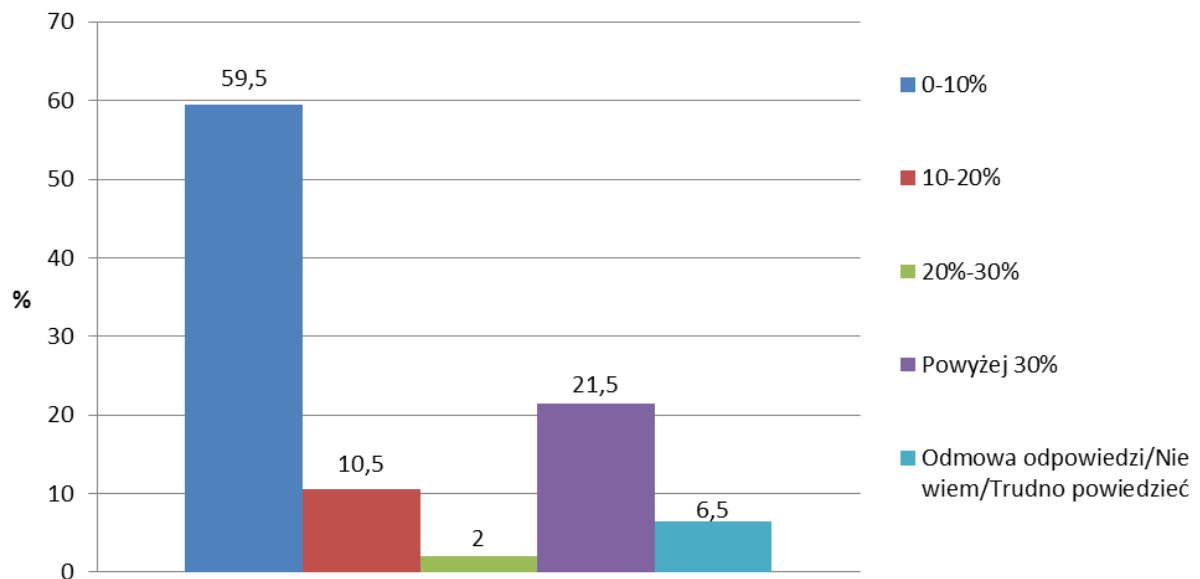


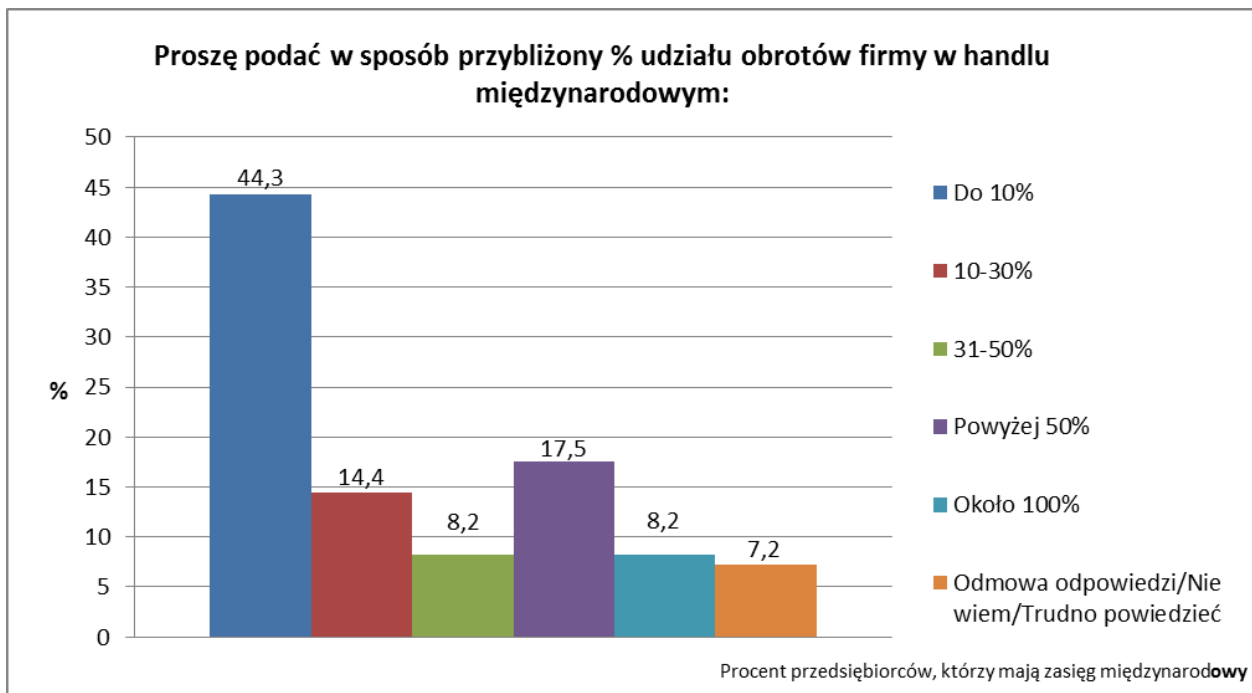
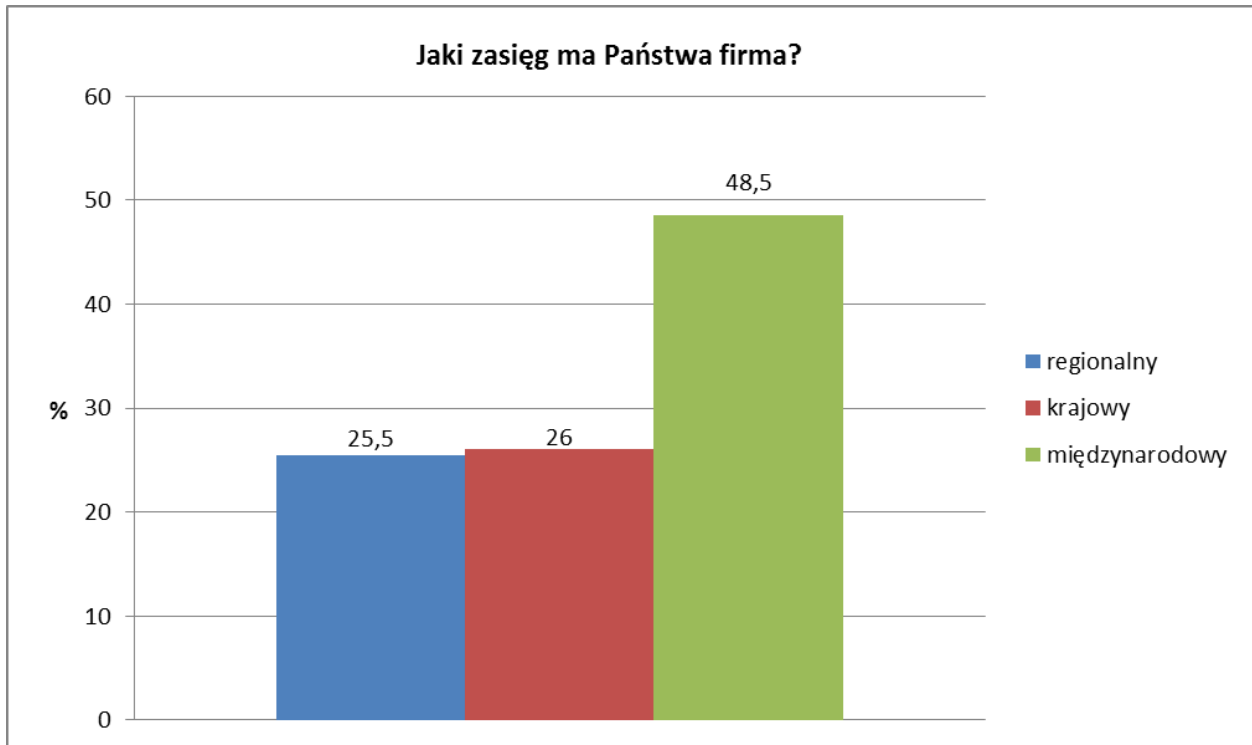


Proszę o szacunkowe określenie ile osób łącznie z Panem/Panią
pracuje obecnie w Państwa firmie?



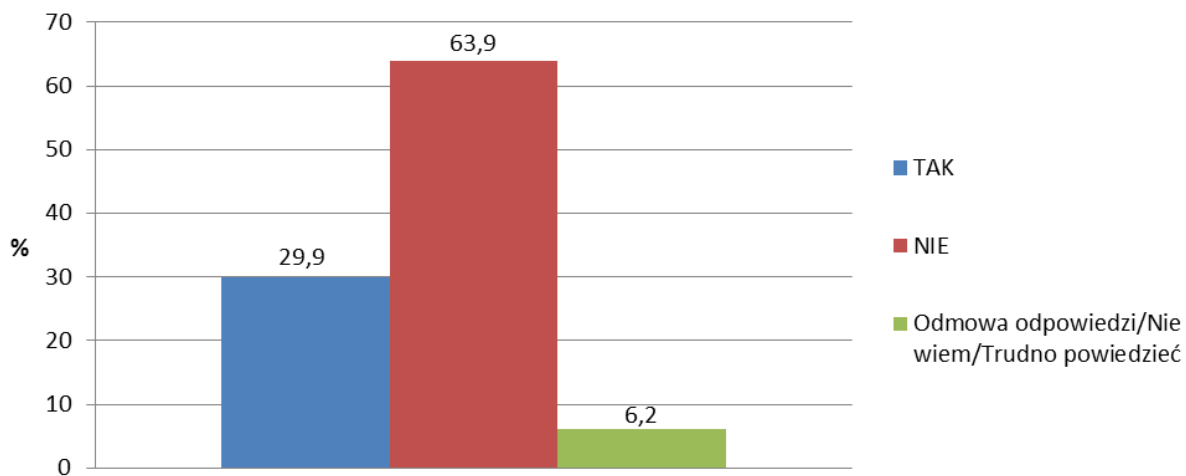
Jaki procent zatrudnienia stanowią pracownicy wysoko wyspecjalizowani?





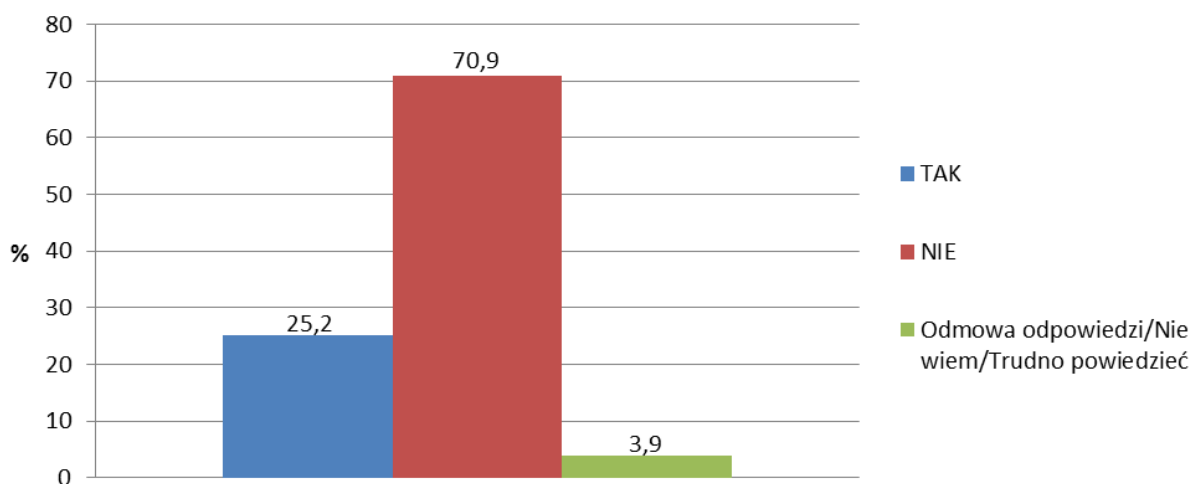


Czy usługi lub produkty, które oferują Państwo na rynkach międzynarodowych są wynikiem wdrożenia innowacji w Państwa firmie?



Procent przedsiębiorców, którzy mają zasięg międzynarodowy

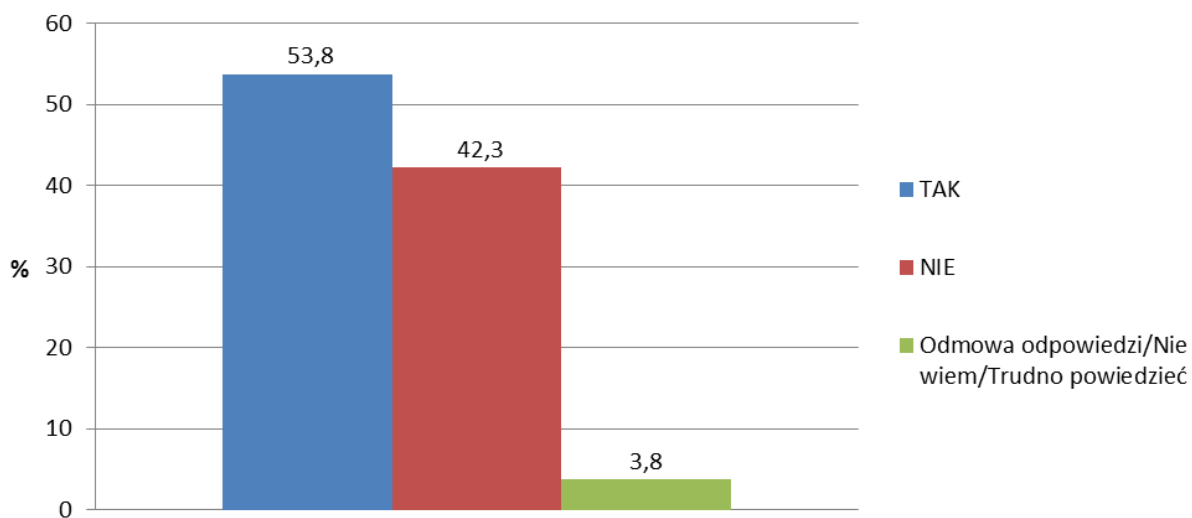
Czy mają Państwo plany, aby wejść na rynki międzynarodowe?



Procent przedsiębiorców, którzy mają zasięg regionalny lub krajowy

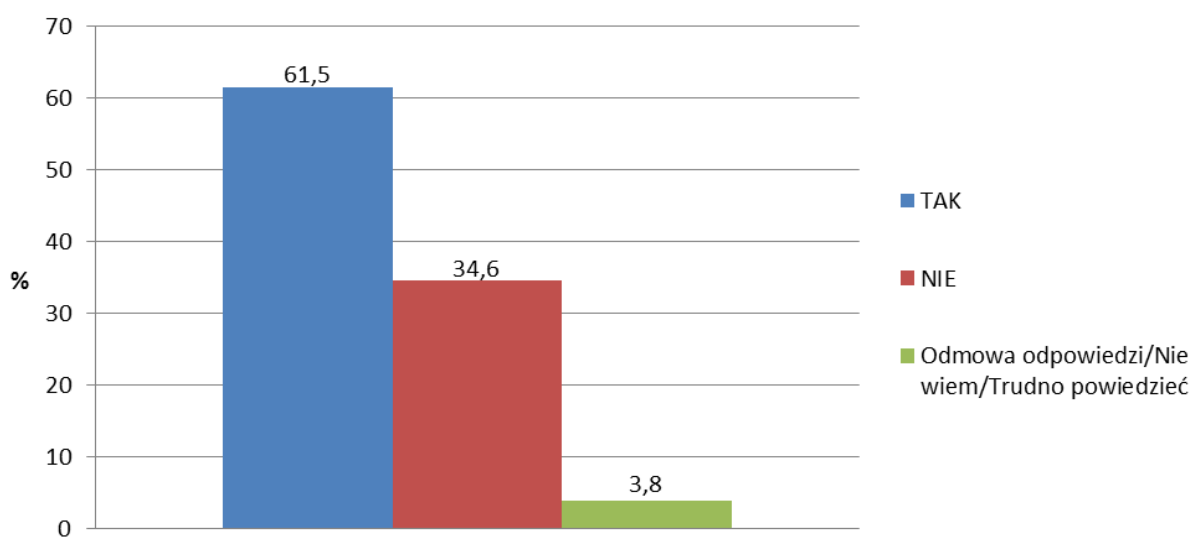


Czy zamierzają Państwo oferować na rynkach międzynarodowych usługi lub produkty, które można uznać za innowacyjne?

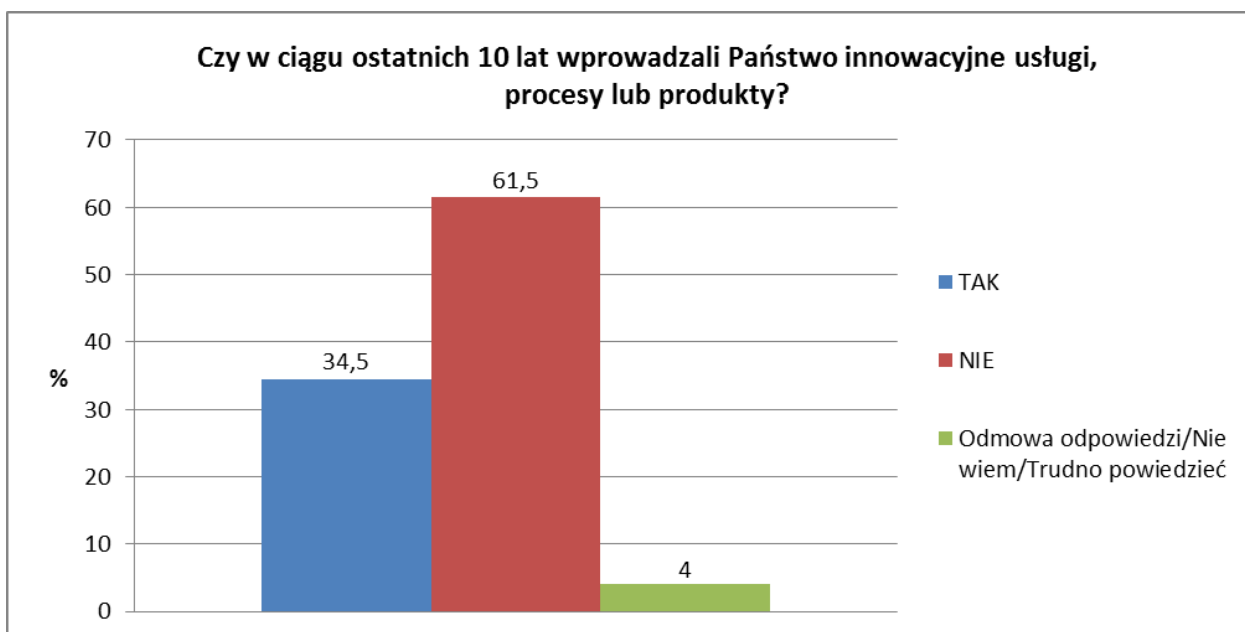
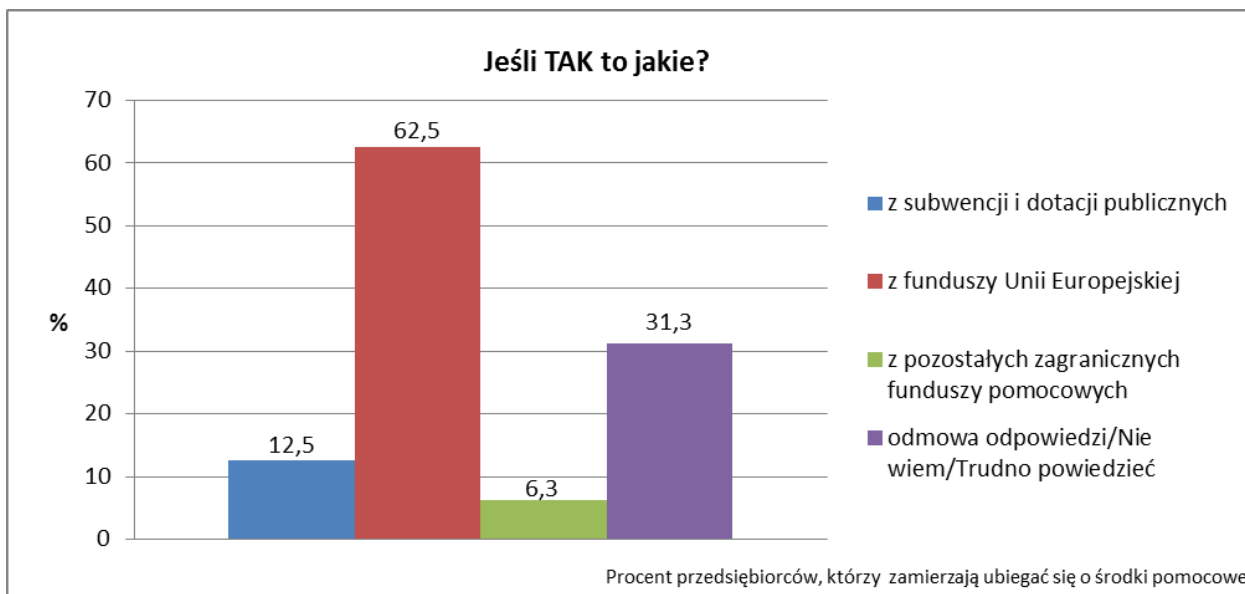


Procent przedsiębiorców, którzy zamierzają wejść na rynki międzynarodowe

Czy zamierzają się Państwo ubiegać o środki pomocowe w celu wejścia na rynki międzynarodowe?

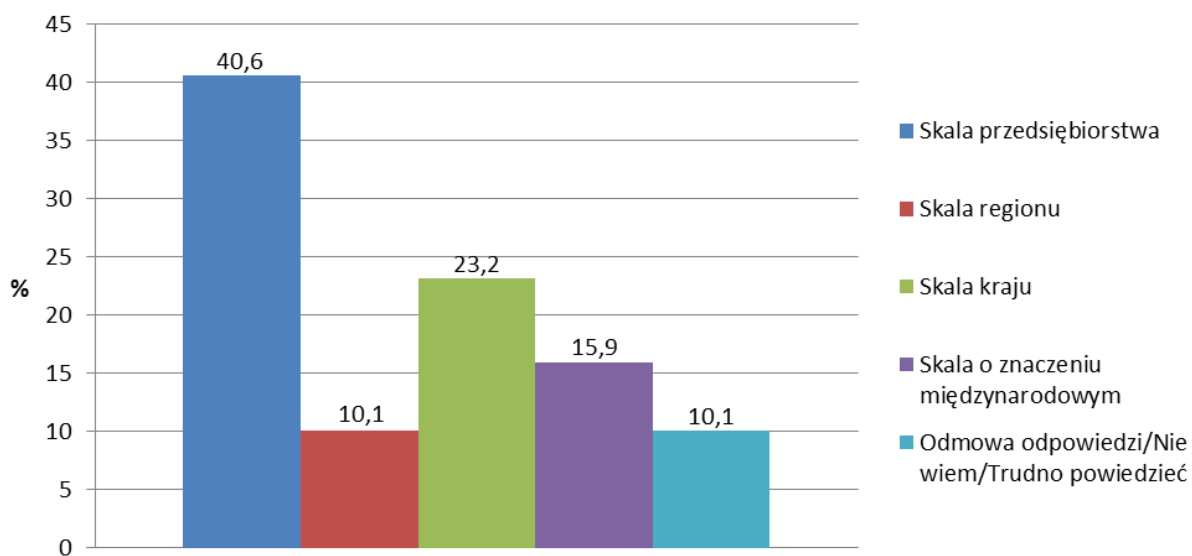


Procent przedsiębiorców, którzy zamierzają wejść na rynki międzynarodowe



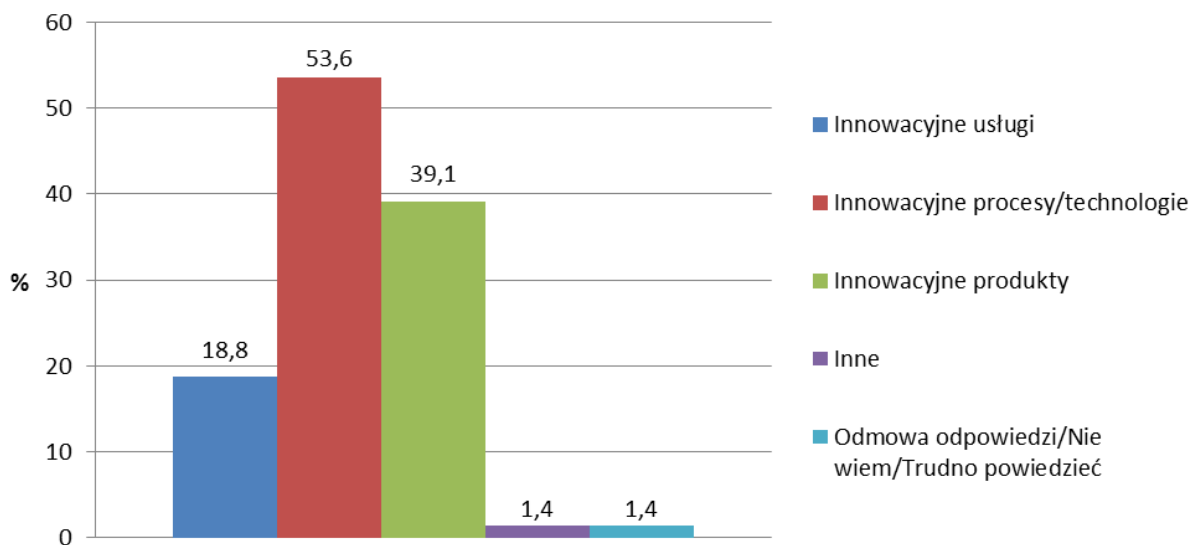


Jeśli TAK, to proszę scharakteryzować skalę tej innowacji:



Procent przedsiębiorców, którzy w ciągu 10 ost. lat wprowadzili innowacje

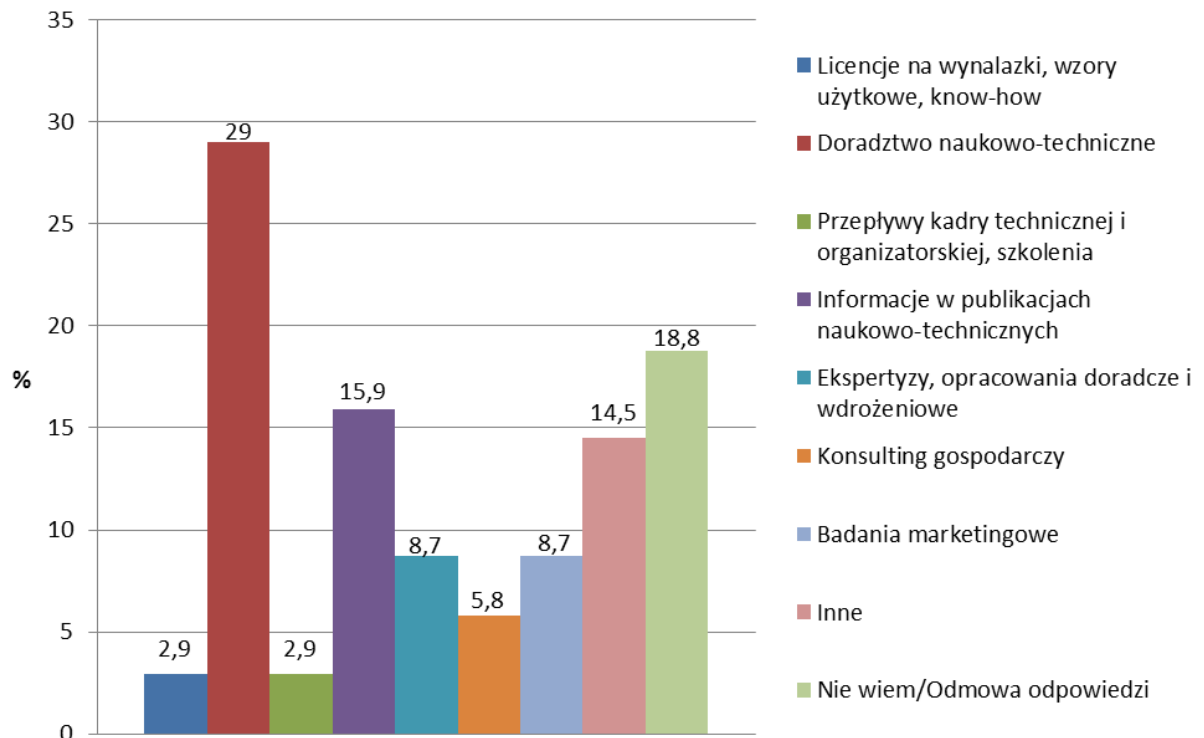
Jakiego rodzaju były to innowacje?



Procent przedsiębiorców, którzy w ciągu 10 ost. lat wprowadzili innowacje

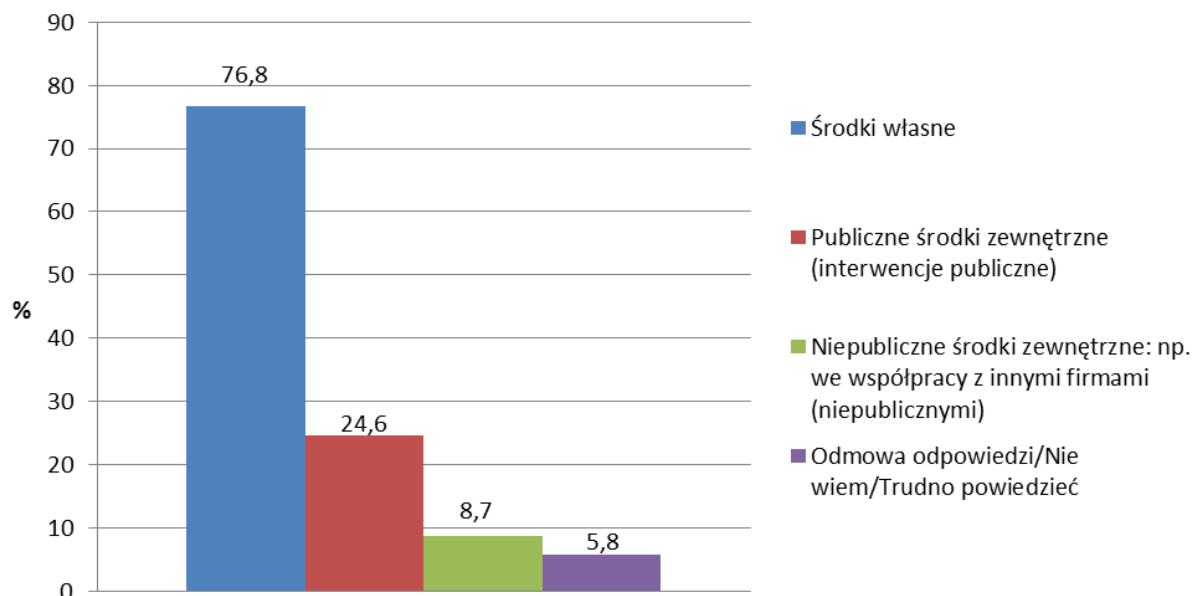


Z jakich form przepływu wiedzy, technologii i innowacji korzystało Państwa przedsiębiorstwo?



Procent przedsiębiorców, którzy w ciągu 10 ost. lat wprowadzili innowacje

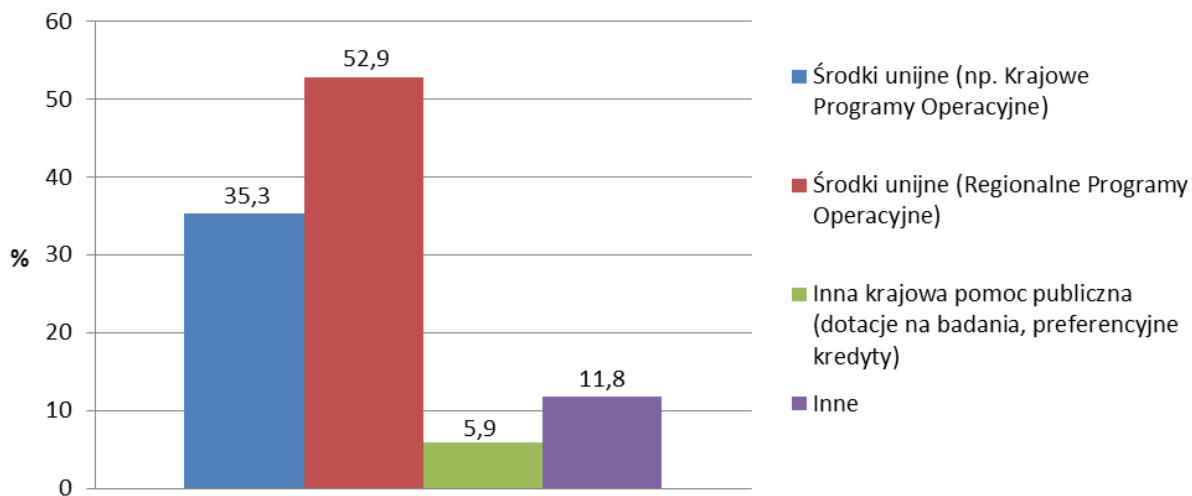
Proszę wskazać w jaki sposób finansowali Państwo wdrażanie innowacji:



Procent przedsiębiorców, którzy w ciągu 10 ost. lat wprowadzili innowacje

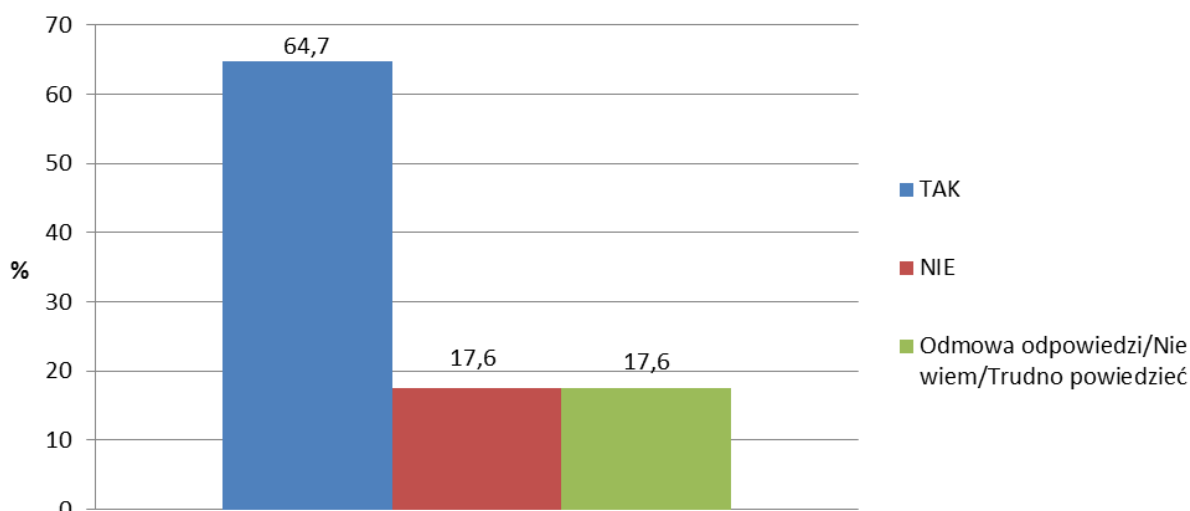


Czy może Pan(i) podać, z których środków publicznych korzystali Państwo przy finansowaniu/wprowadzaniu innowacyjnych produktów i usług?



Procent przedsiębiorców, którzy finansowali wdrażanie innowacji z publicznych środków zewnętrznych

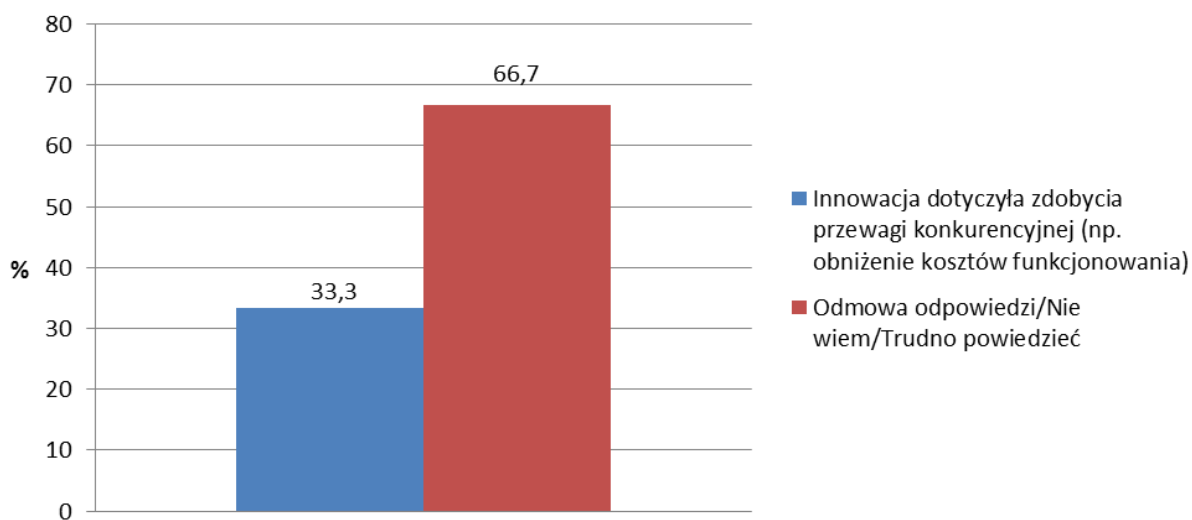
Czy w wyniku tej dotacji (interwencji publicznej) zwiększyli Państwo (znacząco) wartość sprzedaży w wyniku zrealizowanej interwencji?



Procent przedsiębiorców, którzy finansowali wdrażanie innowacji z publicznych środków zewnętrznych

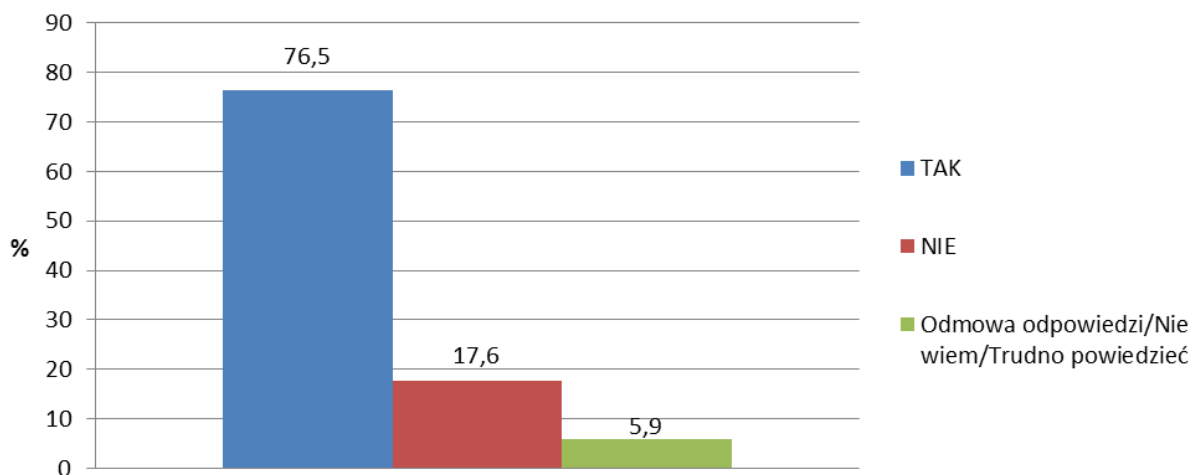


Co było powodem braku zwiększenia sprzedaży?



Procent przedsiębiorców, którzy nie zwiększyli wartości sprzedaży w wyniku innowacji

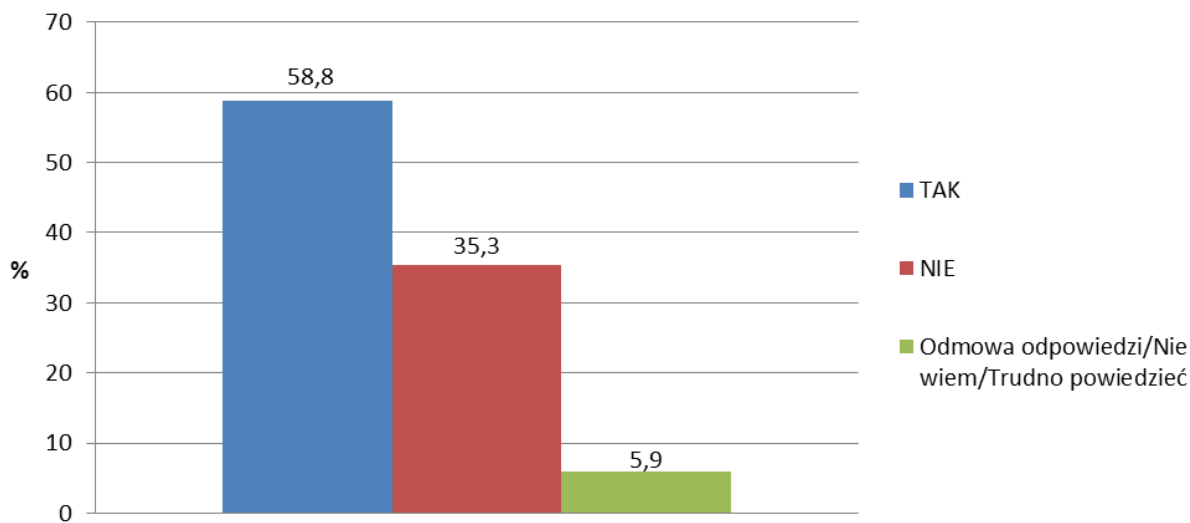
Czy w wyniku tej dotacji (interwencji publicznej) wykazali Państwo nakłady na działalność B+R (Badania i Rozwój)?



Procent przedsiębiorców, którzy finansowali wdrażanie innowacji z publicznych środków zewnętrznych

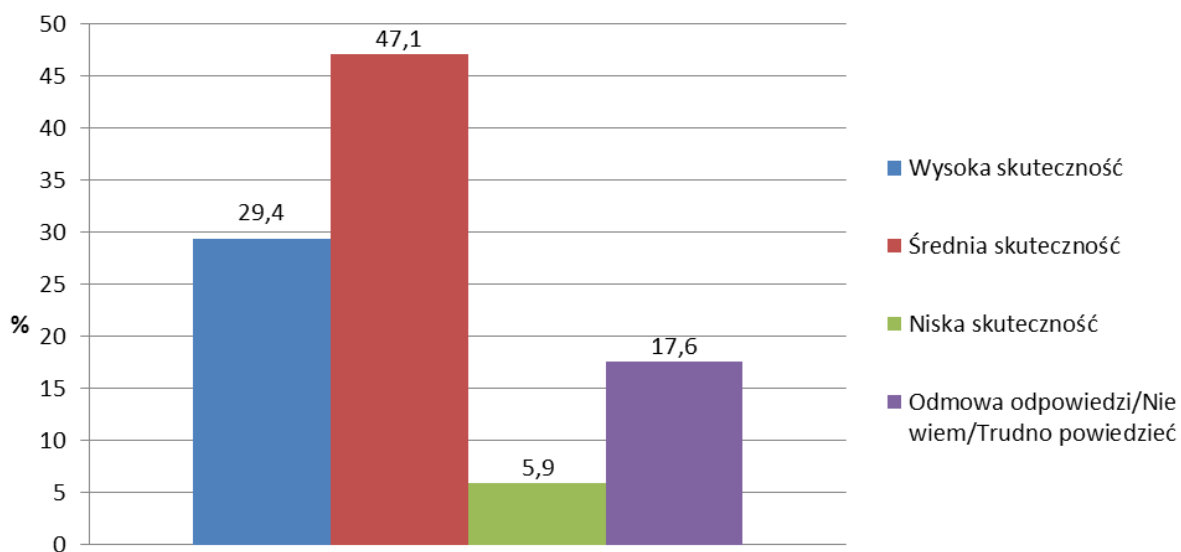


Czy w wyniku tej dotacji (interwencji) udało się nawiązać współpracę prowadzącą do powiązań kooperacyjnych?



Procent przedsiębiorców, którzy finansowali wdrażanie innowacji z publicznych środków zewnętrznych

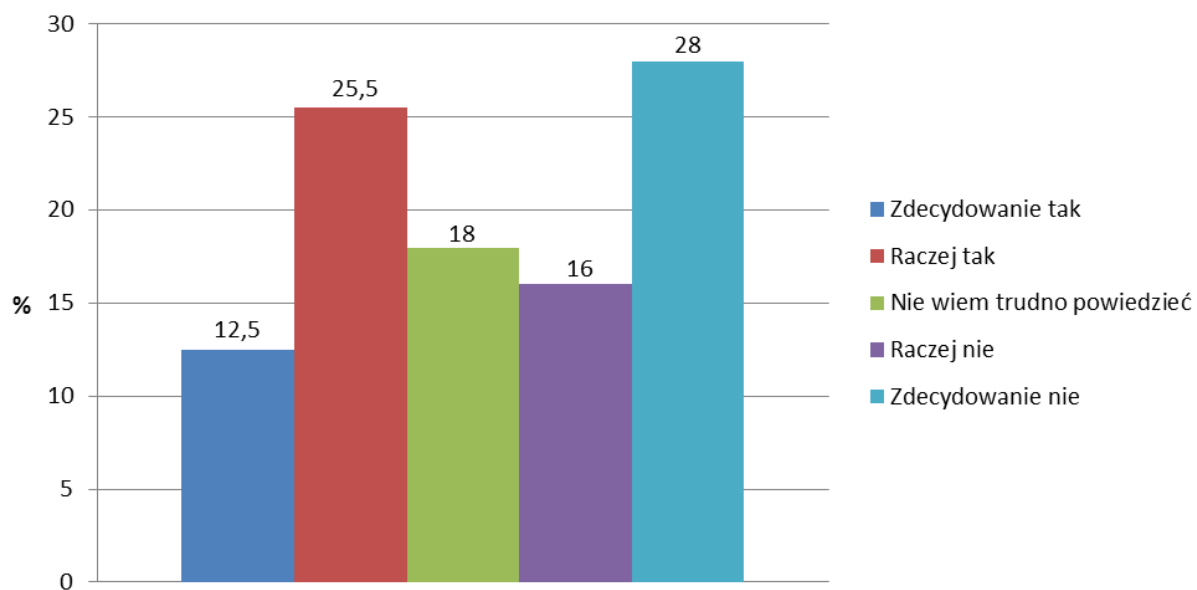
Proszę na podstawie własnych doświadczeń w sposób subiektywny ocenić skuteczność interwencji publicznych w obszarze inteligentnej specjalizacji surowce naturalne i wtórne:



Procent przedsiębiorców, którzy finansowali wdrażanie innowacji z publicznych środków zewnętrznych

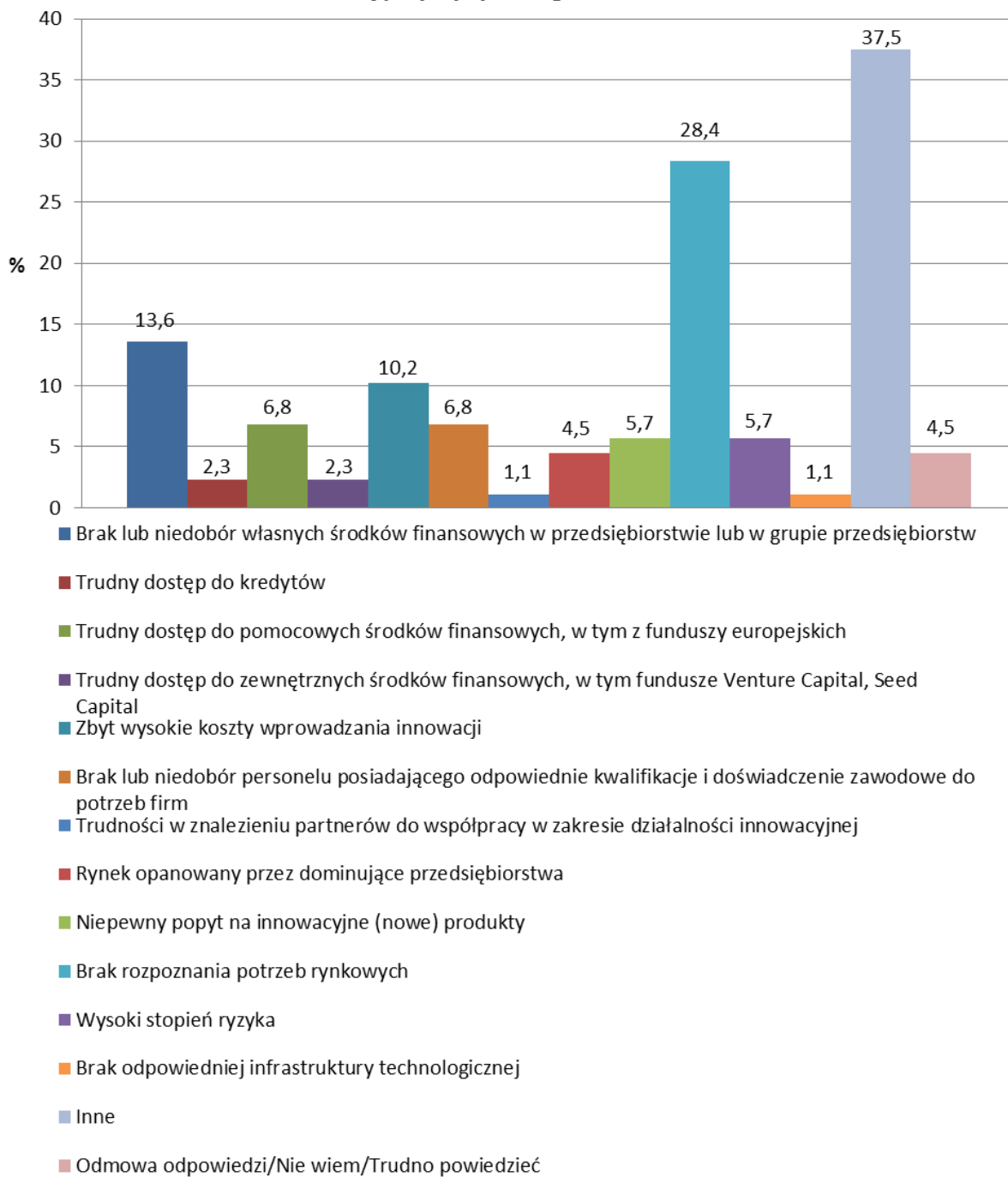


Czy planują Państwo w najbliższym czasie wprowadzenie w przedsiębiorstwie innowacyjnych produktów, technologii, usług?





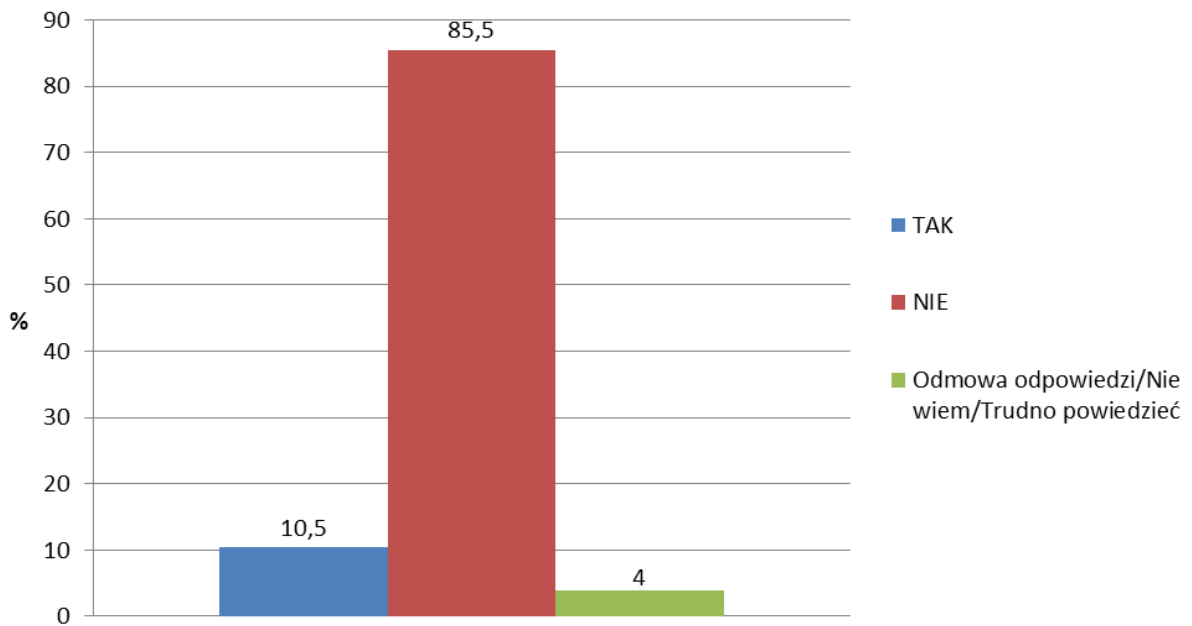
Jakie są przyczyny takiego nastawienia?



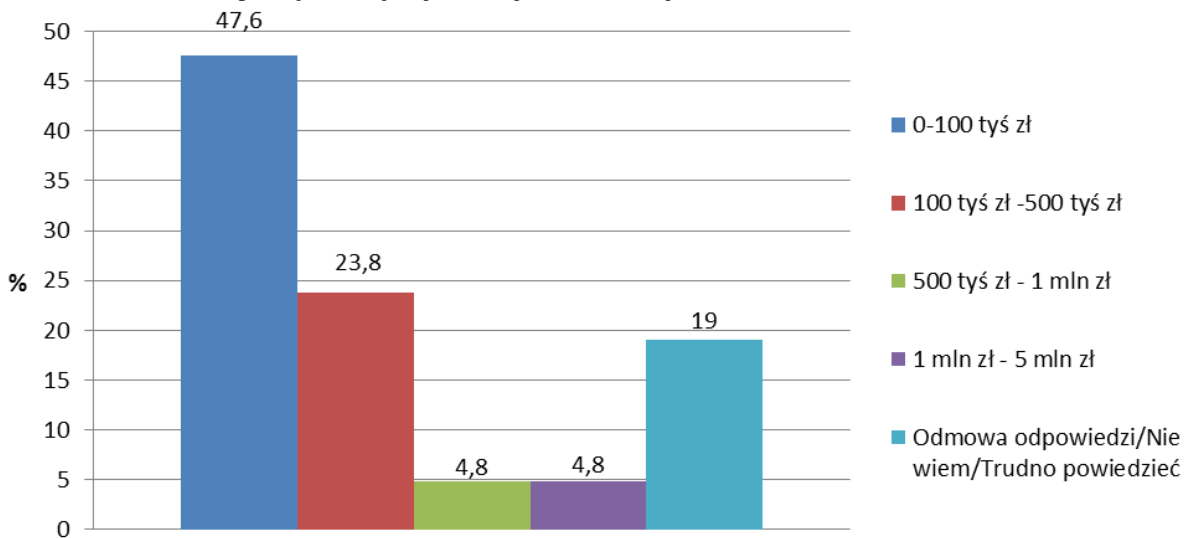
Procent przedsiębiorców, którzy nie planują wprowadzania innowacji w najbliższym czasie



Czy Państwa firma przeznaczą środki na Badania i Rozwój (popularnie B+R)?

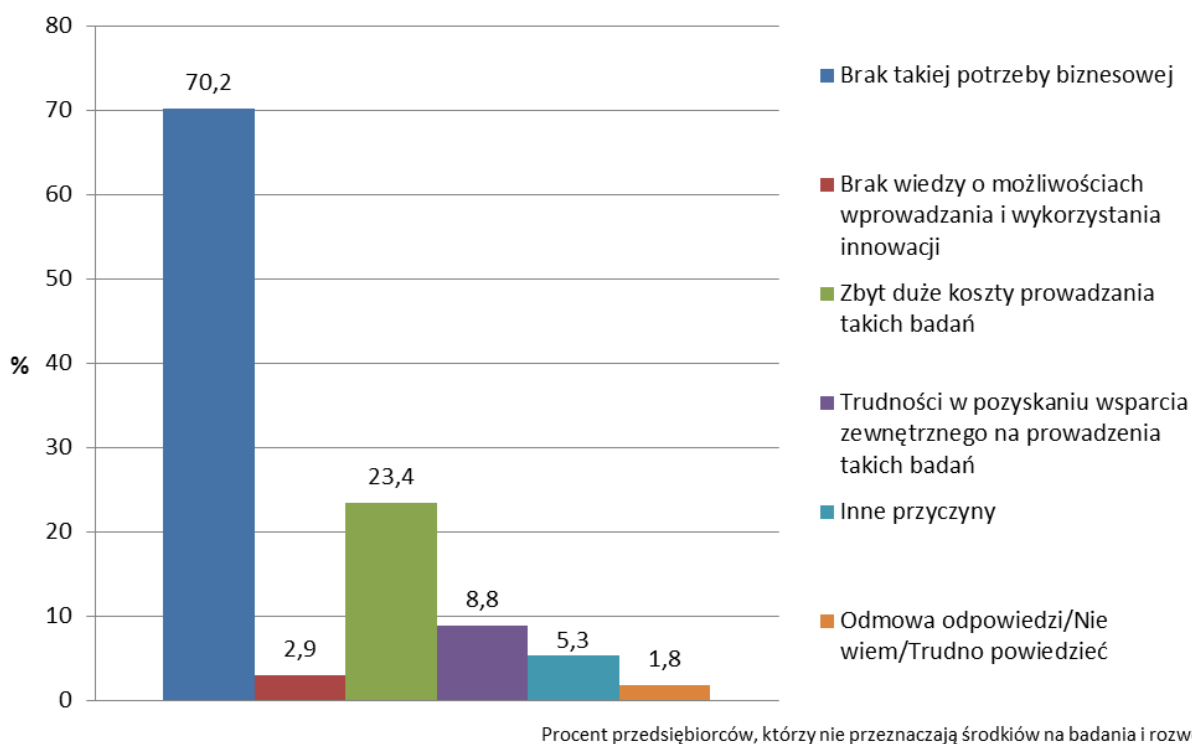


Proszę w sposób przybliżony określić wydatki na B+R - w skali roku:

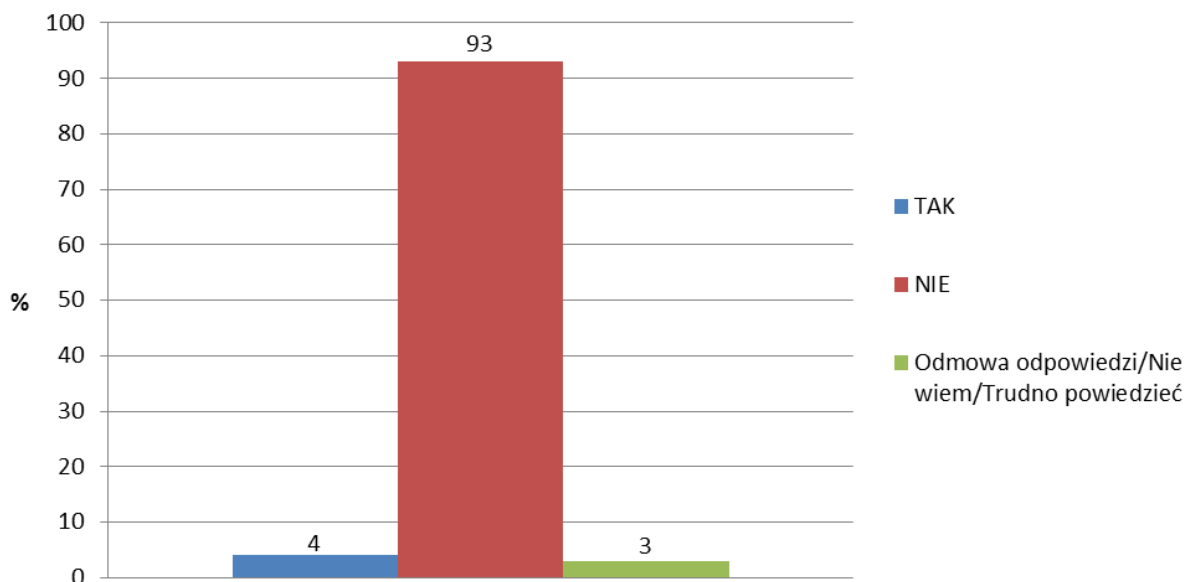


Procent przedsiębiorców, którzy przeznaczają środki na badania i rozwój

Co jest przyczyną braku przeznaczenia środków na badania i rozwój?

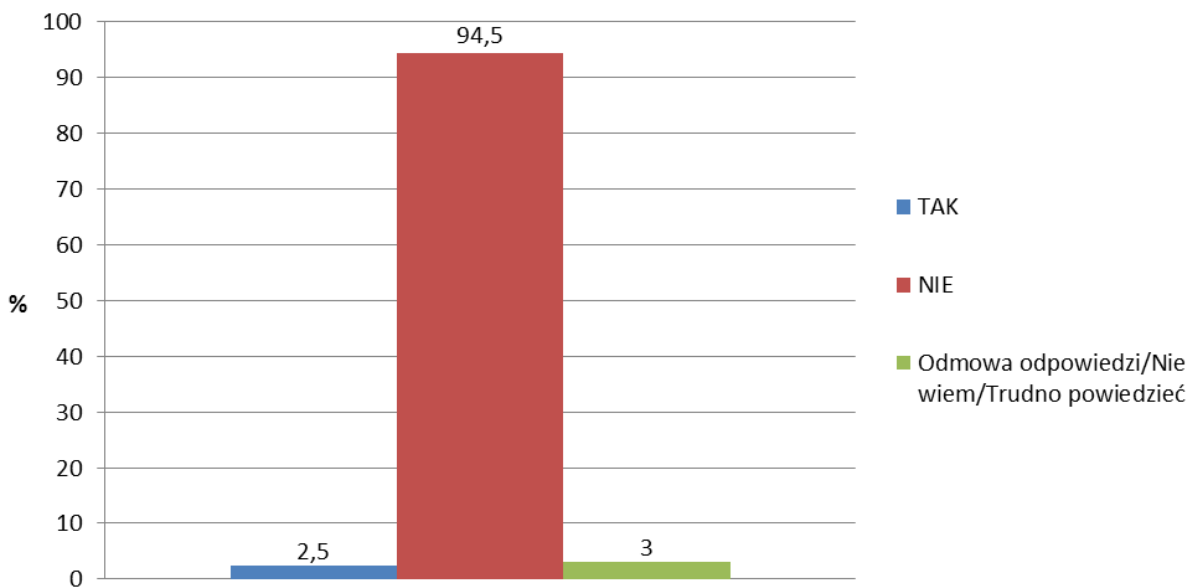


Czy od roku 2000 przedsiębiorstwo dokonało zgłoszeń w urzędzie patentowym - na patent?

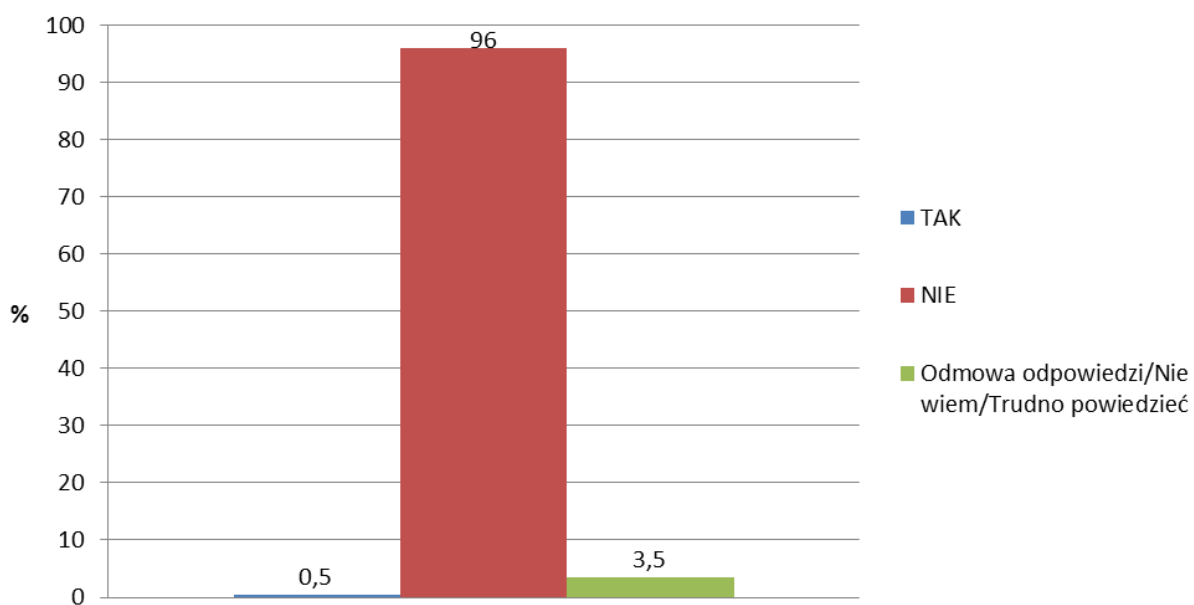




Czy od roku 2000 przedsiębiorstwo dokonało zgłoszeń w urzędzie patentowym - na wzór użytkowy?

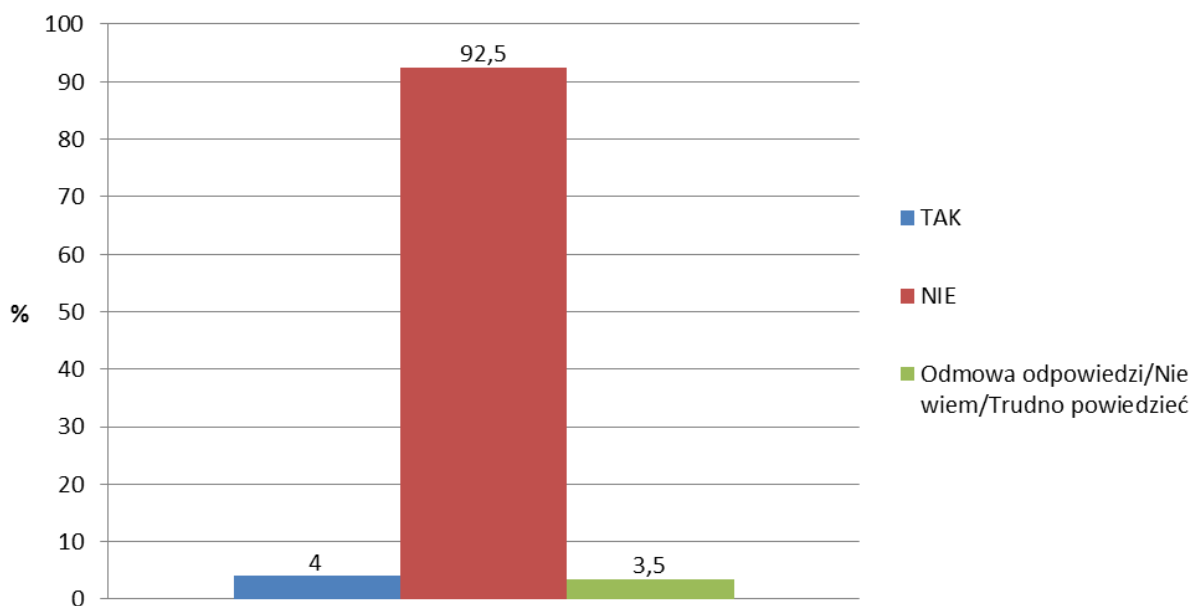


Czy od roku 2000 przedsiębiorstwo dokonało zgłoszeń w urzędzie patentowym - na wzór przemysłowy?

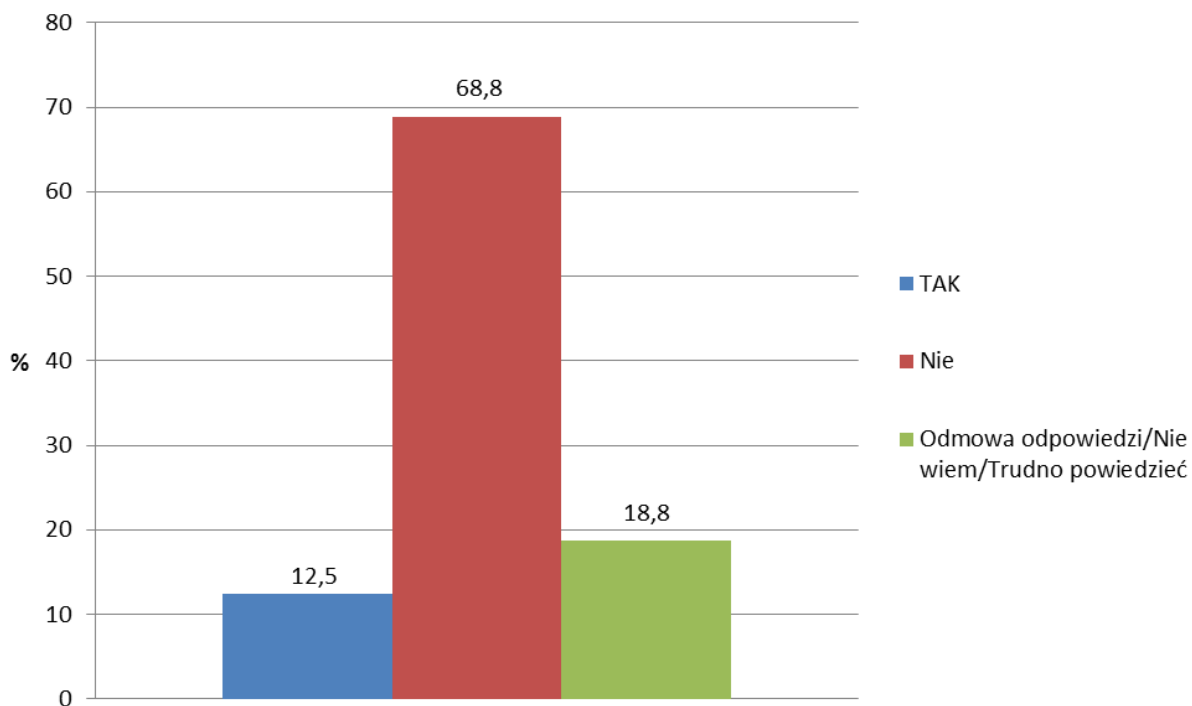




Czy od roku 2000 przedsiębiorstwo dokonało zgłoszeń w urzędzie patentowym - na znak towarowy?



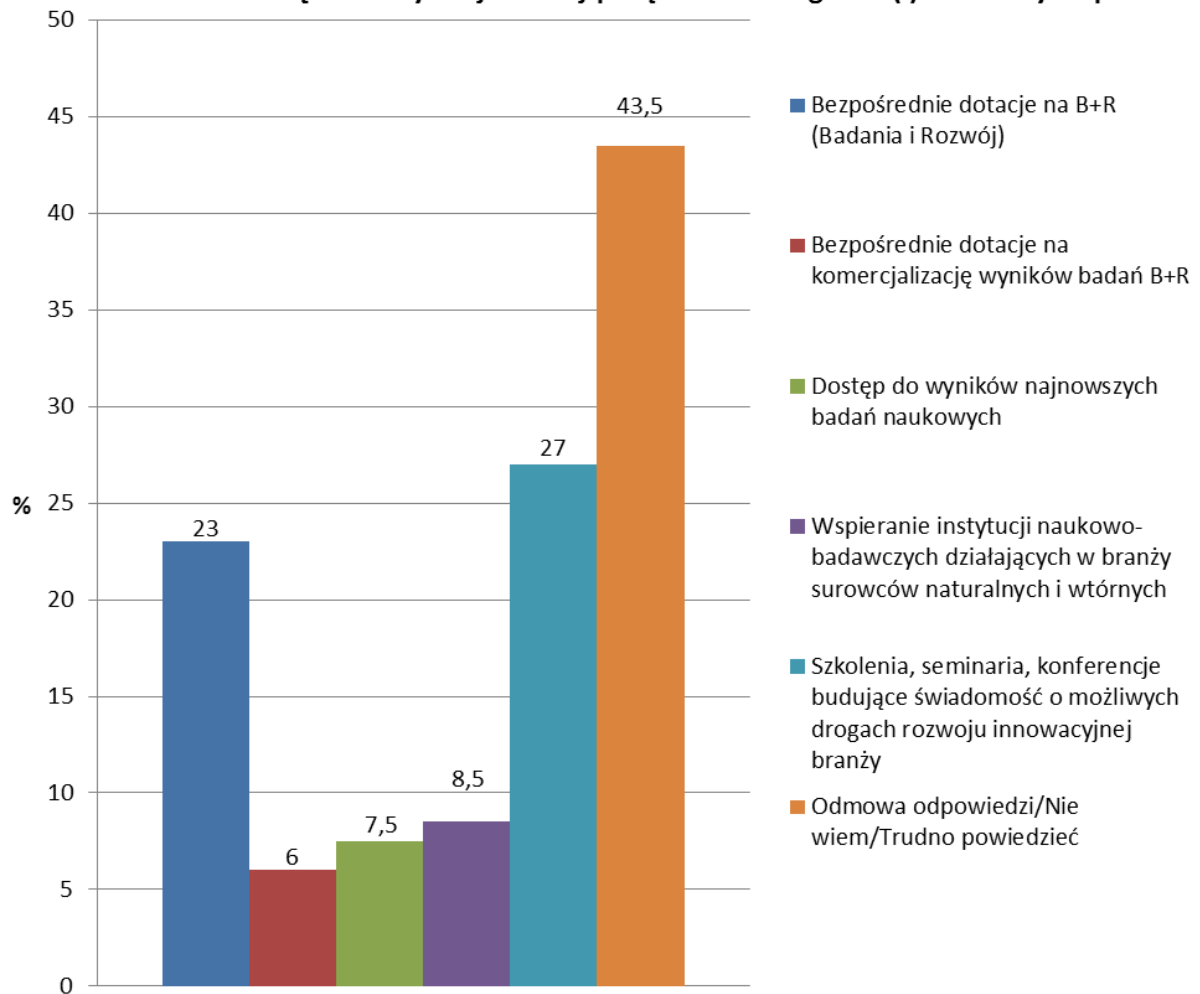
Czy zgłoszenie patentowe było wynikiem interwencji publicznych? (np. dotacji na Badania i Rozwój, dotacji na innowację, szkoleń etc.?)



Procent przedsiębiorców, którzy dokonali zgłoszenia w urzędzie patentowym

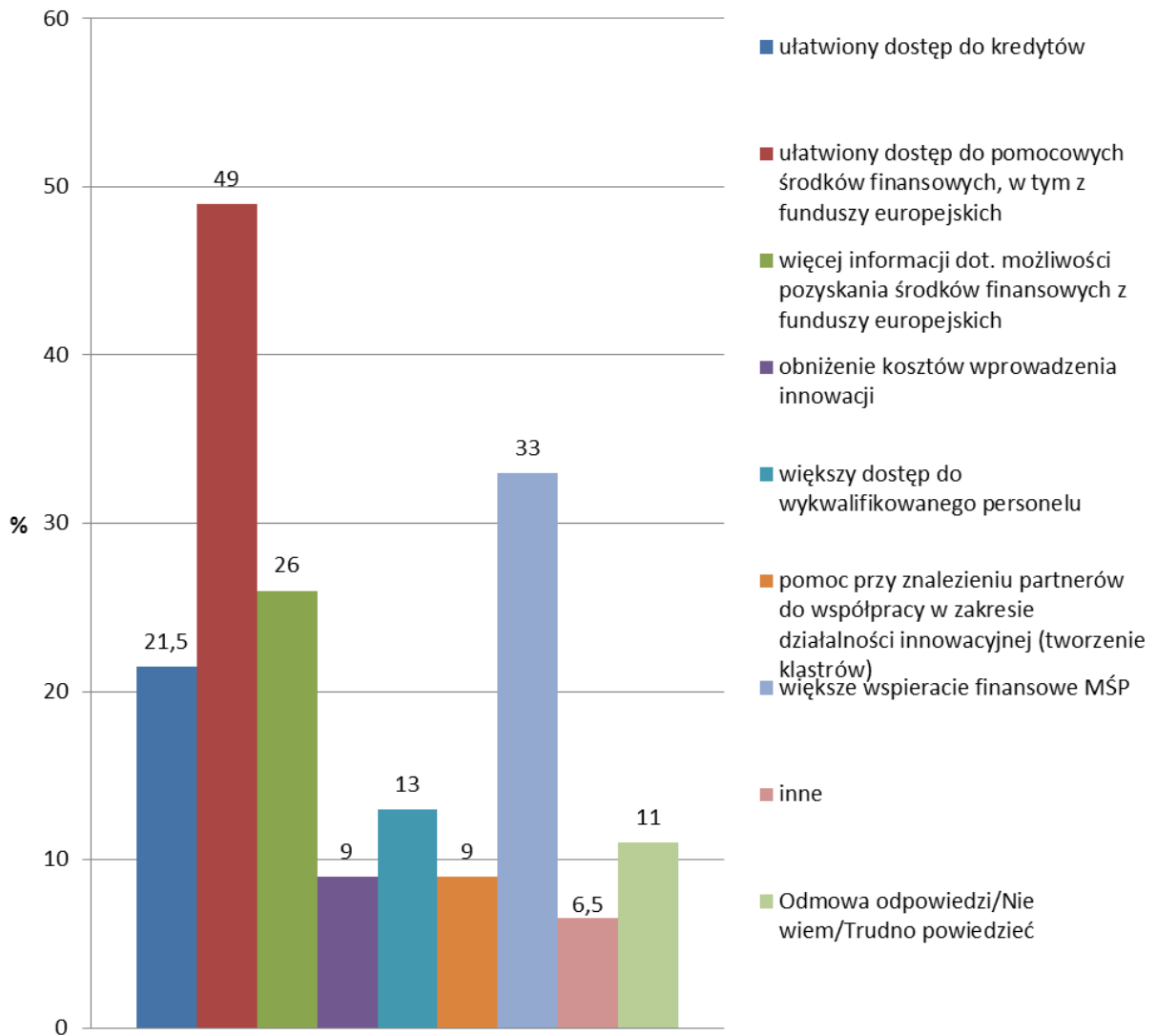


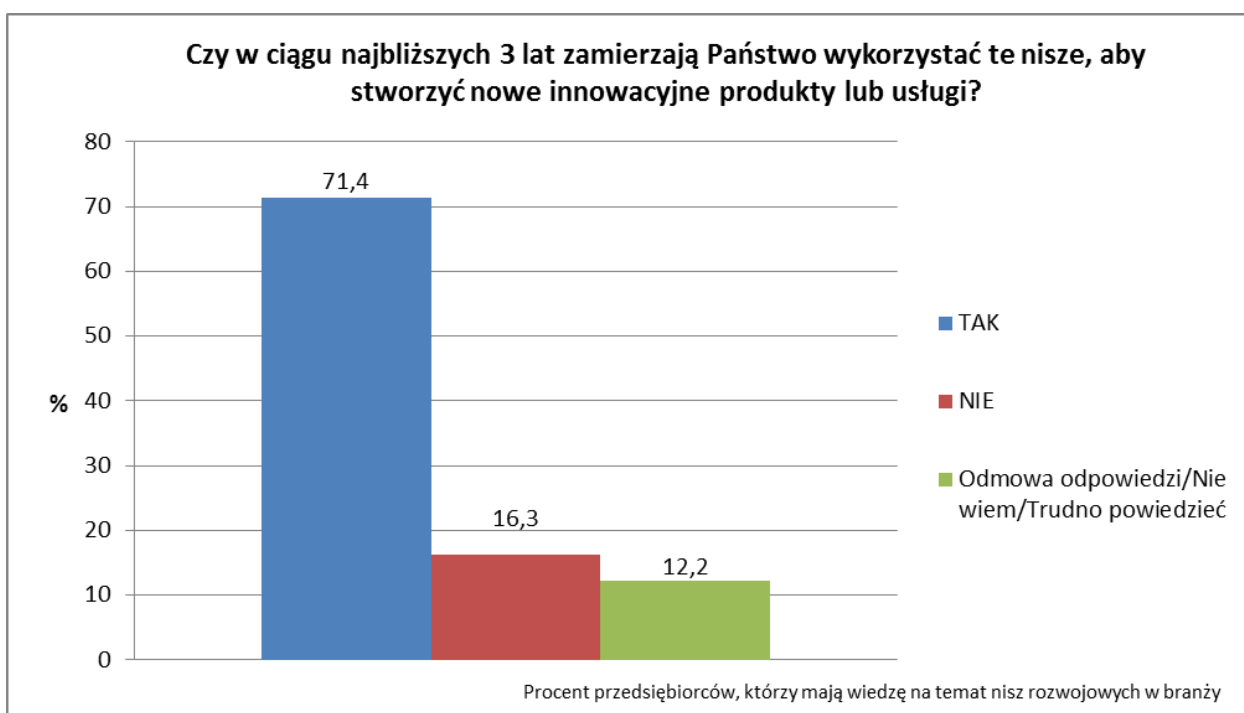
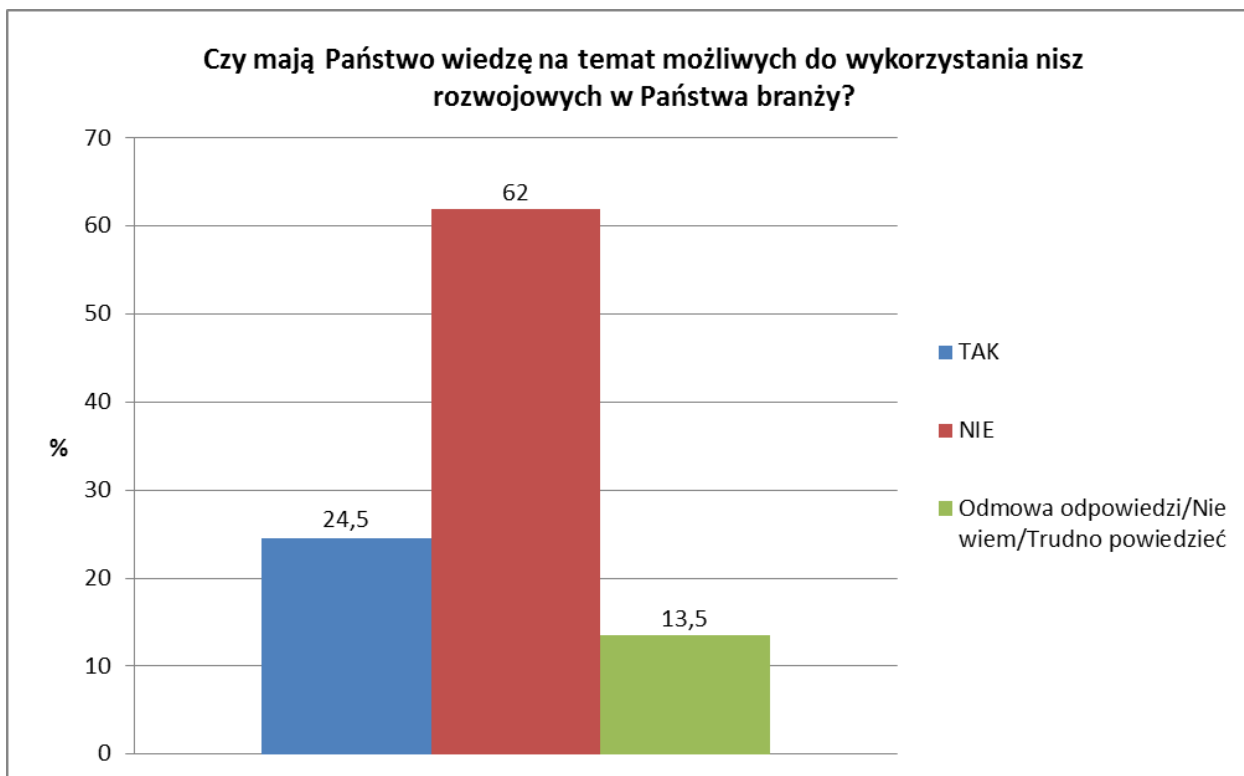
Proszę zaznaczyć najbardziej pożądane według Pana(i) schematy wsparcia:





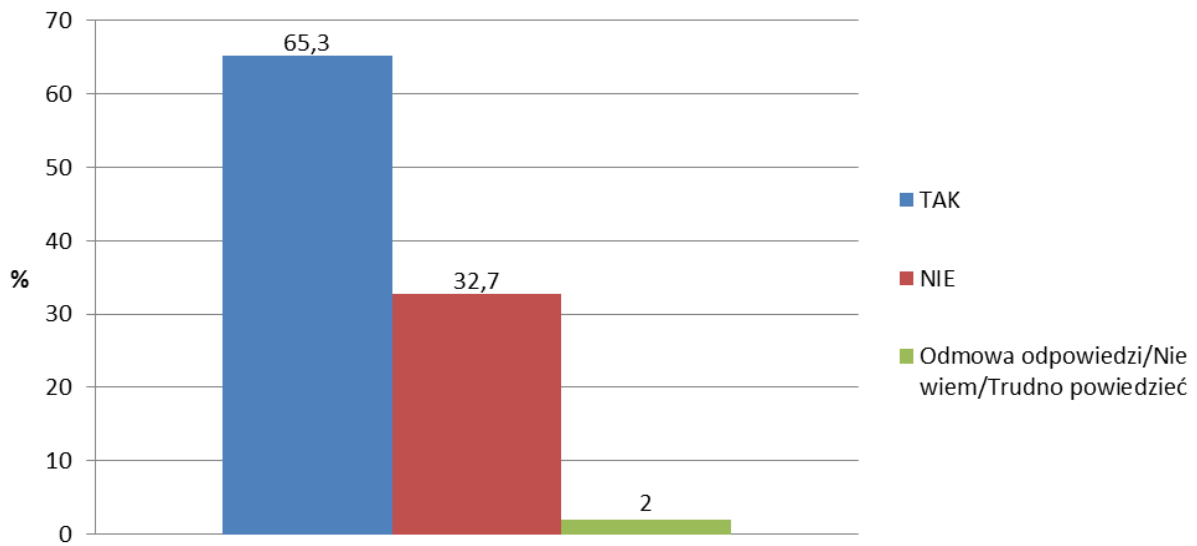
Proszę wymienić czynniki, które w przypadku Państwa firmy mogłyby
wpłynąć na rozwój innowacji:





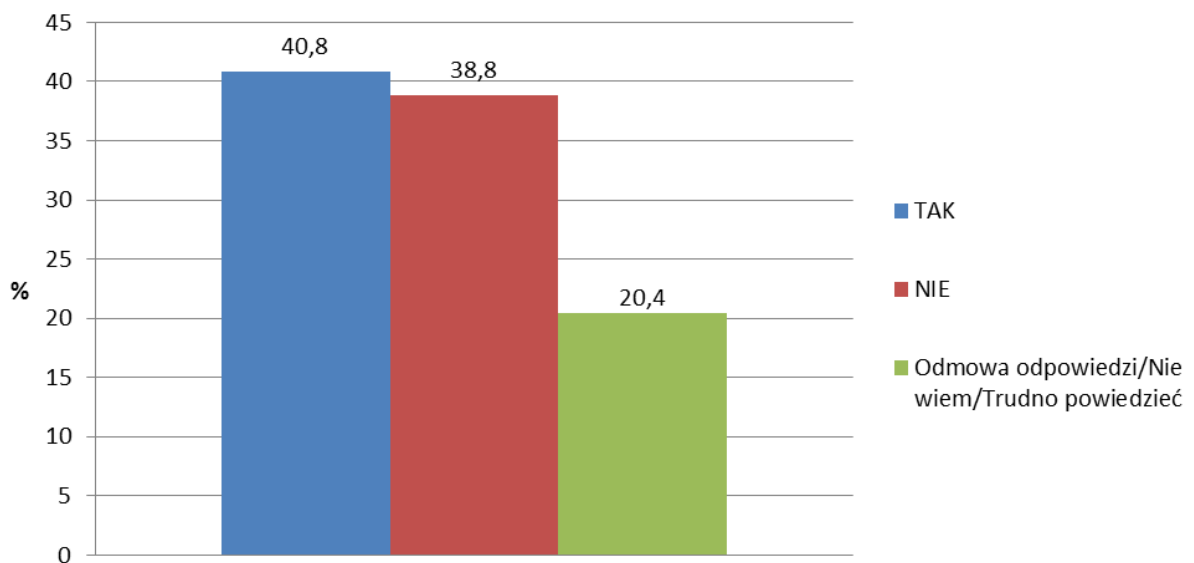


Czy wykorzystanie tych nisz wymaga nakładów finansowych na prowadzenie prac typu B+R?



Procent przedsiębiorców, którzy mają wiedzę na temat nisz rozwojowych w branży

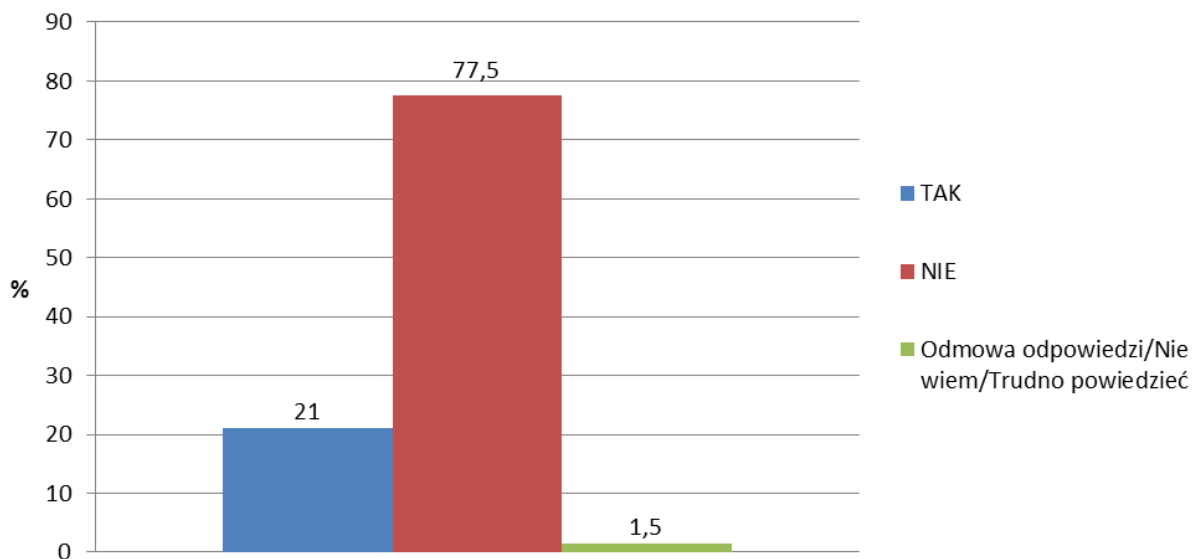
Czy zamierzają Państwo ubiegać się o środki na wykorzystanie tych nisz w ramach Regionalnego Programu Operacyjnego Województwa Dolnośląskiego?



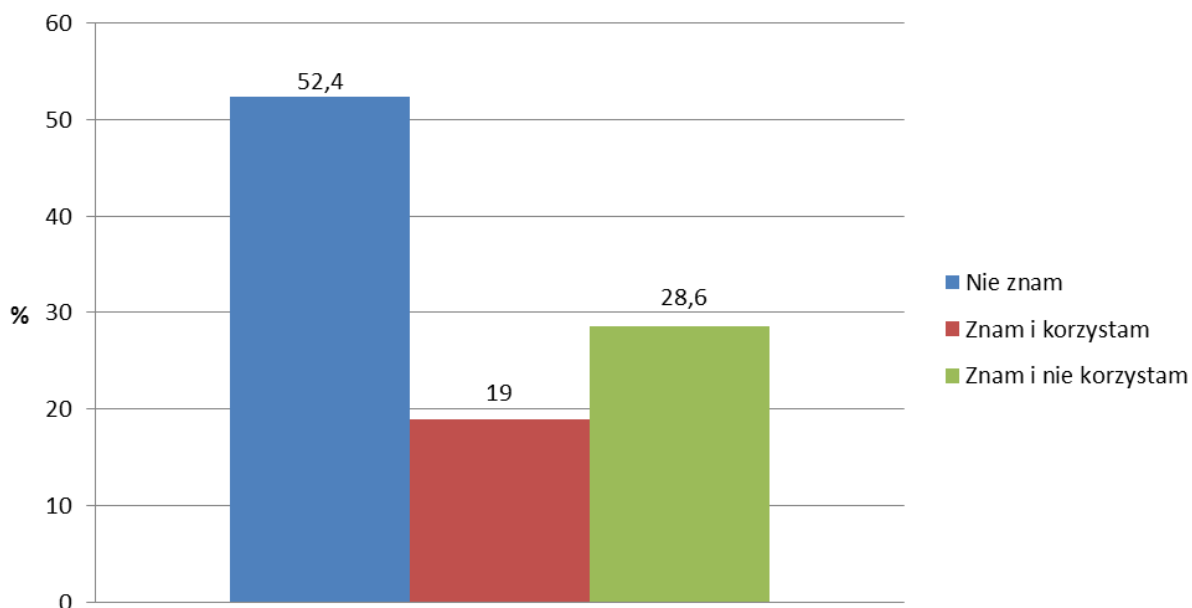
Procent przedsiębiorców, którzy uważają, że wykorzystanie nisz wymaga nakładów finansowych



Czy potrafi Pan(i) wskazać instytucje badawczo rozwojowe branży surowce naturalne i wtórne?



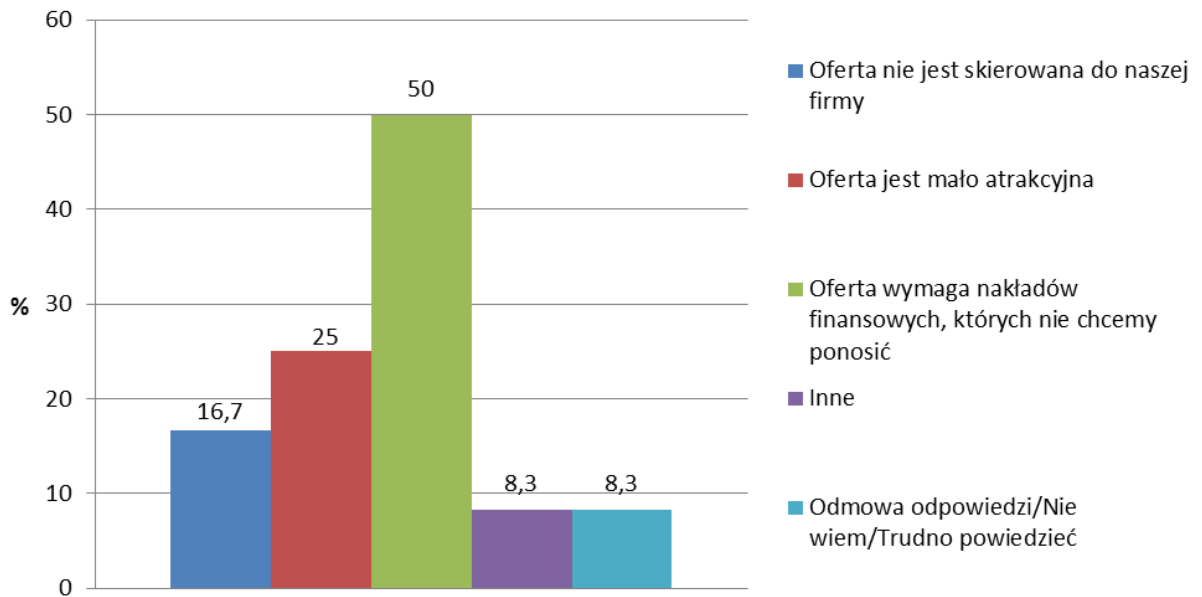
Czy zna Pan(i) ofertę tych instytucji szczególnie w kontekście wspierania rozwoju innowacyjnych rozwiązań i wsparcia jakie Państwa firma może uzyskać?



Procent przedsiębiorców, którzy potrafią wskazać instytucje badawczo-rozwojowe branży

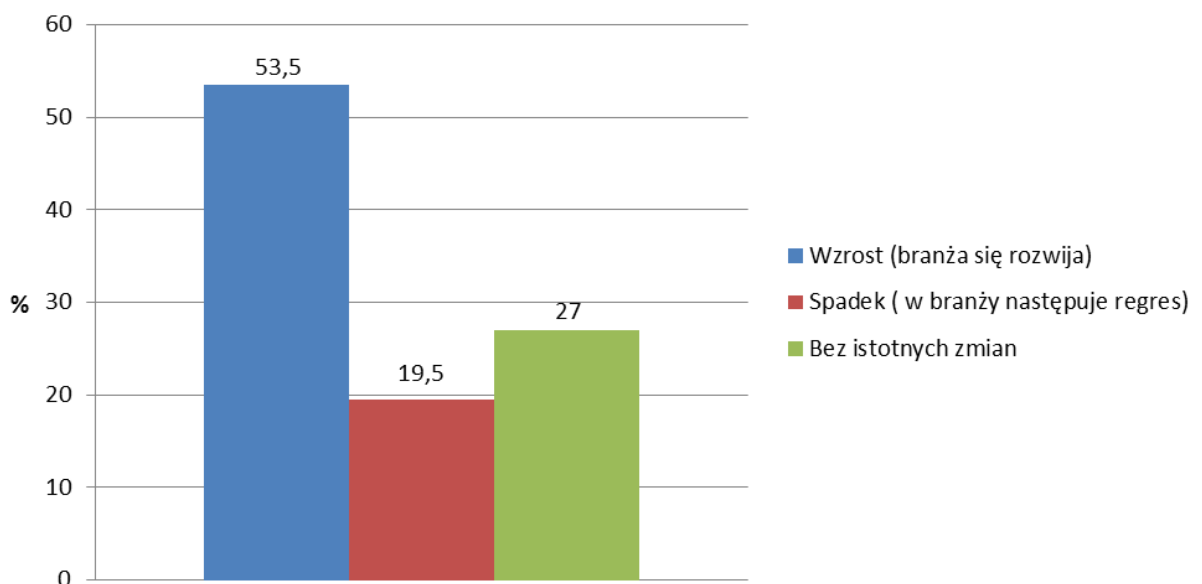


Proszę podać 3 główne powody niekorzystania ze wsparcia:



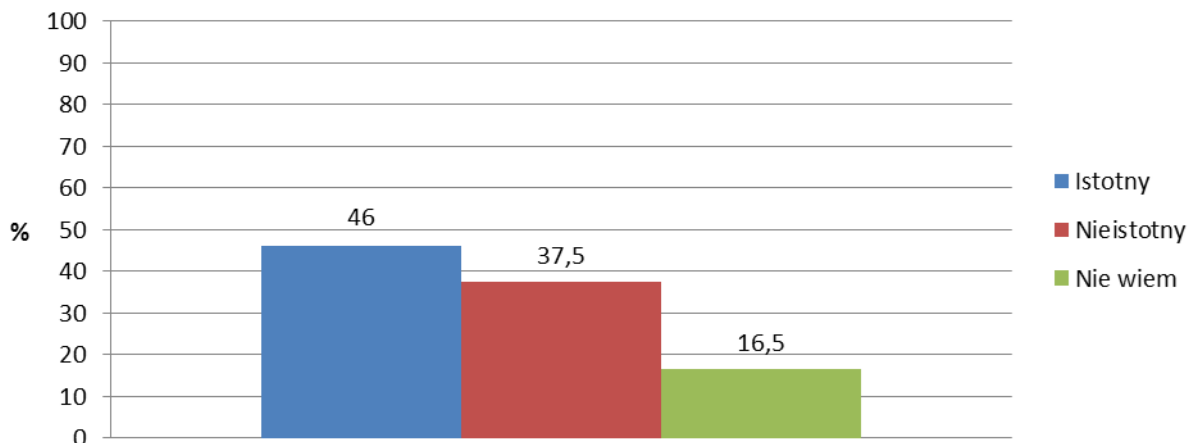
Procent przedsiębiorców, którzy nie korzystają ze wsparcia instytucji badawczo-rozwojowych

Jak mogą Państwo określić na podstawie swojego doświadczenia obecną tendencję rozwojową w Państwa branży biorąc pod uwagę okres od 2000 roku lub od roku rozpoczęcia działalności?





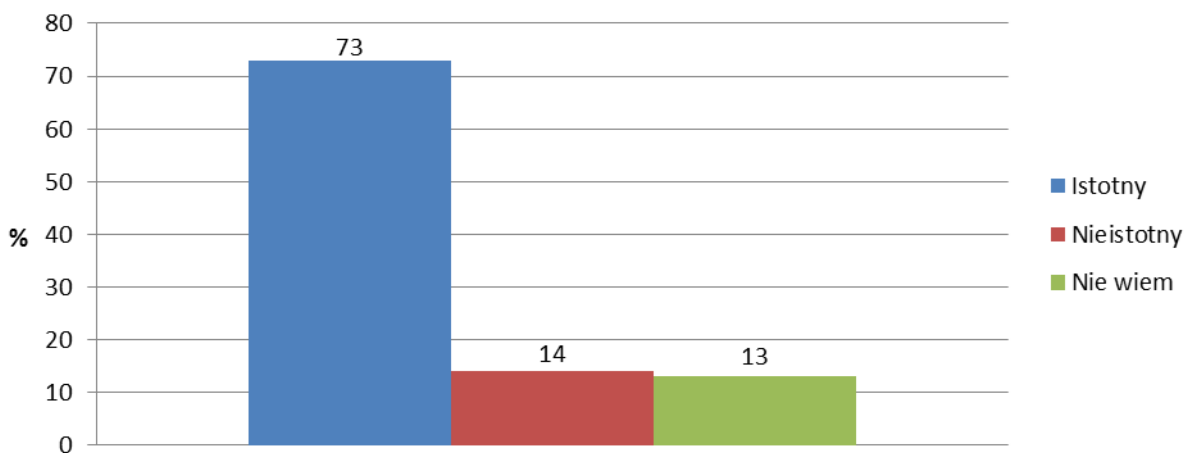
Jaki wpływ na rozwój Państwa firmy mają działania podejmowane przez administrację publiczną?



Jeśli istotny to są szansą czy barierą?



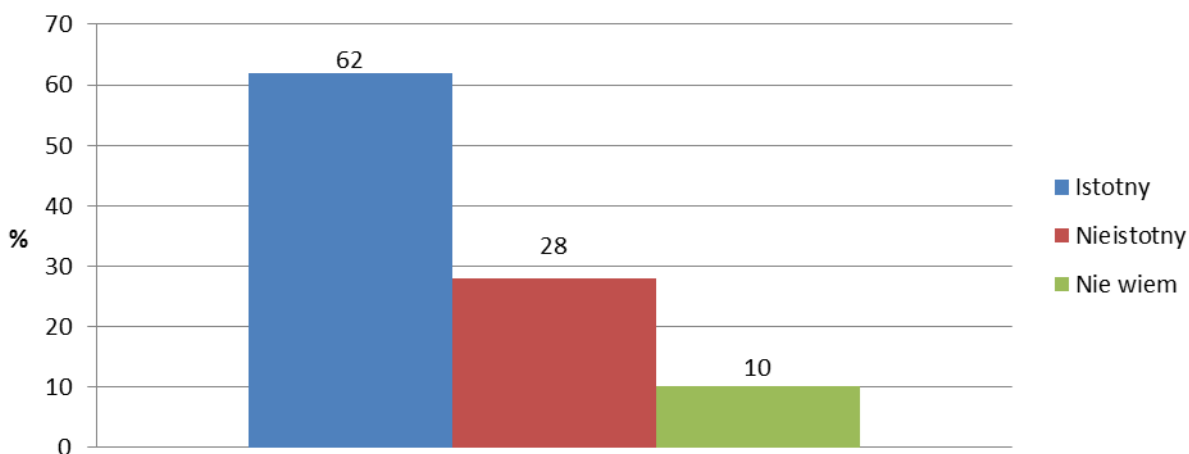
Jaki wpływ na rozwój Państwa firmy ma dostępność do krajowych i unijnych funduszy wspierających działalność?



Jeśli istotny to są szansą czy barierą?



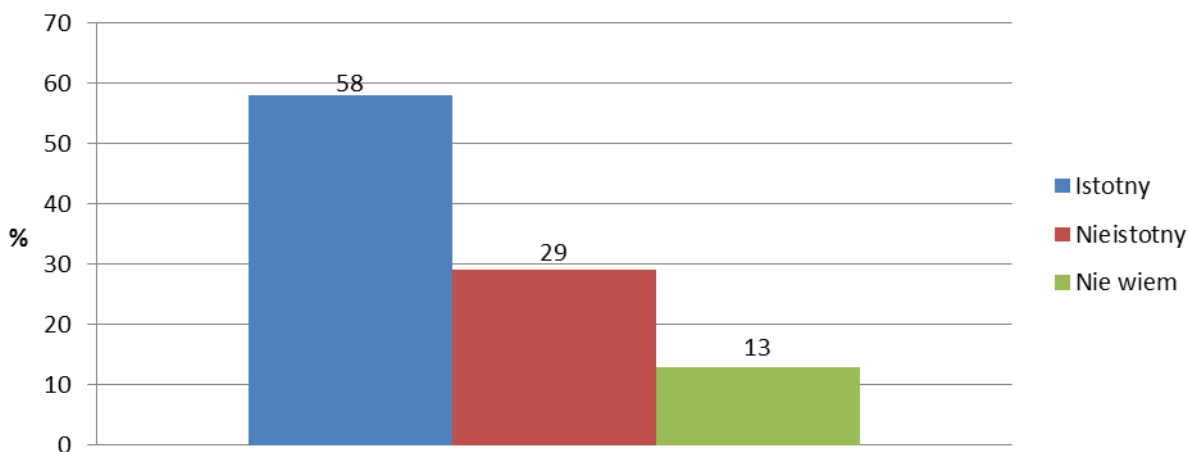
Jaki wpływ na rozwój Państwa firmy ma dostępność instrumentów finansowych (np. pożyczki bankowe)?



Jeśli istotny to są szansą czy barierą?



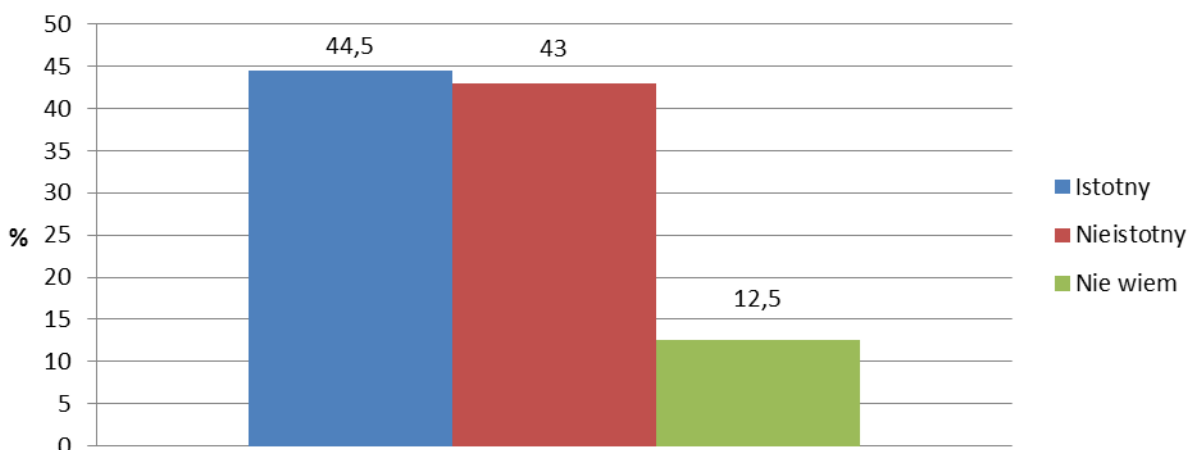
Jaki wpływ na rozwój Państwa firmy mają wymogi prawne w zakresie prowadzenia działalności?



Jeśli istotny to są szansą czy barierą?



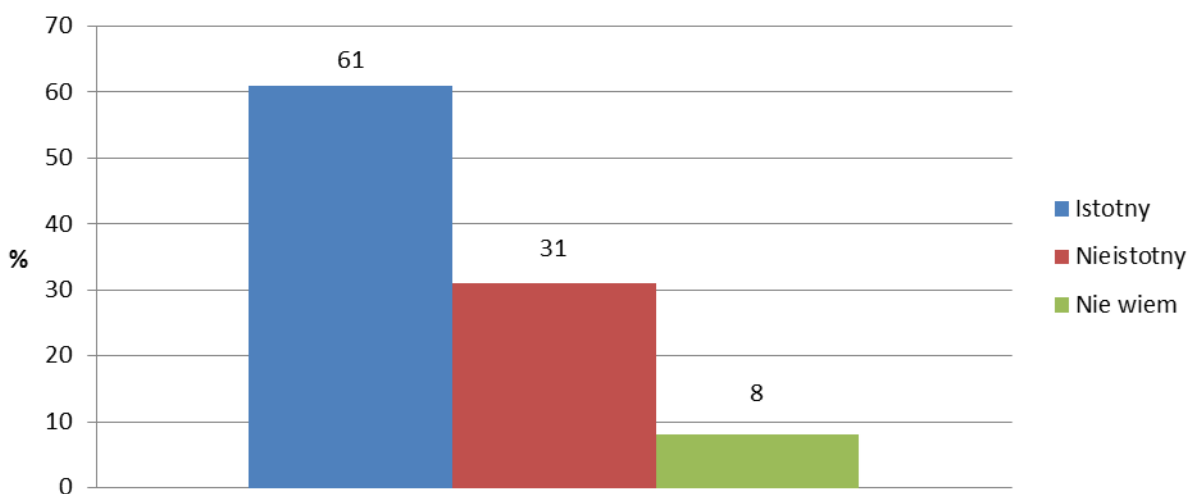
Jaki wpływ na rozwój Państwa firmy mają uwarunkowania naturalne (oddziaływanie na ludzi, na środowisko, na przyrodę)?



Jeśli istotny to są szansą czy barierą?



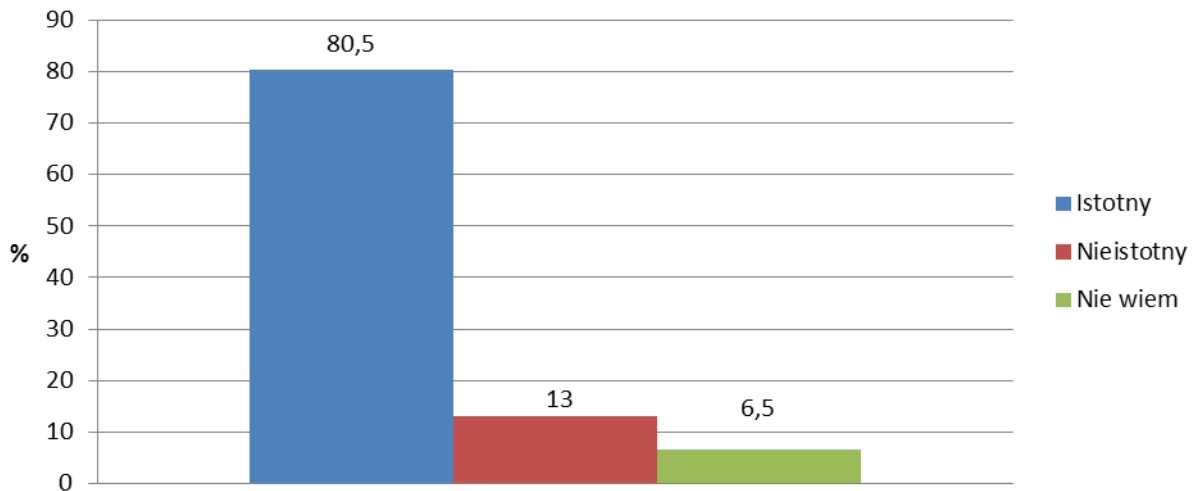
Jaki wpływ na rozwój Państwa firmy ma dostępność złóż?



Jeśli istotny to są szansą czy barierą?



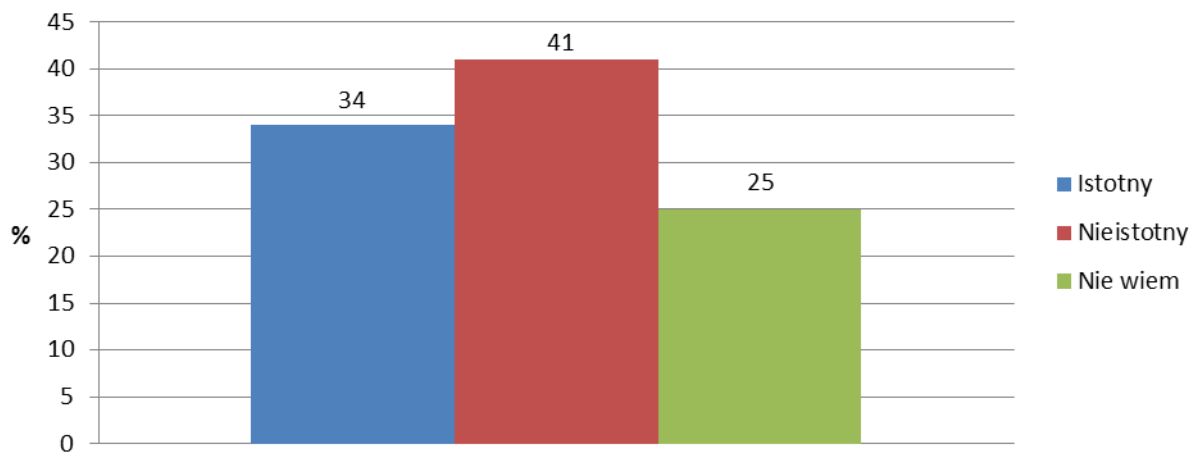
Jaki wpływ na rozwój Państwa firmy mają koszty pracy?



Jeśli istotny to są szansą czy barierą?

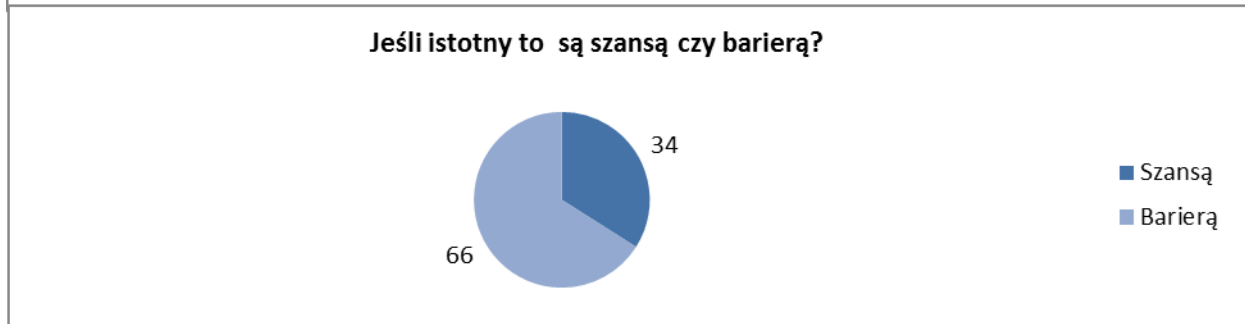
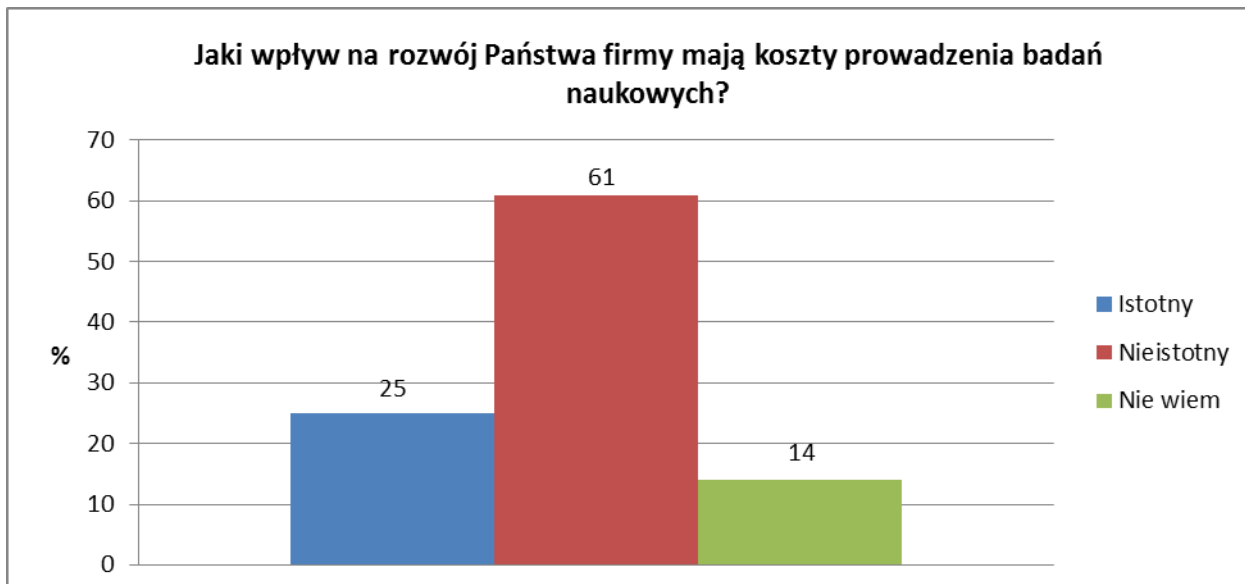
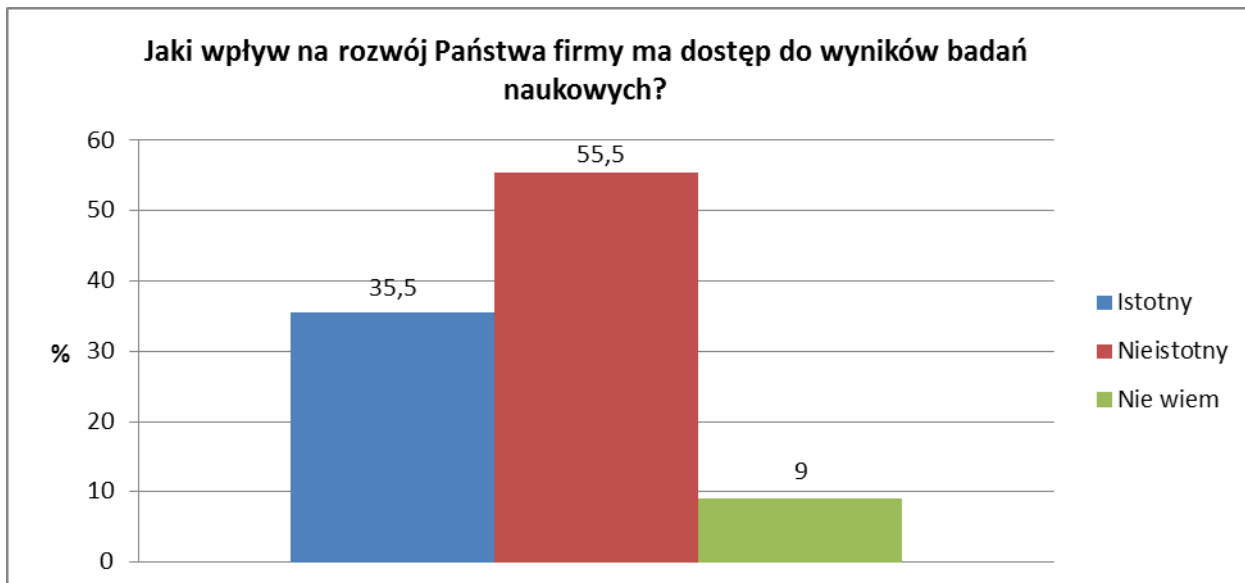


Jaki wpływ na rozwój Państwa firmy ma funkcjonowanie instytucji otoczenia biznesu?

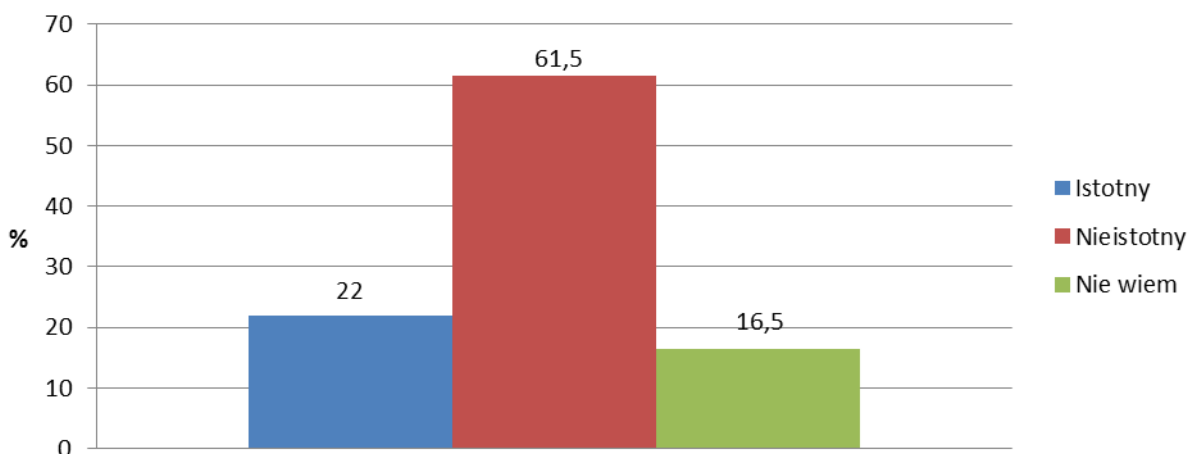


Jeśli istotny to są szansą czy barierą?





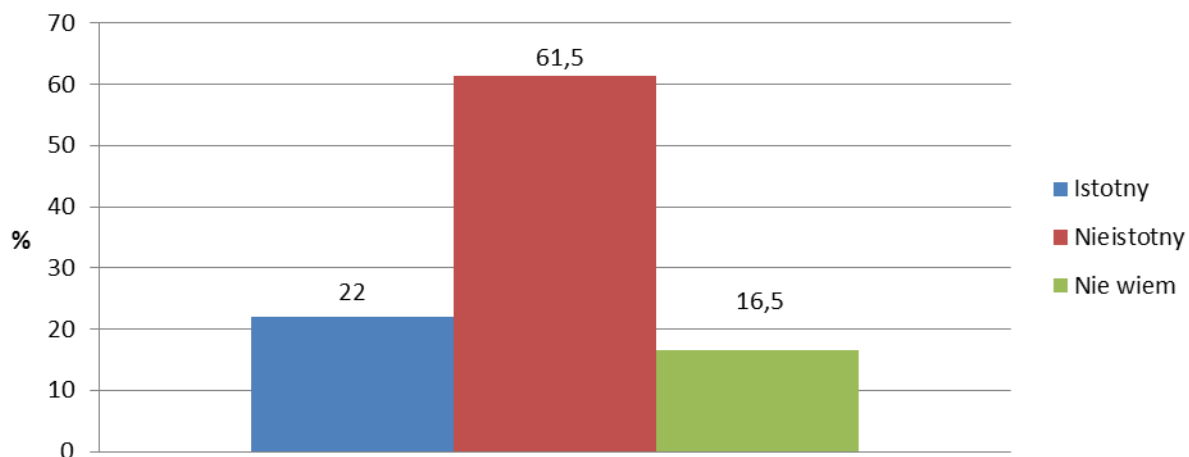
Jaki wpływ na rozwój Państwa firmy mają koszty komercjalizacji wyników badań naukowych?



Jeśli istotny to są szansą czy barierą?



Jaki wpływ na rozwój Państwa firmy ma potencjalna skala popytu na innowacyjne procesy, produkty lub usługi?

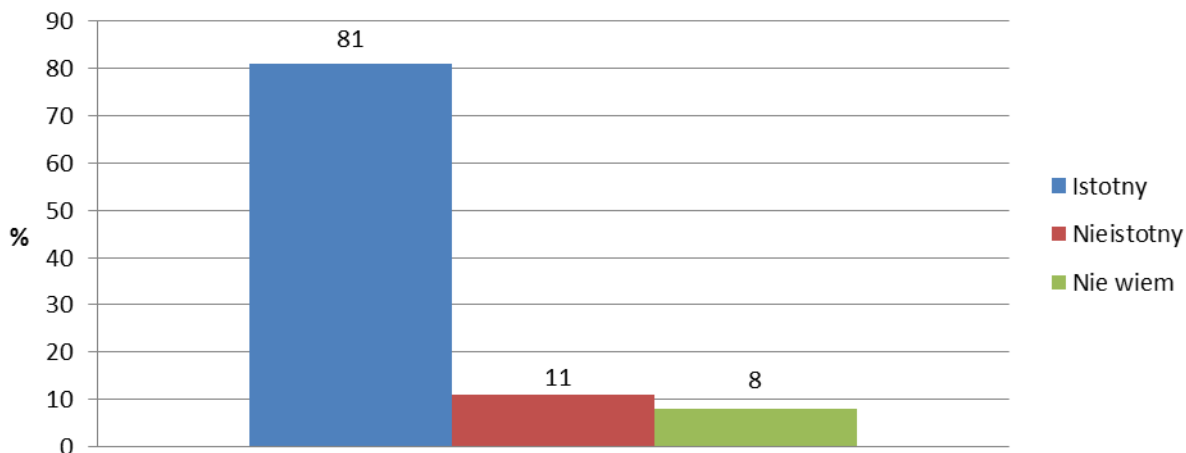


Jeśli istotny to są szansą czy barierą?





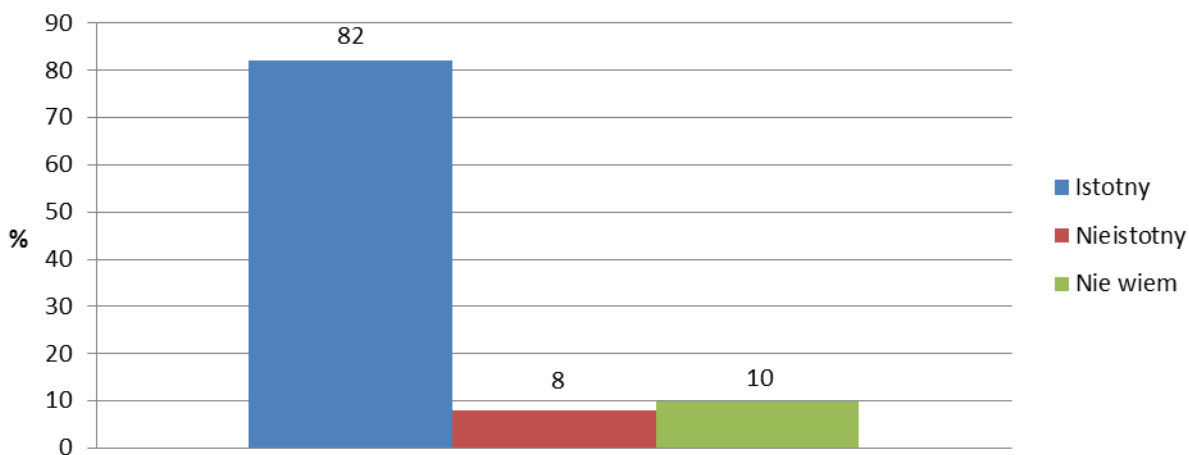
Jaki wpływ na rozwój Państwa firmy mają koszty prowadzenia działalności w Państwa branży?



Jeśli istotny to są szansą czy barierą?



Jaki wpływ na rozwój Państwa firmy ma aktualna kondycja finansowa firmy?



Jeśli istotny to są szansą czy barierą?



ZAŁĄCZNIK 2. PKD WYBRANYCH PODBRANŹ WYTYPOWANYCH DO BADANIA CATI

Na potrzeby badań i analizy danych DIS surowce naturalne i wtórne podzielono na 5 podbranż:

1. Przedsiębiorstwa wydobywcze, typowane po PKD od 05.10.Z do 09.90.Z, obejmujące: górnictwo, wydobywanie, działalność usługową dla wydobywania,

2. Przedsiębiorstwa wytwórcze i przetwórcze surowców mineralnych, o kryterium wyboru PKD: 11.07.Z, od 19.10.Z do 19.20.Z oraz od 23.11.Z do 24.54.B, do których zaliczają się m. in. Producenci napojów bezalkoholowych produkcja wód mineralnych i pozostałych wód butelkowanych, działalność szpitali (w tym sanatoriów, uzdrowisk),

3. Przedsiębiorstwa wytwórcze i przetwórcze materiałów zaawansowanych, wyróżnione na podstawie deklaracji zawartych w odpowiedziach badania CATI, których zbiór mieści się w zbiorze 2 podbranży przedsiębiorstw wytwórczych i przetwórczych oraz 3 podbranży przeróbki drewna,

4. Przedsiębiorstwa przeróbki drewna, reprezentowanych przez podmioty z grupy PKD od 16.10.Z do 16.29.Z oraz od 31.01.Z do 31.09.Z, z wyłączeniem 31.03.Z, do których należą przedsiębiorcy produkujący meble, opakowania drewniane, arkusze fornirowe, płyty wiórowe i pozostałe wyroby stolarskie,

5. Przedsiębiorstwa zajmujące się odzyskiem odpadów oraz rekultywacją, do których zaliczono te z PKD: 38.21.Z, 38.22.Z, 38.32.Z, PKD 39.00.Z, np. zajmujące się obróbką i usuwaniem odpadów innych niż niebezpieczne, odzyskiem surowców z materiałów segregowanych, unieszkodliwianiem odpadów niebezpiecznych czy rekultywacją i innymi usługami z dziedziny gospodarki odpadami.

Poniżej zestawienie szczegółowe 62 PKD wziętych pod uwagę. Oprócz pełnego kodu PKD podana jest ilość firm posiadających dane PKD i krótki opis, czego dotyczy zakres działalności.

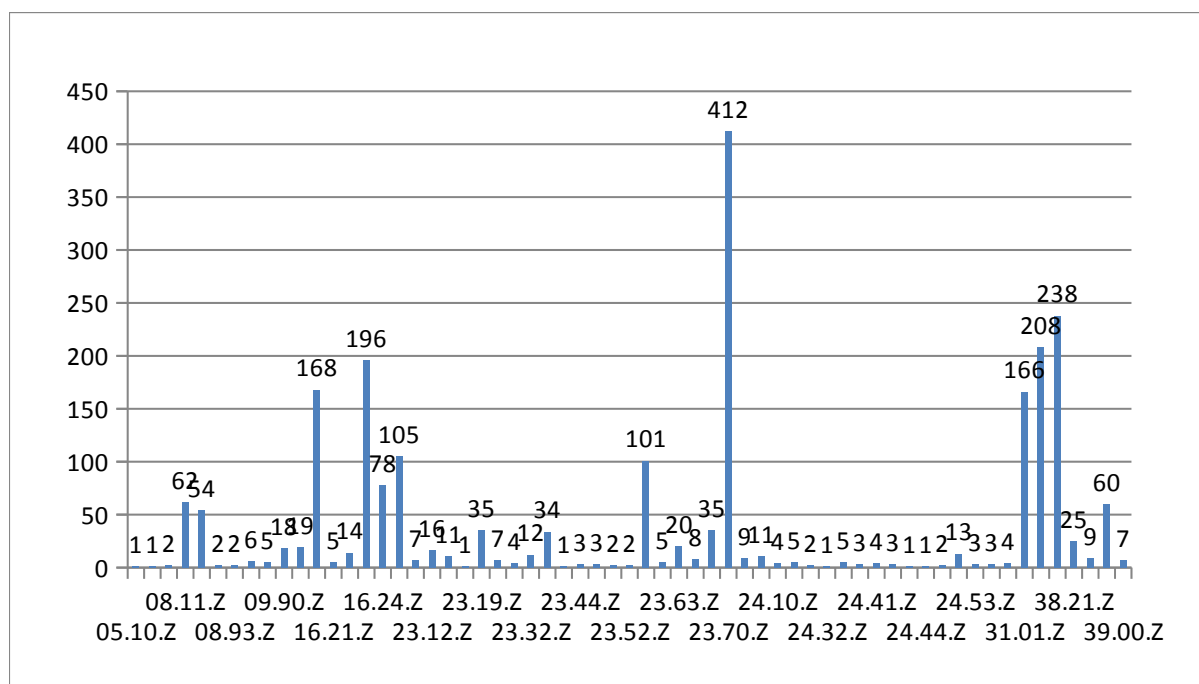
Tabela: Zestawienie PKD przedsiębiorców DIS surowce naturalne i wtórne

KOD PKD	Ilość	Nazwa
05.10.Z	1	Wydobywanie węgla kamiennego
07.10.Z	1	Górnictwo rud żelaza
07.29.Z	2	Górnictwo pozostałych rud metali nieżelaznych
08.11.Z	62	Wydobywanie kamieni ozdobnych oraz kamienia dla potrzeb budownictwa, skał wapiennych, gipsu, kredy i łupków
08.12.Z	54	Wydobywanie żwiru i piasku; wydobywanie gliny i kaolinu
08.91.Z	2	Wydobywanie minerałów dla przemysłu chemicznego oraz do produkcji nawozów.
08.93.Z	2	Wydobywanie soli.
08.99.Z	6	Pozostałe górnictwo i wydobywanie, gdzie indziej niesklasyfikowane
09.10.Z	5	Działalność usługowa wspomagająca eksploatację złóż ropy naftowej i gazu ziemnego.
09.90.Z	18	Działalność usługowa wspomagająca pozostałe górnictwo i wydobywanie
11.07.Z	19	Produkcja napojów bezalkoholowych; produkcja wód mineralnych i pozostałych wód

KOD PKD	Ilość	Nazwa
		butelkowanych.
16.10.Z	168	Produkcja wyrobów tartacznych
16.21.Z	5	Produkcja arkuszy forniowych i płyt wykonanych na bazie drewna.
16.22.Z	14	Produkcja gotowych parkietów podłogowych.
16.23.Z	196	Produkcja pozostałych wyrobów stolarskich i ciesielskich dla budownictwa
16.24.Z	78	Produkcja opakowań drewnianych.
16.29.Z	105	Produkcja pozostałych wyrobów z drewna; produkcja wyrobów z korka, słomy i materiałów używanych do wyplatania
23.11.Z	7	Produkcja szkła płaskiego.
23.12.Z	16	Kształtowanie i obróbka szkła płaskiego.
23.13.Z	11	Produkcja szkła gospodarczego
23.14.Z	1	Produkcja włókien szklanych
23.19.Z	35	Produkcja i obróbka pozostałego szkła, włączając szkło techniczne
23.20.Z	7	Produkcja wyrobów ogniotrwałych
23.31.Z	4	Produkcja ceramicznych kafli i płytek
23.32.Z	12	Produkcja cegieł, dachówek i materiałów budowlanych, z wypalanej gliny
23.41.Z	34	Produkcja ceramicznych wyrobów stołowych i ozdobnych
23.43.Z	1	Produkcja ceramicznych izolatorów i osłon izolacyjnych
23.44.Z	3	produkcję magnezów ceramicznych i ferrytowych,; produkcję ceramiki laboratoryjnej, chemicznej
23.49.Z	3	Produkcja pozostałych wyrobów ceramicznych
23.51.Z	2	Produkcja klinkieru cementowego i cementów hydraulicznych, włączając cement portlandzki, cement glinowy, cement żuźlowy
23.52.Z	2	Produkcja wapna i gipsu
23.61.Z	101	Produkcja wyrobów budowlanych z betonu
23.62.Z	5	Produkcja wyrobów budowlanych z gipsu
23.63.Z	20	Produkcja masy betonowej prefabrykowanej
23.64.Z	8	Produkcja zaprawy murarskiej
23.69.Z	35	Produkcja pozostałych wyrobów z betonu, gipsu i cementu
23.70.Z	412	Cięcie, formowanie i wykańczanie kamienia
23.91.Z	9	Produkcja wyrobów ściennych
23.99.Z	11	Produkcja pozostałych wyrobów z mineralnych surowców niemetalicznych, gdzie indziej niesklasyfikowana
24.10.Z	4	Produkcja surówki, żelazostopów, żeliwa i stali oraz wyrobów hutniczych
24.20.Z	5	Produkcja rur, przewodów, kształtowników zamkniętych i łączników, ze stali
24.31.Z	2	Produkcja prętów ciągnionych na zimno
24.32.Z	1	Produkcja wyrobów płaskich walcowanych na zimno
24.33.Z	5	produkcję otwartych kształtowników stalowych poprzez kształtowanie stopniowe w walcowniach lub przy pomocy prasy
24.34.Z	3	Produkcja drutu
24.41.Z	4	Produkcja metali szlachetnych
24.42.B	3	Produkcja wyrobów z aluminium i stopów aluminium
24.43.Z	1	produkcję ołowiu, cynku, cyny z rud,; produkcję ołowiu, cynku, cyny w procesie rafinacji elektrolitycznej odpadów lub złomu



KOD PKD	Ilość	Nazwa
24.44.Z	1	produkcję miedzi z rud
24.45.Z	2	Produkcja pozostałych metali nieżelaznych.
24.51.Z	13	Odlewnictwo żeliwa
24.53.Z	3	Odlewnictwo metali lekkich
24.54.A	3	Odlewnictwo miedzi i stopów miedzi
24.54.B	4	Odlewnictwo pozostałych metali nieżelaznych, gdzie indziej niesklasyfikowane
31.01.Z	166	Produkcja mebli biurowych i sklepowych
31.02.Z	208	Produkcja mebli kuchennych
31.09.Z	238	Produkcja pozostałych mebli
38.21.Z	25	Obróbka i usuwanie odpadów innych niż niebezpieczne
38.22.Z	9	Przetwarzanie i unieszkodliwianie odpadów niebezpiecznych
38.32.Z	60	Odzysk surowców z materiałów segregowanych
39.00.Z	7	Działalność związana z rekultywacją i pozostała działalność usługowa związana z gospodarką odpadami



Wykres: Ilość przedsiębiorców z danym PKD DIS surowce naturalne i wtórne

ZAŁĄCZNIK 3. WSKAZANIE UWZGLĘDNIENIA W TEKŚCIE ROZWIĘCIA POSZCZEGÓLNYCH PROBLEMÓW BADAWCZYCH

KOD	PROBLEM BADAWCZY	MIEJSCE UWZGLĘDNIENIA W TEKŚCIE
1.1.	Główne determinanty rozwoju gospodarczego Dolnego Śląska oraz charakterystyka branży inteligentnej specjalizacji- surowce naturalne i wtórne (m.in. wartość eksportu ogółem na 1 zatrudnionego PLN, Udział przychodów ze sprzedaży produktów innowacyjnych na eksport w przychodach ogółem przedsiębiorstw przemysłowych, wartość dodana brutto na 1 pracującego (w tys. PLN), średni udział przedsiębiorstw innowacyjnych w ogólnej liczbie przedsiębiorstw, udział przychodów ze sprzedaży produktów innowacyjnych dla rynku w przychodach ogółem przedsiębiorstw przemysłowych, wartość nakładów wewnętrznych na B+R jako % PKB, udział nakładów na B+R finansowanych z sektora przedsiębiorstw w nakładach na działalność B+R ogółem, udział zatrudnionych w działalności B+R w ludności aktywnej zawodowo, udzielone patenty na wynalazki krajowe na 1 mln mieszkańców, odsetek przedsiębiorstw współpracujących w zakresie działalności innowacyjnej w ogóle przedsiębiorstw aktywnych innowacyjnie, wielkość, koncentracja przedsiębiorstw z branży surowce naturalne i wtórne (również wg współczynnika lokalizacji), potencjał naukowy (współczynnik lokalizacji dla udzielonych patentów), liczba i jakość funkcjonujących klastrów w obszarze specjalizacji);	3.2 Potencjał gospodarczy 3.2.1 Liczba i rozmieszczenie firm oraz stan zatrudnienia 3.2.2 Potencjał innowacyjny województwa 4.2. Klastry
1.2.	(1.2) The history of the Lower Silesia industry against the background of the history of industry development in Poland and Europe (2000-2016);	3. Charakterystyka branży 3.1. Podbranże DIS surowce naturalne i wtórne na tle Polski, Europy i Świata
1.3.	Ocena stanu rozwoju podmiotów dolnośląskiej inteligentnej specjalizacji, branży surowców naturalnych i wtórnych na tle Polski i Unii Europejskiej w wymiarze światowym	3. Charakterystyka branży 3.1. Podbranże DIS surowce naturalne i wtórne na tle Polski, Europy i Świata
1.4.	Ocena poziomu innowacyjności przedsiębiorstw reprezentujących branżę „surowce naturalne i wtórne”, w tym określenie	5. Potencjał innowacyjny w branży
1.4.	1.4.1 Rodzajów innowacji w przedsiębiorstwach w ciągu ostatnich 10 lat oraz ich zasięg;	5.1. Rodzaje innowacyjności i ich zasięg
1.4.	1.4.2 Wydatki przedsiębiorstw na badania i rozwój	5.2. Wydatki przedsiębiorstw na badania i rozwój
1.4.	1.4.3 Wielkość i charakterystyka zatrudnienia w tym zatrudnienie wysokiej klasy specjalistów (również wg współczynnika lokalizacji)	5.3. Potencjał pracowniczy oraz 3.2.2 Potencjał innowacyjny województwa
1.4.	1.4.4 Internacjonalizacja przedsiębiorstw branży „surowce naturalne i wtórne” w tym wielkość, dynamika i koncentracja eksportu (również wg współczynnika lokalizacji)	3.1. Podbranże DIS surowce naturalne i wtórne na tle Polski, Europy i Świata 3.2.3 Eksport towarów i usług

KOD		PROBLEM BADAWCZY	MIEJSCE UWZGLĘDNIENIA W TEKŚCIE
I.4.	I.4.5	Aktywność w zakresie ochrony własności intelektualnej, ilość patentów i znaków towarowych (zgłoszonych, zarejestrowanych)	3.2.2 Potencjał innowacyjny województwa 5.4. Patenty i znaki towarowe
I.4.	I.4.6	Zakres i metody finansowania innowacji przez przedsiębiorców	5.5. Finansowanie innowacji przez przedsiębiorców
I.4.	I.4.7	Plany przedsiębiorstw w zakresie rozwoju innowacyjnych produktów i usług	5.6 Plany w zakresie rozwoju innowacyjnych produktów i usług
I.4.	I.4.8	Analiza czynników mikro- i makro-otoczenia	6.2 Identyfikacja czynników mikro i makro otoczenia na podstawie badań CATI
I.5.		Analiza kluczowych czynników powodzenia innowacyjnego rozwoju branży w regionie	6.4. Analiza SWOT
I.6.		Analiza pozycji konkurencyjnej branży względem Polski i regionów Unii Europejskiej	3.1.6 Analiza konkurencyjności względem pozostałej części Polski i Unii Europejskiej
I.7.		Analiza atrakcyjności rozwoju branży dla Dolnego Śląska	6.1 Ocena wpływu uwarunkowań przestrzennych na rozwój podmiotów działających w branży surowce naturalne 3.2.4 Analiza prognoz i trendów rozwojowych w podobszarach specjalizacji surowce naturalne i wtórne
I.8.		Analiza instytucji badawczo rozwojowych branży „surowce naturalne i wtórne” (wielkość i stan jednostek badawczo-rozwojowych działających w badanym obszarze na Dolnym Śląsku, zasoby kadrowe, osiągnięcia i pozycja naukowa, oferta dla przedsiębiorstw branży, osiągnięcia związane z transferem wiedzy i technologii do przedsiębiorstw branży, współpraca między przedsiębiorstwami z branży a jednostkami badawczo - rozwojowymi, wskazanie nowych obszarów współpracy przedsiębiorców z sektorem B+R);	4.1 Jednostki naukowo badawcze działające w branży surowce naturalne i wtórne 3.3 Identyfikacja nisz rozwojowych w podobszarach specjalizacji
I.9.		Analiza kluczowych czynników i barier rozwoju branży	6.3. Wzajemne powiązanie czynników – krzyżowa analiza wpływów 5.6 Plany w zakresie rozwoju innowacyjnych produktów i usług
I.10.		Analiza skuteczności interwencji publicznej w obszarach inteligentnych specjalizacji (na podstawie m.in.: odsetka przedsiębiorstw, które zwiększyły wartość eksportu w wyniku zrealizowanej interwencji, odsetka wspartych przedsiębiorstw, które po raz pierwszy wykazały nakłady na działalność B+R w wyniku zrealizowanej interwencji, odsetka przedsiębiorstw, które	4.3 Analiza skuteczności interwencji publicznej

KOD	PROBLEM BADAWCZY	MIEJSCE UWZGLĘDNIENIA W TEKŚCIE
	złożyły zgłoszenie patentowe w wyniku zrealizowanej interwencji, liczby patentów zgłoszonych ogółem w wyniku interwencji, liczby wspartych klastrów, inicjatyw klastrowych i powiązań kooperacyjnych, liczby aplikacji do programów krajowych (w kategoriach: innowacyjność, B+R, internacjonalizacja, klastry), liczba przedsiębiorstw objętych wsparciem w zakresie prowadzenia prac B+R, liczba przedsiębiorstw wspartych w zakresie internacjonalizacji działalności, liczba przedsiębiorstw wspartych w zakresie wdrożenia wyników prac B+R).	
I.11.	Wskazanie możliwych do zastosowania schematów wsparcia podmiotów	4.3.3 Wskazanie możliwych do zastosowania schematów wsparcia
I.12.	Identyfikacja istotnych problemów branży w świetle wpływu na stan jej dzisiejszego stopnia rozwoju i konkurencyjności	6.4. Analiza SWOT 6.4.4 Zagrozenia
I.13.	Ocena wpływu uwarunkowań przestrzennych na rozwój podmiotów działających w branży surowce naturalne	6.1. Ocena wpływu uwarunkowań przestrzennych na rozwój podmiotów działających w branży surowce naturalne i wtórne
I. Trendy i nisze rozwojowe dolnośląskiej Inteligentnej specjalizacji surowce naturalne i wtórne.		
II.1.	Analiza prognoz i trendów rozwojowych w podobszarach specjalizacji surowce naturalne i wtórne w Polsce i Europie	3.2.4 Analiza prognoz i trendów rozwojowych w podobszarach specjalizacji surowce naturalne i wtórne 6.4. Analiza SWOT
II.2.	Analiza korelacji między kierunkami rozwoju branży na Dolnym Śląsku a Polską i Europą	3.2.4 Analiza prognoz i trendów rozwojowych w podobszarach specjalizacji surowce naturalne i wtórne
II.3.	Analiza czynników (szans), które będą sprzyjały rozwojowi innowacji w przedsiębiorstwach	6.4. Analiza SWOT 6.4.3 Szanse
II.4.	Analiza czynników (zagrożeń), które będą stanowiły bariery rozwoju innowacyjności branży	6.4. Analiza SWOT 6.4.4 Zagrozenia
II.5.	Identyfikacja nisz rozwojowych w podobszarach specjalizacji	3.3. Identyfikacja nisz rozwojowych w podobszarach specjalizacji
II.6.	Korelacja pomiędzy zjawiskiem eksploatacji surowców naturalnych, a powstawaniem odpadów eksploatacyjnych	3.1.2 Podbranża odzysku i rekultywacji

ZAŁĄCZNIK NR 4 – MACIERZ KRZYŻOWEJ ANALIZY WPŁYWÓW

Możliwość uzyskania wsparcia publicznego w zakresie inwestycji (w badania i rozwój oraz w nowe technologie)						
Dostęp do wykwalifikowanych kadr (zawodowe i wysokospecjalistyczne)						
Ryzyko związane z wdrażaniem rozwiązań innowacyjnych						
Dostęp do wiedzy w zakresie możliwych do wykorzystania rozwiązań innowacyjnych						
Sposób funkcjonowanie IOB (klastrów, parków technologicznych, fundacji, stowarzyszeń etc....)						
Możliwość prowadzenie badań naukowo-wdrożeniowych - dostęp i sprawność instytucji mogących świadczyć Badania na rzecz Rozwoju Innowacji						
Uwarunkowania zewnętrzne (dostęp do infrastruktury)						
Uwarunkowania naturalne (dostęp do zasobów, kwestie społeczne, ochrona środowiska)						
Trudności w pozyskaniu i rozliczaniu wsparcia publicznego						
CZYNNIKI WPŁYWAJĄCE NA ROZWÓJ INNOWACJI W FIRMACH	Koniunktura na rynku (np. rozwój budownictwa, rozwój wykorzystania pierwiastków ziem rzadkich)	Możliwość uzyskania wsparcia publicznego w zakresie inwestycji (w badania i rozwój oraz w nowe technologie)	Dostęp do wykwalifikowanych kadr (zawodowe i wysokospecjalistyczne)	Ryzyko związane z wdrażaniem rozwiązań innowacyjnych	Dostęp do wiedzy w zakresie możliwych do wykorzystania rozwiązań innowacyjnych	Sposób funkcjonowanie (klastrów, parków technologicznych, fundacji, stowarzyszeń etc....)